

EFFECT OF POLYA'S PROBLEM-SOLVING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN ALGEBRAIC WORD PROBLEM IN KATSINA METROPOLIS, KATSINA STATE, NIGERIA

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Abstract

This study investigated the effect of polya's problem-solving strategy on senior secondary school students' performance in Algebraic word problem. It is a quasi-experimental design of non-equivalent control. Two (2) research hypotheses were posed and tested in the study. Four (4) schools were purposively sampled with 168 SS 1 students out of 3850 SS1 Students within Katsina Metropolis. The experimental group was exposed to Polya's Problem solving strategy (PPSS) while the control group was exposed to traditional method. Problem solving performance test (PSPT,) was adapted from past WAEC Question papers by the researcher with reliability co-efficient of 0.73 using test-retest method. The data were analyzed using mean, standard deviation and analysis of Covariance (ANCOVA) at 0.05 level of significance. The null hypotheses I was rejected since $P_{value} = 0.000$ and null hypothesis 2 was accepted since $P_{value} = 0.126$. it was concluded that students' exposed to problem solving strategy performed better than those exposed to traditional method and the performance of boys and girls taught using problem solving method had a very slight difference in favor of boys. It was recommended amongst others that teacher's adopt problem solving teaching method in teaching mathematics mostly algebraic-word problems.

Keywords: Mathematics, Secondary Education, Problem-solving strategy, Algebraic-word problem, performance.

Introduction

Mathematics, apart from being a core subject in the school curriculum has become a requirement for most disciplines in higher institutions of learning and compulsory for most students in social and applied sciences (FRN, 2013). Nigeria is a rapidly developing nation, as such; it may not be possible for her states to provide the classroom mathematics teachers with 'all the ready-made teaching materials'. In spite of this situation, it is incumbent upon all categories of mathematics teachers to make use of local resources with their professional ingenuity, so that the subject can be taught for comprehension, assimilation and performance in a meaningful way (Sule & Derya, 2012).

It has been discovered that student's performance in mathematics especially in, the algebraic word problems at the National Examinations (WAEC, 2014 & NECO, 2015) has remained below average. Several factors have been cited as general causes of the poor performance in mathematics. These include ineffective teaching methods (Adeniran, 2012), unavailability of teaching materials, it's specialized language and symbolism used in the subject (Effiom, 2015). The commonly used teaching and learning approaches in mathematics in Nigerian Secondary Schools and other parts of the world is teacher centered which is ineffective. In this study, problem solving-strategy will be used in a mathematics classroom setting to teach Algebraic word problem and its effect on learners' Performance in word problems will be analyzed. Many scholars have outlined the sequence of problem solving technique and one of them is Polya George, a Professor of Mathematics. Polya cited in Harbor-Peters (2012) in his problem solving model identified four steps thus;

1. Understanding the problem
2. Devising a plan to solve the problem
3. Carrying out the plan and
4. Looking back

Poor teaching and learning methods especially the conventional chalk talk method or rote memorization and lack of knowledge of mathematics concepts have been pointed out by researchers (Adeniran, 2012; Adenola, 2012; & Effiom, 2010) as two major contributing factors to process errors students commit in solving mathematics problems that lead to poor performance in mathematics examinations. According to these researchers, problem solving strategies are lacking in the teaching and learning of mathematics in Nigerian secondary schools. These researchers suggested that problem solving should be used in teaching and learning of mathematics for better explanation, demonstration, understanding and retention. Problem solving involves different strategies of teaching mathematics that helps the teacher to create conducive environment and free atmosphere for teaching and learning.

Strategies of teaching can be defined as the ways and means of getting a solution to a problem. Suleiman (2010) defined strategies as sequences of moves frequently used in the teaching of concepts. The moves can be verbal or non-verbal behaviors of a teacher toward attaining some objectives. According to him, the moves are classification, identification, differentiation and exemplification. Maduabum (2006) defined strategies, as approaches of averting in the teaching of school mathematics.

There are many strategies developed for teaching and learning but only eight of them are fit for teaching and learning of mathematic. One of such strategy is Polya's Problem Solving Strategy. Researchers like (Alio (2012), & Effiom, 2015) effectively and successfully used Polya's Problem Solving (PPSS) in carrying out researches in teaching and learning of some mathematics concepts. Hence, PPSS has been identified as one of the strategies for effective teaching and learning of problem solving in mathematics. PPSS has been used to demonstrate effective teaching and learning of algebraic-word problem with a view to re-emphasizing that role memorization and conventional 'chalk talk method of teaching and learning is not the appropriate method for the teaching of Algebraic-word problem,

The PPSS steps imply that one must first understand the problem, determine the list of characters in a problem and which of them need to be solved first. The list of the characters

should be used in the second step to formulate how to solve the problems. The problem is solved in the third step and verified in the fourth step. Word problems in algebra expressions may not be very easy to teach however, the difficulties encountered in teaching them according to Alio (2012) would be reduced if:

- i. The terms involved in the concepts (word problems and algebraic expressions) are properly explained and demonstrated with examples.
- ii. Serious thoughts are given and planning done before embarking on teaching the concepts.
- iii. Process errors to be committed in each concept or topic should be analyzed before embarking on teaching the concept so that the errors will be remedied alongside the teaching and learning activities (this is very important)
- iv. Each topic is studied in advance in the preparation of lesson note or consultations.
- v. There will be mastery of the concepts or topics.
- vi. There will be adequate possession of the skills or techniques on the strategies for teaching the topics.
- vii. There will be availability of resources for teaching the topics

As good as the technique may sound, research evidences (Effiom, 2015, Sule & Derya, 2012) still have no answers to how effective it is in teaching mathematics, especially in topics like algebra which constitute a greater percentage of the secondary school mathematics curriculum. It is based on the above assertion that the researcher deems it necessary to ascertain the effect of problem solving strategy on student's performance in algebraic-word problem.

Statement of the Problem

Over the years, students' poor performance in mathematics has been an issue of great concern to mathematics educators mostly in the area of algebraic word problems. These poor performances have continued at successive years especially at secondary school level as remarked by WAEC chief examiners' Report (2008).

Suleiman (2010) also is of the view that student performance in senior secondary school certificate mathematics examination is very low as many of the candidates scored zero. Adeniran (2012) in his remark as a WAEC (2015) Chief Examiner remarked that students performed very poorly, only 39% of all the students who sat for the WAEC examination in mathematics succeeded. Accordingly, the report observed that student's performance especially in algebraic word problem was very poor. The fact that these student's continue to fail the subject in large number as reported by WAEC Chief Examiners imply that more empirical studies are needed to ameliorate the situation. In view of the above objective, it was noticed that teachers use poor instructional methods to teach mathematics. Therefore the problem of this study stated as a question, what is the effect of problem solving teaching method on performance of Senior Secondary Students' in algebraic word problem? The answer to the above posed question will go a long way to facilitate a good performance in the use of appropriate method in the teaching of algebraic-word problem to students of mathematics

Objectives of the Study

The following objectives guided the study. They are:

1. To determine the effect of problem solving method on the performance of students in Algebraic word problems.
2. To find out the impact of gender difference on the performance of students in Algebraic- word problem.

Research Questions

In order to determine the effect of problem solving strategy on the performance of mathematics students in Katsina metropolis, the study seek answers to the following questions:

1. What are the effect of problem solving teaching method and traditional teaching method on the mean performance of students' in Algebraic word problem?
2. What are the influences of gender on the mean performance of students taught mathematics using problem-solving method compared to the traditional method of teaching?

Research Hypothesis

The researcher posed two null hypotheses to guide the study. These were:

HO₁: There is no significance difference in the mean achievement scores of students taught Algebraic word problem with problem-solving teaching method and those taught with traditional method.

HO₂: There is no significance difference in the mean achievement scores of boys and girls taught word problem using problem solving and traditional teaching Method.

Methodology

The study adopted a quasi-experimental design of non-equivalent control. There was no randomization of subjects since this may disrupt school organization and so intact class was randomly assigned to both experimental and control groups. The population of the entire SS I student was approximately 3850 in all the private and public secondary schools within Katsina Metropolis of Katsina State.

The researcher used random sampling technique to select 84 males and 84 females making a total of 168 SS I students out of 3850 SS I students within Katsina Metropolis. Four schools were purposively sampled out of 14 schools in the metropolis.

Table 1: Shows the Number of SS1 Students from the Sampled Schools.

Schools	No. of boys	No. of Girls	Total
A	21	21	42
B	21	21	42
C	21	21	42
D	21	21	42
Total	84	84	168

The researcher used random sampling to split the four schools into experimental and control groups respectively.

The instruments used for this study were Problem- Solving Performance Test (PSPT). PSPT is a test adapted from WAEC Past questions by the researcher to measure students performance before and after teaching as pretest (pre- PSPT) and Post-test (post- PSPT) respectively. The PSPT was validated by Chief Lecturers in test and measurement with a reliability coefficient of 0.73.

A pretest and posttest consisting of five questions each will be administered to the students. Each question carries 10 marks resulting to 50 marks for each of the test. In each question, the ability to interpret the word problem carries 6(six) marks while the solution to the linear equation carries 4 (four) marks.

Before the onset of the experiment, subjects in both the treatment and control groups were given a pre - test on problem solving performance test. After the pre-test, the researcher with the help of regular teachers started teaching the experimental group using problem solving technique adhering strictly to the lesson procedure which had been developed by the researcher and discussed prior to the pretest. The regular teacher and the researcher taught the control with the lesson notes on conventional method approach in their respective schools. The experiment was conducted during the normal school periods following the school time-table. At the end of the experiment that lasted for six weeks, the post test was administered to the two groups and the data collected.

Data Analysis

Table 2: Mean and Standard Deviation of students on Problem-solving Performance Test (PSPT) for the Experimental and Control Groups

Pretest		Posttest			
Group	N	Mean	SD	Mean	SD
Experimental	84	13.65	4.50	22.05	5.73
Control	84	13.42	4.40	11.71	3.25

Research Question 1: what are the effect of problem solving teaching methods and conventional teaching method on the mean performance of students in algebraic word problem?

Table 2 shows that the mean performance score (22.05) for the experimental group was higher than the mean performance score (11.71) in the post (PSPT) indicating that those in the experimental group performed better than those in the control group as the mean difference (10.34) in favor of experimental group.

Table 3: Mean and Standard Deviation of the Male and Female Student in Experimental Group

Pretest		Posttest			
Gender	N	Mean	SD	Mean	SD
Male	44	13.554	4.59	22.95	4.17
Female	40	13.78	4.45	21.05	6.98

Research Question 2: what are the influences of gender on the mean performance of student taught mathematics using problem solving method compared to conventional teaching method?.

Table 3 shows that male student in the experimental group obtained a higher performance score (22.95) compared to their female counterpart in the experimental group with the mean score (21.05) indicating a slight difference (1.9) showing that the male students scored slightly higher than their female students.

Table 4: Analysis of Covariance (ANCOVA) of students' scores in Problem-Solving Performance Test (PSPT)

Source	Source of Squares	Df	Mean	F	Sig.
Squares Corrected model	4488.935	2	2244.465	102.966	0.000
Intercept	4351.672	1	4351.672	199.736	0.000
Pretest	4.268	1	4.268	196	0.659
Method	4473.974	1	4473.974	205.246	0.000
Error	3596.684	165	21.798		
Total	55960.000	168			
Corrected Total	8085.619	167			

Table 5: Analysis of covariance (ANCOVA) of male and female students' scores in PSPT

Source	Source of Squares	Df	Mean	F	Sig.
Squares Corrected model	89.507	2	44.754	1.376	0.258
Intercept	3505.397	1	3505.397	107.785	0.000
Pretest	13.507	1	13.507	415	0.521
Gender	77.602	1	77.602	2.386	0.126
Error	2634.302	81	32.522		
Total	43556.000	84			
Corrected Total	2723.810	83			

Hypotheses Testing

H0₁: There is no significant difference in the Mean Performance scores of students taught Algebraic word problem with problem-solving teaching method and those taught with traditional method which is less than difference in the Problem-Solving.

From table 4, it can be seen that the calculated value of f- ratio (205.24) is 0.000 to 3 places of decimal which is less than the 0.05 level of significance. Therefore the null hypothesis is rejected because there is a significance difference in the mean achievement score of students taught Algebraic word problem with problem solving teaching method and those taught with traditional.

H0₂: There is no significant difference in the mean Performance scores of boys and girls taught Algebraic word problem using problem-solving and traditional teaching method.

From Table 5, it can be seen that the calculated value of f-ratio (2.386) is 0.126 to 3 places of decimal which is greater than 0.05 level of significance. Therefore the null hypothesis that

there is no significant difference in the mean performance scores of male and female students taught mathematics using problem- solving teaching method is accepted

Discussion of Findings

The findings of this study revealed that problem solving teaching method had significant effect on students' performance in mathematics. The experimental group had higher mean achievement score (22.05) compared to the control group (11.71) in the posttest, as shown in table 2 results and table 4 further confirmed this finding by indicating statistically significant effect of problem solving teaching method on students' performance in mathematics. The observed probability value 0.000 which was significant at 0.05 level of significance testifies to the result. This implies that the efficacy of problem solving teaching method was more positive in enhancing and facilitating student performance in mathematics. Other researchers such as Suleiman (2010) and Adunola (2012) had similar results.

Secondly, on the influence of gender on student achievement in mathematics as a result of the use of problem solving teaching method, table3 shows that the mean performance of males in experimental group in the posttest (22.95) is 'higher than that of females (21.05). However, the analysis of covariance (ANCOVA) shows that the difference in mean performance of males and females in experimental group is not statistically significant. This is because the observed probability value of 0.126 is not significant at 0.05 level of significance. This implies that problem solving teaching method is effective for teaching male and female student alike. This result is in line with the findings of Adunola (2012) that there is no significant difference between the general performance of boys and girls in mathematics when a good method is used in teaching. Also in support of these findings, Galadima (2002) advanced that the cognitive power necessary for mathematical ability correlates with the general intelligence and not on any particular sex. Hence, student's performance in mathematics is dependent on instructional method irrespective of sex.

Conclusions

Based on the findings, the following conclusions were drawn:

Problem-solving teaching method can foster student's performance more positively than the conventional method used in teaching mathematics by most mathematics teachers.

Gender had no influence on student's Performance in mathematics when teaching mathematics with problem solving teaching method.

Recommendations

Based on the findings of this study and their implications, the following recommendations were made by the researchers:

1. Teachers should adopt problem-solving teaching method in our school system since this has been proved to be an effective method of teaching concepts in mathematics.
2. Authors of mathematics textbooks should take into considerations child centered and activity based approaches as they adopt problem solving teaching method.

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