Impact of Polya's Problem-Solving Model On Students' Mathematics Performance in Junior Secondary Schools in Zamfara State, Nigeria

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Abstract- This study sought to find out the impact of Polya's Problem Solving Model on students' mathematics performance in junior secondary schools in Zamfara State Nigeria. Two research questions were drawn and two hypotheses were formulated and tested at 0.05 level of significant. Quasi-experimental design was used for the study. The population of the study is (229) junior secondary schools with an estimated population of (97,334) students. A sample of (360) students was drawn from six junior secondary schools. A multi-stage sampling technique was used to select the schools and intact classes were selected using connivance sampling techniques. The researcher used Polya's Problem Solving Instructional Model (PPSIM) as treatment for experimental groups while Discussion Method was used for control group. The instrument used for data collection was Mathematics Performance Test (MPT) was subjected to face and content validity by some experts. The reliability of the instrument was determined using split half was used to determine the reliability using Pearson Product Moment Co-efficient (PPMC) and corrected with Spearman's Brown, Coefficient which was found to be 0.82. The data collected were analyzed using mean, standard deviation and t-test statistics. The findings of the study revealed that there was significant difference between performance of students in experimental group taught word problem using Polya's Problem Solving Instructional Model and control group taught word problem using Discussion Method. It was therefore recommended among others that since Polya's Problem Solving instructional model improves students' performance in mathematics word problem than the discussion method, there is need to provide opportunities for students to engage in problem solving on a regular basis. This facilitates better understanding of various method of teaching problem solving in our school.

I. INTRODUCTION

Polya's problem solving model is explicit in characterizing the heuristics of effective problem solving. Essentially, the model attempts to understand how people think and the strategies they use when solving problems. Polya (1973) contends that to solve any problem, the characteristics and properties of the problem should be analyzed. Once the problem is understood then a plan is devised and strategies are implemented and finally, opportunities to reflect upon the solution are required. George Polya's book marked a line of demarcation between two eras, problem solving before and after Polya's. In order to realize the objectives of teaching mathematics at the secondary school level, the readiness of the learner, teacher proficiency and effective use of appropriate teaching strategies are important indexes (Agwagah, 2004). A lot of innovative mathematics teaching strategies have been developed by Ghosh, (2012) in order to intimate students with the applicability of the mathematics concepts, reducing mathematics phobia and anxiety among students, easing their proficiency in mathematics problem solving skills and mastery of the concepts rather than rote and memorization. These strategies include the use of Polya's problem solving model (Ghosh, 2012).

In today's society, people are constantly faced with problems or dilemmas they must sort through to arrive at a solution. Many times the problems are complex with many different aspects, so there are no step by step algorithms for people to apply. According to Schoenfeld (2002), Students are not going to become quantitatively literate and logical thinkers, and therefore be successful in today's society, without some changes occurring in the mathematics classroom.

These students typically have been taught in traditional mathematics classrooms, learning basic skills and algorithms to solve problems, and have not been provided with opportunities to think on their own. This method is still the norm in our nation's schools and has continued to dominate the mathematics classroom. In traditional teaching, students acquire mathematical skills through imitating demonstrations by the teacher and the textbooks. Also, in traditional mathematics instruction, the teacher on daily basis shows the students several examples of how to solve a certain type of problem and have them practise this method in the class and as homework. This is what Ogunkunle (2007) refers to as talk and chalk method.

The use of talk and chalk method has become burdensome and worrisome because it does not establish the link between mathematics concepts learnt in the classroom and their applicability to real life situations hence denying students of meaningful learning (Ogunkunle & George, 2015; Sidhu, 2006). Jonah-Eteli (2010) observed that generally teachers discuss worked examples, sometimes leading to formulae and then ask the students to work exercises based on the examples or using the formulae. This method of teaching leads learners to memorize

mathematical formulae methods and examples as presented by the teacher.

The performance of students in mathematics has been of great concern to the society (Awokoya in Maliki, Ngban & Ibu 2009). Fafunwa in Maliki et.al (2009) both agreed in different researches that we live in a world where science and technology have become integral part of the world culture, therefore, for any nation to be relevant, it must not overlook the importance of mathematics in her educational system. Accordingly, the observed poor performance in mathematics has been a matter of serious concern to all well-meaning educators. Students' poor performance in mathematics over the years has been attributed to the fact that the subject is difficult. In the same view, students' performance in mathematics tests has been observed to vary from student to student, from school to school and from state to state in Nigeria. This prompted the researcher in using Polya's problem solving model to teach certain concepts in mathematics to see whether it will improve performance in mathematics more specifically in Zamfara state.

II. STATEMENT OF THE PROBLEM

Mathematics has acquired the status of a compulsory subject up to a certain academic level in almost every nation of the world. The need of students for reckoning in everyday life has caused a change on their performance in mathematics. Yet many students complain that it is difficult to learn, understand and pass mathematics examinations. One begins to ask what might be the reason for such poor performance of students in mathematics. Some of the problems are as follows: Students' problem, teachers' problem, administrative problem, environmental problem, parental and schools' problems.

Lack of interest, motivation and mathematics belief as well as negative attitude towards mathematics on students' side may hamper their academic progress. For example, students may not be promoted into the next class or even get admission into university if they fail mathematics. Some of the schools within Zamfara Metropolis revealed that most teachers are in a hurry to solve a problem and make it a teacher-centered without allowing students to participate, teachers' do not use variety of methodology and instructional materials in teaching, mathematics which may cause students to become frustrated and loose interest in the subject and the entire academics. Also, schools' inability to provide adequate time for mathematics lessons, adequate facilities, adequate instructional materials and enough space in classrooms have resulted to students' poor performance in mathematics.

Whatever factor(s) may be responsible for such complain how to improve students' performance in mathematics has always been one of the major problems confronting the government, mathematics educators, teachers of mathematics and parents alike. Previous studies have shown that methods of teaching mathematics through listening, looking and learning have not been successful. If anything, the method has only resulted in making students dislike mathematics. The result of this traditional approach is poor literacy in mathematics, poor performance in internal examinations and students' general dislike or phobia for mathematics. The results of mathematics examination of students in Junior Schools (JLSC) from 2011 to 2016 have shown that more

than 40% of students in the year 2014 and 2015 failed mathematics examination in Zamfara state the reasons is because of unqualified teachers, lack of support from parent and government. Therefore, it is in attempt to find alternative way of teaching mathematical concepts to students of Junior Secondary Schools in Zamfara State that the researcher sought to impact the use of Polya's problem solving model on students' performance in mathematics as opposed to the use of discussion method.

III. OBJECTIVES OF THE STUDY

The objective of this research to find out:
1. Whether the performance of students will improve if taught word problem using Polya's problem solving model instead of using discussion method.
2. If there exist a gender difference among students' performance in word problem when Polya's problem solving model are used;

Research Questions
The study answered the following questions:
1. What is the difference between the performance of students taught word problem using Polya's problem solving model and discussion method?
2. Is there any difference in the performance of male and female students taught word problem using Polya's problem solving model?

Null Hypotheses
The following hypotheses stated in null form were tested: at 0.05 level of significance.

H_{01}: There is no significant difference between performance of students' taught word problem using Polya's problem solving model and discussion method.

H_{02}: There is no significant difference between performance of male and female students' taught word problem using Polya's problem solving model.

IV. METHODOLOGY

This study aims at investigating the use of Polya's Problem Solving Model on students' performance in word problems. The effectiveness of these models was compared with that of the Discussion Method. The study employs quasi-experimental design of the type pretest, posttest equivalent, non – randomized and control group only. The target population of this study is junior secondary school students of Zamfara State. There were two hundred and twenty nine (229) Junior Secondary Schools in Zamfara State, with an estimated population of ninety seven thousand three hundred and thirty four (97,334) students. The sample for the study was drawn from junior secondary school two (JSS II), the use of multi-stage sampling techniques i.e. hat-draw method was used to select the schools and intact classes were selected using convenience sampling technique. The instrument that was used in carrying out this study was; Mathematics Performance Test (MPT). The MPT consisted of five (5) theory questions for the students to answer all. MPT was subjected to face

and content validation. By experts in the Department of Science and Vocational Education, Usmanu Danfodiyo University Sokoto. A pilot study was carried out using one (1) intact class Sixty (60) students of Junior Secondary School II at Ibrahim Gusau Government Days Secondary School, Zamfara State. The selected school is part of the population but not part of the sample for this study. A split half was used to determine the reliability using Pearson Product Moment Co-efficient (PPMC) and corrected with Spearman's Brown, Coefficient which was found to be 0.82. After the marking sessions, the raw scores were subjected to analysis. The descriptive statistics mean and standard deviation to answer the research questions and t-test to test the null hypotheses formulated to further confirm the veracity of the difference in mean scores using SPSS Package (20.0) at 0.05 level of significance.

V. RESULTS

The research questions and the corresponding hypotheses were answered and tested using one table. These are presented as follows:

Research Question one: What is the difference between the performance of students' taught word problem using Polya's Problem Solving Model and Discussion Method?

Null hypothesis one

H_{01}: There is no significant difference between mean scores of students' taught word problem using Polya's problem solving model and discussion method.

Table 1: t-test Analysis of Performance Mean Scores of Experimental and Control Groups

Variables	N	Mean	S.D	Df	t-value	p-value	Decision
Experimental Group	157	33.86	17.09				
				358	6.18	0.000	Rejected
Control Group	203	23.72	13.89				

$\alpha = 0.05$
Source: Field work, 2018

To test this hypothesis, the mean scores of students in experimental and control groups were subjected to t-test statistic and summary of analysis are shown on Table 1. The result shows that the experimental group has higher mean scores of 33.86 as compared to that of control group with mean scores of 23.72. The calculated t-value was 6.18 while the p-value is 0.00 which is less than $\alpha = 0.05$ level of significance at 358 degree of freedom. Hence, the null hypothesis was rejected.

Research Question two: Is there any difference in the performance of male and female students' taught word problem using Polya's problem solving model?

Null hypothesis two

H_{02}: There is no significant difference between mean score of male and female students' taught word problem using Polya's problem solving model.

Table 2: t-test Analysis of Post Test Means Scores of Male and Female Students Taught Word Problem Using Polya Problem Solving Model.

Variables	N	Mean	S.D	Df	t-value	p-value	Decision
Male Experimental	83	20.36	14.39				
				155	- 4.91	0.000	Rejected
Female Experimental	74	33.23	18.39				

$\alpha = 0.05$
Source: Field work, 2018

To test this hypothesis, the mean scores of male and female students in experimental groups were subjected to t-test statistic and summary of analysis are shown on Table 2. The results in Table 7 shows that at df 155, t-value is - 4.91 and p-value observed is 0.000 and is less than 0.05 level of significance. Consequently the null hypothesis is rejected.

VI. DISCUSSIONS

The main objective of this research was to find out whether the use of Polya's problem solving model has effect on the performance of junior secondary schools students in Zamfara State Nigeria in word problem. To achieve this aim student in experimental group were taught Word Problem using Polya's

Problem Solving Instructional Model while students in control group were taught Word Problem without Polya's Problem Solving Instructional Model. Therefore, the observed differences in the result were due to treatment. The result of the analysis of data on the research question and null hypotheses are hereby discussed.

The results of analysis presented in Table 1 show that Polya Problem Solving Model was found to improve the performance of experimental group in word problem compared to that of control group taught with discussion method. The students taught word problem with Polya's problem Solving Model had a higher mean score than the students taught using Discussion Method. These findings agree with the earlier findings of Galadima (2002), who conducted his study on effect of heuristic

problem solving instruction on secondary school students' performance in algebraic word problem and found out that Polya model has the greatest effect on students' performance. This result is in agreement with the findings of Suleiman (2010) whose works, found a significant difference between the performance of the experimental and control group where the experimental group taught with Polya's Problem Solving Model performed better than their counterpart taught with Conventional Method.

The result of the analysis presented on Table 2 between male and female student showed that Polya Problem Solving Model was found to improve the performance of female students more than male students in the experimental group, the finding from this study indicated that gender has effect on learning word problem with Polya's Problem Solving Model. The finding agrees with the earlier findings of sulaiman (2010) which was found that gender has effect on students' performance. Also Fasasi (2015), conducted a study on the effect of Heuristic Teaching Approach on academic achievement of Senior Secondary School Mathematics students in Adamawa State, Nigeria the results revealed that the Heuristic teaching approach benefited boys in the experimental groups as they achieved significantly better than girls in the experimental group and the control group in their mathematics achievement test. It also revealed that the difference in the achievements of male and female is significant. The finding in lines with that of Galadima and Okogbenin (2012) did a research on the effect of mathematical games on the academic performance and attitudes of senior secondary school students toward mathematics in Sokoto state. The result shows that there was no significant difference in the performance of male and female students exposed to mathematical game method. The result of this finding concur with that of Fajemidagba (2012), who revealed that both the polya's and Branford model has effect on the gender of the students.

VII. CONCLUSIONS

From the analysis and interpretation of the data collected, the following conclusions were drawn:
1. The use of Polya's Problem Solving Instructional Model as a means of instruction tools in word problem improve the students' performance as observed in the means scores of the experimental group taught word problem and those with discussion method.
2. The use of Polya's Problem Solving Instructional Model was found to be gender friendly because female student perform better than male students taught word problem using PPSIM.

VIII. RECOMMENDATIONS

The following recommendations are made in the light of the findings of this study.
1. Polya Problem Solving instructional model improved students' performance in mathematics word problem than the discussion method. Therefore there is a greater need to provide opportunities for students to engage in problem solving on a regular basis. This facilitates better

understanding of various method of teaching problem solving in our school.
2. It was observed that, Polya Problem Solving Model improve Male and Female Students performance in mathematics word problem than the traditional method. Secondary school mathematics teacher should be trained through intensive workshop, seminars, and in-service training on the use of Polya Problem Solving model for teaching and learning of mathematics. This will expose the teachers to the various problems solving model and use them in the classroom for better understanding and learning of mathematics by the students.

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