Cooperative Problem-Solving Strategy and Students' Learning Outcomes in Algebraic Word Problems: A Nigerian Case

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Abstract

This paper examined the impact of a cooperative problem-solving strategy on the learning outcomes of Nigerian secondary school students in algebraic word problems, an aspect of mathematics. The sample used for this study was two hundred and forty (240) junior secondary school students in Ilesa township of Osun State, Nigeria. The subjects were randomly assigned into two equal groups: one control and the other experimental. The control group was exposed to the normal traditional method of teaching, while the experimental group was taught via the cooperative Problem-Solving Strategy (CPS). The instruments used for this study are (a) the CPS instructional modules for solving word problems in Algebra (b) the Mathematics Achievement Test (MAT) (c) the Problem-Solving Attitude Scale (PSAS). The results of the study were subjected to 't' test statistics: Results from the analysis of the achievement and attitudinal tests showed that there was a significant main effect of treatment on students learning outcomes in both achievement and attitude towards algebraic word problems. In other words, the overall achievement of students exposed to (CPS) was better than those exposed to the conventional method. The study therefore recommended that the training of mathematics teachers should incorporate the various strategies of presenting mathematical tasks to Nigerian students especially the cooperative problem-solving strategy.

1. Introduction

Mathematics, apart from being a core subject in the schools' curriculum has become a requirement of most disciplines in higher institutions of learning and compulsory for most of social and applied sciences. 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 sophisticated teaching materials. In spite of this situation, it is incumbent upon all categories of mathematics teachers to make use of the local resources with their professional ingenuity, so that the subject can be taught for comprehension, assimilation and permanence in a meaningful way.

It has been discovered that students' performance in mathematics especially in the algebraic and problems at the National examinations has remained below average [11] several factors have been cited as general causes of the poor performance in mathematics. These include ineffective teaching methods [3] [4], unavailability of teaching materials; its specialized language; and symbolism used in the subject.

The commonly used teaching and learning approaches in mathematics in Nigeria's Secondary Schools and other parts of the world are teacher centered [2] [8] which are ineffective. In this study, cooperative Problem-Solving (CPS) strategy was used in a mathematics classroom setting and its effects on learners' achievement in word problems was analysed.

Cooperative Problem-Solving is a strategy of instruction whereby students work together in groups of varying composition to achieve common objectives. To be successful in this strategy, students share ideas rather than working alone and assist one another in order to maximize mutual benefits [10] [4]. This is unlike the use of conventional teaching methods where learners work individually or competitively.

An analysis of different studies conducted on effects of the CPS on learners achievement in different subjects in the school curricular indicated that 61% of them found significant greater achievement than in traditionally taught control groups [10]. The positive results were found in all major subjects, all grade levels in urban rural, and sub-urban schools, and for high, average and low achievers [7].

There are several methods used in CPS categorized on the basis of group composition, organization and direction of study [10]. This study (CPS) used the students' teams comprising five to six students working on a mathematics task given to each group. In this strategy, the teacher presented the mathematics lesson first, and then students' teams used a variety of methods to master the material, such as quizzing each other, discussing and using worksheets. The teacher just acted as a facilitator. To recognize team members' output, performance scores were computed on the basis of team members' improvement scores, after which certificates and school bulletin boards were used to recognize high scoring teams. In effect, CPS

strategy was able to promote face-to-face communication, positive interdependence, individual acceptability, interpersonal, collaborative skills, and positive attitudinal change which are essential in improving the learning of mathematics thereby leading to high academic performance and positive attitude of learners [4].

2. Purpose of Study

The purpose of this study was to examine the effects of the cooperative Problem-Solving Strategy (CPS) on the learning outcomes of students in algebraic word problems. The learning outcomes considered in this study are: (a) the students' achievement in mathematics and (b) the students' attitude towards mathematics.

Hypothesis of the Study: Two null hypothesis were raised and tested at 0.05 significance level.

HO1: there is no statistically significant difference in the mathematics achievement among students taught with CPS and the control.

HO2: There is no statistically significant difference in the attitude towards mathematics among students taught with CPS and the control.

3. Conceptual Framework

Before one can study or solve mathematical word problems, one must read them. The need to read problems carefully is implicit in Polya's approach to teaching problem-solving [9]. At the secondary school level, it is assumed that students are instructed verbally and that reading is only important when students are given written problems in homework or tests. In several studies, it has been established that there exists a significant relationship between the students' interests in the subject and the corresponding performances. That is, the more positive the attitude of students is towards a subject, the higher their achievement in that subject. Hence this study attempted to investigate the relationship between the teaching strategy (CPS) and the attitude of learners in algebraic word problems.

Findings also indicate that positive attitude in teachers were positively associated with high achievement and positive attitudes in pupils. [4] [1].

Life is full of problems, some of which require mathematical knowledge, hence the need for problem-solving as "finding an appropriate response to a situation which is unique and novel to every problem-solver."

[9] thought of problem solving as the ability of the learner to develop mathematical concepts through active participation in the lesson going on in the class. Similarly [10] concluded that problem-solving presents opportunities for students to draw for themselves relationships between things they know and the learning task at hand. In fact, problem-solving is a means of stimulating intellectual curiosity and it aids transfer of learning.

[9] in his book "How to Solve it" gave four steps as a model for solving problems:

1st step: Understanding the problem
2nd step: Devising a plan
3rd step: Carrying out a plan
4th step: Looking back.

Clearly, the above model can be applied to solving problems of varied types in all aspects of mathematics, even to geometrical problems as reported by [3].

3.1. Algebraic / Word Problems

Mathematics is concerned with reasoning about certain special concepts, the concepts of number and geometry. It is the use of symbols and of reasoning in terms of symbols which is generally regarded as the transition from Arithmetic to Algebra [6].

Language of instruction in Nigerian schools is always the second or third language. Often the majority of students are not well versed in the second language to understand what is taught in the school. So in the study of Algebraic word problems, a thorough understanding of the language is very important.

The language of algebra involves more than the use of letter to represent a number. For instance, the expression contains, in addition to the usual plus sign of arithmetic, the parentheses which denotes 5 multiplies the entire quantity. Thus, algebra uses many symbols to represent quantities and operations with quantities.

For the purpose of this study the idea of Algebraic word problems would be limited to "word problems" leading to simple and simultaneous equations as contained in the Junior Secondary School Curricular of Federal Ministry of Education in Nigeria [5].

The Polya's model of Problem-Solving was adapted to solve word problems. A simplified example is illustrated here below:

A number of two digits is such that the sum of the digits is 11 and the number is 27 greater than the number obtained by reversing the digits. Find the number.

3.2. Solution

Using the Polya's Heuristics:

Step 1. Let the required number be abc; that is the ten's digits is 'a' and the unit digit be 'b'. Then

the number will be. Then the number with digits reversed is $10b + a$

Step 2. $10a + b - (10b + a) = 27$

$$\Rightarrow 9a + 9b = 27$$

$$a + b = 3 \_\_\_\_\_ (i)$$

$$a + b = 11 \_\_\_\_\_ (ii)$$

Step 3. Adding equations (i) + (ii)

$$2a = 14 \Rightarrow a = 7.$$

On subtraction

$$2b = 8 \Rightarrow b = 4$$

So the required number is 74.

Step 4. Looking back or checking

$$7 + 4 = 11.$$

and

$$74 - 47 = 27$$

4. Sample and Instrument

The study sample survey consisted of two hundred and forty Junior Secondary School students' (JSS3) randomly selected from six Secondary Schools in Ilesa Local Government Area of Osun State in Nigeria. Forty (40) students were randomly selected in each of these schools. These six schools were randomly assigned to control and experimental groups as analysed below.

Experimental Groups: This is the group of students who were taught algebraic word problems using (CPS).

Control Group: This is the group of students who were taught via the conventional teaching methods.

The researcher prepared an instructional package for teaching algebraic word problems called the cooperative problem-solving package which consisted of weekly teaching guide on CPS procedures, elements of cooperative learning and Polya's heuristics for solving algebraic problems. This was used to teach the experimental group.

Similarly, a sixteen item questionnaire based on a modified Likert scale version was constructed by the researcher. This instrument was used to investigate the changes in attitude scores as a result of introducing some experimental variables. A twenty-item multiple choice achievement test on algebraic word problems was constructed based on the approved syllabus for the JSS students. This was validated and field tested, the coefficient of reliability yielded 0.782.

The researcher engaged the services of the regular mathematics teachers in the teaching, and conducting the test. The experiment lasted for four weeks. At the end of the fourth week, the two groups were post tested.

Results: The hypotheses of the study investigated whether there is any significant difference in both the achievement and attitude of students exposed to algebraic word problems by the use of CPS. The t-test statistic was used to analyze post-test data.

Table 1 shows the t-test results of mathematics achievement scores.

Table 1. Sample t-test of the Post-test MAT scores of Experimental and control groups

Group	N	Mean	SD	DF	T	p-value
Experimental	120	36.34	12.11	238	3.65	0.05
Control	120	30.04	10.66			

The results in Table 1 indicates that the difference in MAT post-test mean scores between two groups were statistically significant, t (238) = 3.65, P < 0.05. The null hypothesis was therefore rejected and this showed in effect that the experimental group performed better than the control group.

Similarly, the attitudinal scores of the two groups were also subjected to t-test statistics and the results are displayed on Tables 2.

Table 2. Difference between the means of the attitude scores of the Experimental and the control group

Group	N	Mean	SD	DF	T	p-value
Experimental	120	20.69	4.93	238	5.95	P<0.05
Control	120	18.46	4.05			

The results in table 2 shows that the difference in attitude scores between the two groups was statistically significant, t (238), = 5.95, P < 0.05 with experimental group having higher mean score than the control group. This in effect shows that the experimental group displayed a better attitude towards mathematics than the control group. So hypothesis 2 was therefore rejected.

5. Discussion

The findings of this study were – that the experimental group exposed to cooperative problem-

solving (CPS) strategy produced superior overall gains in both achievement an attitude scores than the control group taught via the conventional method.

Therefore the CPS strategy proved to be more effective in enhancing mathematics achievements than the conventional teaching methods. It also improves the attitude of learners towards mathematics. This corroborates the findings of [4].

6. Recommendations

The use of cooperative problem-solving strategy in teaching algebraic word problems in particular and mathematics in general has been found to be very effective in mathematics classrooms. It is also a veritable tool in minimizing mathematics phobia in the learners and improving their attitudes towards the learning of mathematics. The study therefore recommends that (a) Pedagogical training of teachers in Nigerian Colleges of Education and Universities should incorporate the in-depth study of various methods of mathematics task presentation to students especially the cooperative problem-solving strategy. Similarly (b) Text-writers should take cognizance of cooperative problem-solving strategy in the treatment of algebraic word problems. (c) Education stakeholders should encourage teachers to use this strategy in teaching mathematics so that students share their intellect, coexist harmoniously and learn without anxiety and enjoy mathematics lessons.

7. References

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