Effect of two Problem-solving Models on Junior Secondary School Students' Achievement in Algerba

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ABSTRACT

This study explored the effect of two problem-solving models on students' achievement in algebraic word problem. The study adopted a quasi- experimental design referred to as pre-test, post test control group design. It was restricted to Education Zone C of Benue State of Nigeria. Three coeducational secondary schools were drawn for the study using purposive and simple random sampling techniques. In each of the three schools used, two intact classes were randomly drawn from the JSS III classes. The experimental groups were taught the algebraic word problem using Greeno and Metes et al problem-solving models respectively, while the control group was taught the same topics using the conventional method. A total of 260 subjects were involved in the study. The reliability of the objective test item was determined using kuder-Richardson formula 20 which was found to be 0.93 and 0.94 for the essay questions using inter rater reliability.

Two research questions were answered using mean and standard deviation while three hypotheses were tested using ANCOVA. Data in the word problems were collected using Mathematics Achievement Test (MAT) and the candidates in the experimental and control groups were given pre-test before the commencement of the experiment and post-tested after the experiment. The result of the study revealed that there was a significant difference in the mean scores of subjects exposed to the two problem-solving models. Out of the two models, metes et al produced a higher achievement. Based on the findings, the researcher recommended that both Greeno and Metes et al problem solving models should be adopted in the teaching of word problems in algebra at Junior Secondary school levels of the educational system.

KEY WORDS: Greeno, Metes et al, Mathematics Achievement Test, Pre-test. Posttest, teaching methods, problem Solving, Algebra, Experimental and Control.

INTRODUCTION

Mathematics is the backbone of science and technology and no nation can hope to achieve any measure of scientific and technological advancement without proper foundation in school mathematics. According to Abiodun (2005), while science is the bedrock that provides the springboard for the growth of technology, mathematics is the gate and key to the sciences. It is a core subject that is compulsory at primary and secondary schools, and in addition, a credit level pass in mathematics at Senior Secondary Certificate Examination (SSCE) is a requirement for admission into all science related courses such as medicine, pharmacy, Engineering among others.

Mathematics is also important in everyday life in that most effective solutions of everyday basic human problems involve the use of mathematics, either directly or indirectly. For instance, the need to calculate the quantity of materials needed to build a storehouse, quantities of fuel that could be used for a journey, use of operation research in quadratic, linear and integer programming and indirectly through the professional activities of Engineers, Lawyers, Doctors among others, are everyday examples of the use of mathematics (George, 2007).

However, despite this important role of mathematics, it still remains one of the subjects in which many students at all levels of the school system persistently perform very poorly (Ale 2003; Obodo, 2004; Emedo, 2004; Buhari, 2006 and Ifamuyiwa, 2007). Some researchers including Moore and Norman (2002), Obioma (2004) and Enukoha (2005) have observed that some mathematics teachers strike fear into students by the uninspiring ways they teach their students. The

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researchers cited above, observed that teaching of mathematics is characterized by rote memory of basic mathematical processes and abstract presentation of facts and principles. This development has not been able to bring about the desired improvement in performance. This poor state of mathematics education in Nigeria is giving a lot of concern to mathematicians and mathematics educators. Although efforts are being made by government, researchers, Mathematical Association of Nigeria (MAN) among many other groups to improve mathematics education in Nigeria, achievement in the subject continues to be poor year after year (Ogbonna, 2003).

However, some studies attributed the poor achievement of students in mathematics mostly to teaching approaches adopted by mathematics teachers in presenting instruction. Most teachers adopt the conventional approach in the teaching of mathematics where the focus is on what is being taught rather than who is being taught and as such, it is a teacher or subject – centered approach. The curriculum is held as absolute in many schools and teachers are reticent to tamper with it even when student do clearly not understand the most important concepts.

A number of problem-solving models have been developed by some researchers to enhance the problem-solving capabilities of students by minimizing their problem-solving difficulties. Out of the fifteen problem-solving strategies found in literature, only six were designed for mathematical problem-solving (Polya, 1957; Guilford and Holfiner, 1971; Newell and Simpsons, 1972; Greeno, 1973; Metes, Pilot, Rooznick and Krammers-Pal, 1980). However, out of the Six problem-solving models mentioned, some research findings including Abiodun (2005) showed that the Polya (1957) problem-solving model has been in use over the years, yet students' achievement in word problems in mathematics is still very discouraging. It is in the realization of this that the researchers decided to conduct researches using two of the models (Greeno and Metes et al problem-solving models). This could offer solutions to the students' level of mathematical abstractions, which is predominant in word problems in Algebra.

From the foregoing, it becomes necessary to empirically investigate and identify an effective instructional approach that fosters achievement in mathematics word problem-solving. More-over, since all sciences and technology based courses and programmes are highly dependent on mathematics, efforts should be geared towards the development of problem-solving models that are capable of improving the achievement of students in mathematics at all levels of the school system. A number of problem-solving models have been in use as mentioned earlier. Hence, the need to compare the effect of Greeno and metes etal problem-solving models on students achievement in word problems in algebra.

Purpose of the Study

The purpose of this study is to empirically compare the Greeno problem-solving model and Metes et al problem-solving model in order to determine which of the models is more effective on secondary school students' achievement in algebra. Specifically, this study is to determine:

1. Effects of the Greeno problem-solving model and the metes et al problem-solving model on the achievement of students in algebra.
2. Influence of gender on students' achievement when exposed to the Greeno and metes et al problem-solving models.
3. Interaction effects of model and gender on students' achievement in algebra

Research Questions

The following Research Questions guided the study:

1. What is the difference in the mean achievement scores of students taught with Greeno and metes et al problem-solving models and those taught with the conventional method?
2. To what extent would gender influence the mean achievement scores of students taught with Greeno and Metes et al problem-solving models in the Mathematics Achievement Test (MAT).

Research Hypotheses

The following null hypotheses (Ho) were tested at 0.05 levels of significance.

Ho_1: There is no significant difference in the mean achievement scores of students' taught using the problem-solving models and those taught with the conventional method.

Ho_2: There is no significant difference in the mean achievement scores of male and female students taught with Greeno and metes et al problem-solving models.

Ho_3: There is no interaction of model and gender on students' achievement in algebraic word problems as measured by the Mathematics Achievement Test (MAT).

MATERIALS AND METHODS

This study adopted a quasi –experimental design referred to as pre-test, post-test control group design. The study was conducted in Education Zone C of Benue State. Out of the nine Local Government Areas that make up Education Zone C in Benue State, simple random sampling techniques were used to draw three Local Government Areas for the study. Three coeducational secondary schools from the three LGAs were drawn using purposive and simple random sampling for the study. The choice of coeducational schools is to justify the normal school structure gender factor in the study. One school each was selected at random from the three Local Government Areas. Two of the schools were respectively assigned to each of the two experimental groups (treatment groups) and the other remaining school was used as the control group. A total of 260 students were used for the study. Out of this, 180 students were used for the experimental groups and 80 students were used for the control group.

Instrumentation

The Mathematics Achievement Test (MAT) consisted of 25 multiple-choice objective questions with options (a-d) and five free response essay questions developed by the researchers from JSS three scheme of work, which was taught in the lesson.
The contents are:
- Direct variation
- Inverse variation
- Joint variation
- Partial variation

Also lesson notes were prepared by the researchers; two of them were prepared using the Greeno and Metes et al problem-solving models respectively. These were given to the trained regular mathematics teachers that were used in the study to avoid Hawthorne effect. The remaining lesson note was prepared using the usual conventional problem-solving method. The experimental and control groups were taught the same contents.

RESULTS

The results of this study are presented according to the research questions.

Research Question 1

What is the difference in the mean achievement scores of students taught with models and those taught with the conventional method?

Table 1
Mean scores and standard Deviations (SD) of students in MAT

Group	N	Mean	SD
Greeno	83	33.7108	12.20209
Metes et al	96	38.0625	10.28521
Control	79	17.5443	5.62913
Total	258		

From the data presented in Table 1, it was observed that the students in the two experimental groups (Greeno and Metes et al) had mean scores of 33.71 and 38.06 and corresponding Standard deviations of 12.20 and 10. 29 respectively. For the students in the control group, it was observed that they had a mean score of 17.54 and a standard deviation of 5.63. The observation implied that the use of the two models indicated a positive effect on the students' achievement in algebra.

Research Question 2

To what extent would gender influence the mean achievement scores of students taught with Greeno and metes et al problem-solving models in the Mathematics Achievement Test?

Table 2
Mean Achievement scores and standard Deviations of male and female students in the Achievement Test

Group		N	Mean	SD
Greeno	**Male**	**43**	**32.74**	**11.61**
	Female	**40**	**34.75**	**12.88**
Metes *et al*	**Male**	**59**	**38.03**	**10.24**
	Female	**37**	**38.11**	**10.51**
Control	**Male**	52	17.62	5.38
	Female	27	17.41	6.19
Total		258		

Table 2 shows that the males in the two respective experimental groups had mean scores of 32.74 and 38.03 with corresponding standard deviations of 11.61 and 10.24 respectively. It was also observed that the female in the two experimental groups had mean scores of 34.75 and 38.11 with their corresponding standard deviations of 12.88 and 10.51 respectively.

For the male and female students in the control group, it could be seen that the males had a mean score of 17.62 and standard deviation of 5.38, while the females on the other hand were observed to have a mean score of 17.41 and a standard deviation of 6.19 respectively. The above observation implied that the female students achievement was higher than their male counterparts.

Table 3 was used to test the hypotheses on students' achievement in Mathematics.

Table 3
ANCOVA results on the students' Achievement by Treatment, Gender and Interaction

Source of variation	Sum of squares	Df	Mean square	F	Sig.	Decision
Corrected model	20858.472	6	3476.412	37.172	.000	
Intercept	30645.953	1	30645.953	327.682	.000	
Pre MAT	1171.709	1	1171.709	12.529	.000	
Method	18352.823	2	9176.411	98.119	.000	S
Gender	6.000	1	6.000	.064	.800	NS
Method. Gender	27.813	2	13.907	.149	.862	NS
Error	23474.303	251	93.907			
Total	282450.000	258				
Corrected Total	44332.775257					

Computed at alpha (α) 0.05

For $H0_1$, computed at alpha(α) = 0.05 the result in Table 3 suggest that treatment (Greeno and metes et al problem-solving models) is a significant factor on students' achievement in algebraic word problem. The probability level of 0.05 is greater than 0.000 (P $\angle$ 0.05) as seen in Table 3. thus the hypothesis $H0_1$ of no significant difference is rejected. This implied that there was a significant difference in the mean scores of subjects exposed to the two problem-solving models and those not exposed.

For $H0_2$, the F-ratio for the gender factor was not significant since 0.05 is less than 0.80 (P>0.05). The conclusion is that there was no significant difference between the mean achievement scores of male and female students taught algebraic word problems using the models.

The results of ANCOVA analysis from Table 3 shows that the probability level of 0.05 is less than 0.862 thereby accepting the null hypothesis that there is no interaction of model and gender on students' achievement in algebraic word problems as measured by MAT.

Discussion of Findings

Effect of the two problem-solving models on students' achievement in algebra

Results from Table 1 showed that the mean achievement scores of the students in the two experimental groups were higher than those in the control group. This was further confirmed by the result in Table 3, which revealed that method was a significant factor on students' achievwment in algebraic word problems. Thus, students who were taught word problems using Greeno and Metes et al problem-solving models performed better than those taught with the conventional method. This finding supports the finding of other previous researchers such as (Obodo, 2004; Agwagah, 2003;

Ogbonna, 2003; Ogwuche, 2002) where the use of new methods of teaching mathematics as experimental treatment proved better than the use of conventional method.

However, of the two experimental groups, the students taught with metes et al problem-solving model had a higher mean achievement score of 38.03 than those taught with Greeno problem-solving model who had a mean score of 32.74 (see Table 1). The mean score gain of students taught with Metes et al is 5.29. In Table 3, the method employed on the students' achievement in algebraic word problems as measured by MAT was significant. This significance could be attributed to the higher mean score gain of students taught with Metes et al problem solving model.

Differential effects of the treatments due to gender on students' achievement in algebra

The result of Table 2 showed that both male and female students in the two experimental groups achieved significantly higher than those in the control group. For example, in Greeno problem-solving model, the mean achievement score for male was 32.74 and that of female was 34.75 respectively. For metes et al problem-solving model, the mean achievement score for male was 38.03 and 38.10 for female. Female students in both Greeno and Metes et al problem-solving models had higher mean scores than their male counterparts. From these findings, it was observed that differences existed in the achievement of male and female students taught algebraic word problems with different or similar methods. Though ANCOVA results' in Table 3 revealed that gender was not a significant factor on students' achievement in algebra but there was difference in male and female achievement.

This result is in compliance with the findings of (Hardings 2005; Erinosho, 2007), which indicated that female students tend to achieve significantly higher than their male counterparts if they were taught with the same method. From the findings of this study, parents should be encouraged to train their female children in the study of mathematics since they (female students) could also cope with different methods of teaching if exposed to. However, the present result was contrary to the findings of earlier students, which revealed no significant differences in the achievement of male and female students in mathematics (Olagunju, 2001; Ogwuche, 2002 and Ogbonna, 2003).

Summary of findings

The following observations emanated from the findings of this study:
1. The students taught using the two problem-solving models achieved better than those taught using conventional model.
2. The students who were taught using Metes et al problem-solving model achieved slightly better than those taught using Greeno model.
3. The female students in both Greeno and metes et al problem-solving models had higher mean scores than their male counterparts. This means that the female students achieved higher than their male counterparts in the variation problems when taught with the two models.
4. The interaction effect of treatment and gender on students' achievement was not significant. From the result presented in Table 3, it was observed that the probability level of 0.05 is less than the calculated value of 0.86; therefore there is no significant interaction effect of treatment and gender of the students' achievement in solving algebraic word problems.

Recommendations

Based on the findings of this study, the following recommendations were made:
1. Since Mathematics is an indispensable tool in science and technological advancement, students should be encouraged to take the study of mathematics seriously by exposing them to instructional approaches that will stimulate and sustain their interest in this study of algebraic word problems.
2. Secondary school mathematics teachers should use these models in teaching their students how to solve mathematical problems relating to word problems in algebra.
3. Mathematics educators, Federal and State Ministries of Education should organize workshops and seminars to acquaint the teachers with how to use metes et al and Greeno problem-solving models in teaching mathematics.
4. Mathematics textbook authors and publishers should incorporate mostly the metes et al phases in their solved examples in order to offer teachers and students the opportunity of learning the approach with ease.

Teacher educators should ensure that they train their student teachers on how to use the metes et al problem-solving model to solve worded problems in algebra.

Conclusion

From the result of this investigation, there was a significant difference in the mean achievement scores of students who were taught problem-solving in word problems in algebra using both metes et al and Greeno problem-solving models and those who were taught using the conventional method in favour of the groups taught using the models. It was also seen that out of the two experimental groups, students taught with metes et al problem-solving model generally had a higher mean achievement than those taught using Greeno problem-solving model.

As a result of the problem-solving models employed in the teaching of word problems in algebra, achievement in this subject was significantly improved.

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