

Effect of Problem Solving Technique on Secondary School Students' Academic Achievement in Selected Topics in Algebra.

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ABSTRACT

This study investigated the effect of problem solving techniques on secondary school students' academic achievement in algebra. Two research questions were posed and three null hypotheses were tested at 0.05 level of significance. The study adopted a quasi-experimental design, specifically, the pre-test posttest non-randomized control group design. The sample consisted of 80 senior secondary school two (SS 2) mathematics students from two co-educational schools in Owerri West Local Government Area of Imo State, Nigeria. Achievement Test in Algebra (ATA), developed by the researchers and validated by experts, was used for data collection. A reliability coefficient of 0.94 was obtained using Kuder-Richardson formula 20. Data were analyzed using mean and ANCOVA. The findings showed that the students taught with problem solving technique achieved higher than those taught with lecture method. Gender was found to have no significant influence on achievement in mathematics though the females performed slightly higher than the males. In addition, no significant interaction effect was observed between gender and treatment. The researchers recommended among others, that problem solving technique should be adopted by mathematics teachers to help students learn mathematics more effectively.

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Introduction

Mathematics has been regarded as an essential and integral part of science education whose importance is needed in everyday life, hence the Federal Government of Nigeria (2014) in her National Policy on Education placed mathematics as a core subject all secondary school students must offer at both junior and senior secondary school certificate levels. In spite of this emphasis, mathematics achievement by secondary school students seem to have remained very poor. Literature is replete with evidence of poor mathematics achievements. For example, West African Examination Council (WAEC) Chief Examiners' annual report in mathematics (WAEC, 2011; 2012; 2013 and 2014) respectively revealed poor mathematics achievement by secondary school students. A summary of the reports shows that only 24.93, 30.71, 38.81, 38.60 and 37.05 percentages of the total enrolment in mathematics for the respective years were able to make up to credit pass and above in mathematics in the Senior Secondary Certificate Examination (see Appendix). In addition, the reports further revealed that students were weak in answering algebraic questions (WAEC 2013 & 2014).

Efforts have been made in the past to solve the problem of poor Mathematics achievement. These include individualized instruction, extended day programs, flexible grouping and the use of calculator in solving mathematics questions (Slavin, 1990). Abonyi and Ume (2014) stated that cooperative learning strategy, mathematical game and explicit instruction are some of the methods of curbing poor achievement in mathematics. Though these methods and strategies have been found to be efficacious for teaching

mathematics, secondary school students mathematics achievement still remain poor. The implication is that there is need for further investigation on how to improve students' achievement in mathematics. Some researchers in mathematics education, for example, Abonyi and Nweke (2014a) recommend that teaching and learning enterprise should be structured to accommodate new instructional strategies which will make students good problem solvers. Thus, this study investigated the effect of problem solving technique on secondary school students' academic achievement in selected topics in algebra.

Problem solving technique is the process of solving questions that deal with understanding the problem by splitting it into parts, identifying the knowns and unknowns, proffering a solution method and solving it (Egbo, 2004). Mayer and Wittrock (2006) defined Problem solving technique as a cognitive process directed at transforming a problem from the given state to the goal state when the problem solver is not immediately aware of the solution method. Similarly, Polya as cited in Ojukwu (2010) stated that great opportunity abound through problem solving technique for the learners to discover their mathematical talents, and further asserted that if the teacher challenges the curiosity of the students by setting problems proportionate to their knowledge and helps them solve their problems with stimulating questions, the teaching may sharpen their thinking ability. Mwelese (2014) observed that it is through problem solving technique that learners' thought-processes can be shared and translated into action, thereby making them to develop confidence in their ability to solve mathematical problems.

Egbo (2004) tabulated the branches of algebra as pre-algebra, elementary algebra, abstract algebra, linear algebra and universal algebra. The selected topics used in this work are from elementary algebra and they are word problems in simultaneous equation, variation and sequences. Word problems are problems in a sentence format. In algebraic expression, they constitute important topics in the mathematics curriculum at all levels of education in Nigeria. Achievement of students in algebra will likely contribute to their achievement in mathematics in general.

Mayer and Wittrock (2006) consider achievement as the product of mastery of concepts. Achievement therefore may be said to be an accomplishment or an act of achieving or performing desired task. Academic achievement is defined as the attained ability or degree of competence in school tasks, usually measured by standardized test and expressed in grades or units based on norms derived from a wide sampling of pupils' achievement (Nwanna, 2007). It can also be seen as the expected outcome of learning from students over a period of time which could be good or poor.

One of the factors that can influence academic achievement is gender. The issue of the influence of gender on achievement of students in mathematics has remained inconclusive. For instance, Abonyi and Nweke (2014b) established gender differences in students' achievement and interest in favour of males in Ebonyi State, Nigeria while Kolewale and Kolewale (2007) reported that girls performed better than boys in secondary school mathematics in Oyo State, Nigeria. Oguleye and Babajide (2011) stated that gender had no significance effect in science and mathematics. Based on these conflicting findings, there is need to further determine the influence of gender on students achievements in algebra when taught using problem solving technique.

Against this background, this study seeks to determine the effect of problem solving techniques on secondary school students' academic achievement in selected topics in algebra.

Research Questions

Two research questions guided the study.

Research Question One

What is the difference between the mean achievement scores of mathematics students taught selected topics in algebra with lecture method and those taught with problem solving technique?

Research Question Two

What is the difference in the mean achievement scores of male and female students taught selected topics in algebra with problem solving technique?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students taught selected topics in algebra with lecture method and those taught with problem solving technique.
2. There is no significant difference in the mean achievement scores of male and female students taught selected topics in algebra with problem solving technique.
3. There is no significant interaction effect of teaching method and gender on the mean achievement scores of students in algebra.

Table 2. Mathematics Students' Mean Scores in selected topics in algebra by teaching method and gender.

Teaching Approach	Male			Female			
	Mean Pretest	Mean Posttest	Mean Gain Score	Mean Pretest	Mean Posttest	Mean Gain Score	Difference in Mean Gain
Lecture	28.40	43.90	15.50	30.85	44.70	13.85	
Problem Solving	30.70	50.35	19.65	31.45	51.95	20.50	
Group Mean Difference			4.15			6.65	2.50

Method

The study adopted a quasi-experimental design, specifically the pre-test, posttest non-randomized control group design.

Eighty (80) SS2 mathematics students (40 males and 40 females) from two intact classes randomly selected from two co-educational schools in Owerri education zone 1 of Imo State Nigeria formed the sample of the study. One intact class was assigned the experimental group and the other the control group by tossing of the coin. Data were collected using Achievement Test in Algebra (ATA) developed by the researchers and validated by four experts. Before commencement of the treatment, ATA was administered to both groups as pre-test. Thereafter, the experimental group was taught using problem solving technique while the control group was taught using lecture method. The treatment lasted for six (6) weeks after which the ATA was reshuffled and re-administered as post test. Data were analysed using mean to answer the research questions and ANCOVA for testing the hypothesis at 0.05 level of significance. When the F-value is greater than 0.05, the hypothesis is to be accepted, otherwise reject. The reliability of ATA was obtained using Kuder-Richardson formula 20 (KR-20). The coefficient of internal consistency was found to be 0.94.

Results

Research Question One

What is the difference between the mean achievement scores of mathematics students taught Selected Topics in Algebra with lecture method and those taught with problem solving technique?

Table 1. Mean Scores of Students Taught Selected Topics in Algebra using Lecture Method and Problem solving technique.

Teaching Approach	Pre-test		Post-test	Mean Gain Score	Mean Gain Difference
	N	Mean	Mean		
Lecture Method	40	29.63	44.30	14.67	
Problem Solving	40	31.08	51.15	20.07	
Mean Difference		1.45	6.85	5.40	5.40

Table 1 shows a mean gain of 14.67 for students taught algebra with lecture method and mean gain of 20.07 for those taught with problem solving technique showing a mean gain difference of 5.40 in favour of problem solving group.

Research Question Two

What is the difference in the mean achievement scores of male and female students taught selected topics in algebra.

Table 2 shows that male students taught with problem solving technique had a mean gain score of 4.15 higher than their male counterparts taught with lecture method. Similarly, the female students taught with problem solving technique had a mean gain score of 6.65 over their female counterparts taught with lecture method. Therefore, the female students taught with problem solving technique gained higher than their male counterparts taught with the same method with a mean score of 2.50.

Hypothesis 1

There is no significant difference in the mean achievement scores of students taught selected topics in algebra with lecture method and those taught with problem solving technique.

Table 3. Summary of Analysis of Covariance of Mathematics students' mean achievement scores in selected topics in algebra by Teaching Method.

Source	SS	Df	MS	F	P
Pre-Test	366.84	1	366.84	3.96	.050
Teaching Method	860.52	1	860.52	9.29	.003*
Error	7130.66	77	92.61		
Total	190650.00	80			

Significant

Table 3 shows that there is a significant difference in the mean achievement scores of students taught mathematics with lecture method and those taught with problem solving technique. This is because the F-value of 9.26 is significant at .003 which is less than 0.05. The null hypothesis which proposed no significant difference between the two groups was therefore rejected and the alternative hypothesis accepted.

Hypothesis 2

There is no significance difference in the mean achievement scores of male and female mathematics students taught selected topics in algebra.

Table 4. Summary of Analysis of Covariance of Mathematics students' mean achievement scores in selected topics in algebra by Gender.

Source	SS	df	MS	F	P
Pre-Test	354.12	1	354.120	3.78	.055
Teaching Method	860.52	1	860.52	9.204	.003*
Gender	16.08	1	16.08	.17	.680
Error	7114.58	76	14.14		
Total	190650.00	80			

*Significant

Table 4 shows that there is no significant difference in mean achievement scores of male and female mathematics students taught selected topics in algebra with lecture method and those taught with problem solving technique. This is because the F-value of 0.17 is significant at 0.68 which is higher than 0.05. Therefore, the null hypothesis was not rejected.

Hypothesis 3

There is no significant interaction effect of teaching method and gender on the mean achievement scores of students in mathematics.

Table 5. Analysis of covariance of achievement scores of students in Achievement Test in Algebra (teaching method by gender).

Source	SS	Df	MS	F	P
Pre-Test	354.12	1	354.120	3.78	.055
Teaching Method	860.52	1	860.52	9.204	.003*
Gender	16.03	1	16.03	.17	.680
Teaching Method*Gender	6.28	1	6.28	.07	.798
Error	7108.30	75	94.78		
Total	8435.95	80			

*Significant

The interaction effect of teaching method and gender was found not to be significant at $P < 0.5$. This is because the F-value of 0.07 was significant at a probability of 0.798 (0.80) which is higher than 0.05. This is an indication that the effect of method appeared not to have significantly affected the effect of gender (see Figure 1). Therefore, the null hypothesis was accepted.

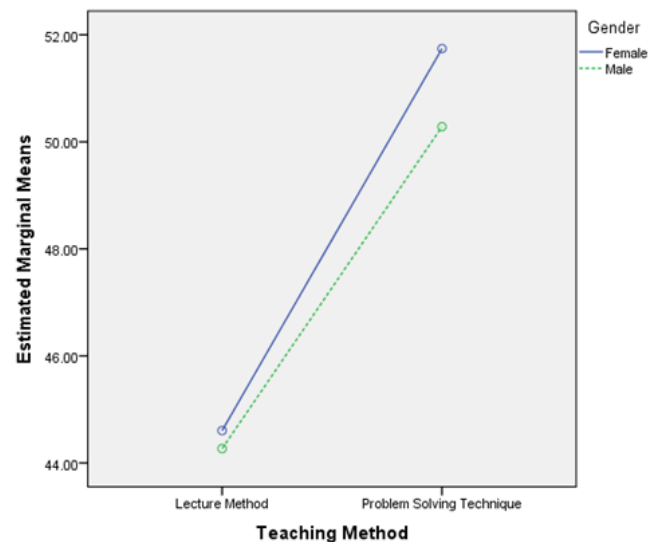


Figure 1. Interaction effect of teaching method and gender on mean achievement scores.

Discussion

The result of research question one and hypothesis one revealed that the students taught with problem solving technique achieved significantly higher than students taught with lecture method. This result is in adherence with Mayer and Wittrock's (2006) proposition that achievement is the product of mastery of concept. It entails that students in the experimental group achieved higher than those in the control group because they had mastery of the topics taught as a result of the method used in teaching them.

Results also showed that there is no significant difference in mean achievement scores of male and female mathematics students taught algebra using problem solving technique even though the female students had slightly higher mean gain score than the males. This means that problem solving technique is effective for both male and female students. This is in line with Kolewale and Kolewale (2007) who reported that girls performed better than boys in secondary school mathematics. This result supports the view of educationalists who believe that the popular notion that boys perform better than girls in mathematics and other related subjects like physics may not always be true. However, the no significant difference in the mean achievement scores of male and female mathematics students indicated in this study is in line with Ojukwu (2010) who found out that there was no significance difference between instructional method and gender on students achievement in mathematics. However, in contrast to the result of this study, Anyichie's (2012) study has it that male students outperformed the female students in mathematical word problems.

Hypothesis three shows that there was no significant interaction effect of teaching method and students' gender on their achievement in topics taught. This finding is in agreement with the studies by scholars like Osuafor, 2001; Longjohn, 2009; Ojukwu, 2010 and Ikokwu, 2013 who found no significant interaction effect between treatment and gender on students' achievement. This implies that the instructional strategies that are student-centered like problem solving technique favour both male and female students. However, this finding is not in agreement with some researchers like Mari (2002) and Nekang (2006) who found that there was significant interaction between gender and treatment on achievement.

Conclusion

This study proves that problem solving technique has more positive effect on students' achievement in mathematics than the lecture method and this positive effect tended to be higher for the female students than the males even though the difference in achievement for both groups was not significant. Overall, the results obtained from this study comply with the general expectation of science educators that activity-oriented teaching methods which center on the children are more educationally rewarding than the conventional lecture method which is teacher-centered.

Recommendations

Based on the findings, the researchers recommend that:

1. Teachers should employ problem solving technique in teaching mathematics in secondary schools.
2. Professional bodies such as Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN) and Nigeria Mathematical Society (NMS) should integrate problem solving technique into their training manual for their annual panel workshops and conferences for thorough practical demonstration of its use to all participants.
3. The Nigeria Educational Research and Development Council (NERDC) should design the mathematics curriculum in such a way as to emphasize students' active participation in the teaching and learning process of mathematics through problem solving technique.
4. Educators in Teacher Education Institutions should employ the technique in teaching pre-service teachers to enable them learn how to apply same in their respective classrooms.

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APPENDIX: Performance in Mathematics at the SSCE May/June

Year	Total No. Registered	Grades 1-6	Grades 7-9
2010	1,351,557	337,070 (24.93%)	1,144,887 (75.07%)
2011	1,540,250	473,015 (30.71%)	1,067,239 (69.29%)
2012	1,695,878	649,729 (38.8%)	1,046,722 (61.19%)
2013	1,741,298	672,130 (38.599%)	1,069,168 (61.4019%)
2014	1,887,484	699,240 (37.05%)	1,188,244 (62.95%)

Source: West African Examination Council Annual Reports (2010 – 2014)