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EFFECT OF SOLVE MNEMONIC STRATEGY AND LOCATION ON BASIC EDUCATION STUDENTS' ACHIEVEMENT AND RETENTION IN ALGEBRAIC WORD PROBLEMS IN NASARAWA STATE, NIGERIA

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Abstract

This study determined the Effect of Solve Mnemonic Strategy on Basic Education Students' achievement and retention in Algebraic Word Problems in Nasarawa State, Nigeria. The study adopted Quasi – Experimental, pretest, posttest post- posttest, non-equivalent control group design. The target population comprised all the 1853 JSII Students (1012 Male and 841 Female). The sample for the study consisted of 87 JS II Students from three intact classes out of which the experimental group consisted of 42 students (26 Urban and 16 Rural) while the control group consisted of 45 students (24 Urban and 21 Rural), their selection is purposeful in order to have data that have state representative. In choosing students, stratified random sampling technique was used on the bases of school location. The instrument for data collection was Algebraic Word Problems Achievement Test (AWPAT). The reliability of AWPAT was found to be r=0.82 using Split – Half Method. The data collected were analyzed and interpreted using mean and standard deviation to answer research questions and analysis of covariance (ANCOVA) to test the null hypotheses at 0.05 level of significance. The study revealed that Solve Mnemonic strategy enhanced students' achievement and retention in Algebraic Word Problems than those taught using conventional strategy, the findings further revealed that urban and rural students retain differently in algebraic word problems using SOLVE mnemonic strategy.

Keywords: Solve Mnemonic Strategy, Achievement, Retention, Location, Algebraic Word Problems.

Introduction

Mathematics is a powerful tool that enables us to solve problems and make informed decisions in various fields such as science, engineering, and economics Abayomi (2017). Mathematics is one of the core subjects that is taken very serious in the school system regardless of

country or level of education. Nneji and Alio (2017) stated that mathematics uncovers hidden patterns that help us to understand the world around us. Mathematics is a core subject in Nigerian education system, taught at all levels from primary to secondary education. It is considered essential for building a strong foundation in science, technology and mathematics (STEM) fields. In Nigeria, mathematics education is crucial for developing critical thinking skills and problem-solving abilities among students (FGN, 2017).

More so, the National Policy on Education states that mathematics education aims at developing individuals who are able to think mathematically, who can apply mathematical knowledge effectively and responsibly in solving problems and making decisions (Federal Republic of Nigeria, 2014). Researchers such as Obi, Abugu and Ayogu (2015) observed that despite the practical utilization, scientific, technological and cultural values of mathematics, its teaching and learning are still characterized by lots of challenges. Abdulhamid, Abubakar and Tela (2017) expressed that teaching mathematics requires application of effective methods that bring active learning, but the absence of this makes the students not to participate actively in a mathematics class.

Algebra as one of the major branches of mathematics concerns itself with the study of the rules of operations, relations, constructions, and the concepts arising from them, including terms, polynomials, equations, and algebraic structures. Algebra, according to Adeniyi and Ibrahim (2015), is an aspect of mathematics which involves the use of letter and numbers. These letters combine with figures bring a lot of confusion to the students; more so, with the letters changing values or one letter replacing another letter at intervals. Although, algebra is considered as one of the most important aspects of school mathematics; it does not only play an important role in mathematics but functions as a gatekeeper to future educational and employment opportunities (Silver, 2017).

Again, algebraic word processes contain applications to word problem involving basic arithmetic operations with algebraic symbols, word problems leading to simple linear equations, simultaneous linear equations, quadratic equation, and practical applications to word problems. However, the persistent poor achievement of students in mathematics has been a major concern for parents, mathematics educators and government who spend a lot of money in funding education but to no avail. Mashina and Timayi, (2015), ascribed the poor achievement of students to the curriculum and methods of teaching, rather than to student's

lack of capacity to learn. The selection of teaching technique is not an easy task; this is because there is no single method that seems to work well for everyone and for all situations. This is because the conventional method of teaching mathematics is no longer effective (Bolaji, Kajuru & Timayi, 2015). Also, the external mathematics examination is made up of algebraic word problems in form of mensuration, trigonometry, compound interest, to mention a few, which are to be translated into algebraic expressions or equations and solved. Students usually perform poorly in these areas and the NECO Chief Examiner reports (2014-2023) attributed the students' failure to poor grammatical expression, misinterpretation of questions, weakness in algebraic expression and word problems, among others.

The Chief Examiner reports suggested among other things, that students should try to read and understand the questions before answering them. For the candidates' weakness in algebraic expression and word problems, Kovarik (2012) posited that the inability of students to understand the vocabulary used in instructions and word problems are among the reasons. Kovarik explained further that although students may excel in computation, their ability to apply their computational skills in algebra will be hindered if they do not understand the vocabulary used in instructions and in the word problems' tests.

In addition, memory of factual information is essential for success in addressing inconsistencies in mathematics achievement and retention; additional studies are needed to determine if mnemonic strategy instruction can be considered an evidence based practice in mathematics as well. There are a number of mathematical mnemonic strategies (SOLVE, TINS) that are being used by secondary teachers across United States of America. For example, the National Training Network has published curricula (e.g., Algebraic Thinking) that are being implemented across the U.S.A by districts and individual schools with the SOLVE and TINS mnemonic strategies as some of its major components. Mnemonic means are often applied in mathematics instruction to help students memorize steps or operations (Mastropieri & Scruggs, 2013). A number of mnemonics means have been used with these students in learning mnemonic skills such as SOLVE and TINS with an acronym to represent each step for learners to follow. SOLVE is a mnemonic strategy, representing studying the problem, organizing the facts, lining up a plan, verifying the plan with action, and evaluating the answer (Mastropieri & Scruggs, 2013). SOLVE mnemonic strategy is taught through Direct Instruction by breaking

down the skill into a step-by-step procedure; for example, lessons address each of the five steps in small parts of information. First, students learn how to solve a word problem by following a sequence which begins with studying the problem. In this step, students are instructed to determine what the problem is being asked. The second step is to organize the facts. Students are shown how to identify the important facts in the problem. The third step is to line up a plan. Students are instructed to plan to solve the problem without using numbers. The fourth step is to verify the plan with action. Students learn to verify the plan they created in the third step, plug in numbers and solve the equation. The final step is to evaluate the answer. Students are shown how to check their results by asking questions such as, does the answer make sense or is it reasonable and correct?

Maghy (2015) examined the effect of mnemonics on Students' Performance and Retention in Algebraic Word Problems in mathematics at high school level. The results showed a significant difference in performance in favors of the mnemonics group. Also, the mnemonics group were observed to have better retention ability compared with their counterpart in the conventional group.

Closely connected to achievement is retention. This is because if knowledge is retained, then it can be recalled when needed. Retention in mathematics refers to the ability of students remember and apply mathematical concepts over and skills over time (Adebayo & Ogunniyi, 2017). Retention comes in before recall. It is recall that reveals how much knowledge the students have retained after the teaching and learning. Retention can be the extent to which one can retrieve information from long term memory. Research evidence have consistently indicated teaching method as a major factor determining the achievement and retention of students in mathematics. Hence the search for better methods and newer innovations is a great challenge facing mathematics educators.

School location is another moderator variable whose choice is based on research reports that there is a variation in the achievement of students in mathematics in terms of school location (rural or urban) appears to affect students' achievement and retention in mathematics. Olueh (2016) surveyed the works of different researchers on school location and achievement and found that there were sharp contrasts between rural and urban schools in terms of staff quality and instructional facilities.

Objectives of the Study

The objectives of the study are to determine:

1. effects of SOLVE Mnemonics strategies and conventional method on JS students' achievement in algebraic word problems.
2. effect of SOLVE mnemonic strategy on JS students' achievement by school location in algebraic word problems.
3. effects of SOLVE Mnemonics strategies and conventional method on JS students' retention in algebraic word problems.
4. effect of SOLVE mnemonic strategy on JS students' retention by school location in algebraic word problems.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of JS students taught algebraic word problems using SOLVE mnemonic strategy and conventional method?
2. What are the mean achievement scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?
3. What are the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy and conventional method?
4. What are the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?

Test of Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

H_{01}: There is no significant difference in the mean achievement scores of JS students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

H_{02}: There is no significant difference in the mean achievement scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools.

H_{03}: There is no significant difference in the mean retention scores of JS students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

H_{04}: There is no significant difference in the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools.

Methodology

This study adopted quasi-experimental design of pretest posttest, post-posttest non-equivalent control group design. The population of the study consisted of all the junior secondary school students' studying mathematics in Nasarawa State. The target population of the study comprised all the JSII students in the public co-education schools. It was made up of a total of 1853 students (1012 males and 841 females) in the 2020-2021 academic session. The sample for the study consisted of 87 JS II students from four junior secondary schools. The study adopted multi-stage random sampling technique. Out of the three senatorial zones in Nasarawa State, three Local Government Areas (LGAs) were selected, namely; Akwanga, Lafia and Keffi. Their selection was purposeful in order to have a data that have State representation. Using the ballot technique, two schools from each of the three selected LGAs were used. Co-educational schools were drawn from the list of schools in the area of study, the bases for the selection of the participating schools were: The schools must be co-educational, there must be qualified mathematics teachers who have been in the schools for a minimum of 3 years, as well as school location, willingness on the part of the schools to cooperate with the researcher, and the schools must be distant from each other to avoid interaction effects. In each school, one intact class was randomly drawn and the number in each class was collected through physical presence of students.

Algebraic word problem achievement test (AWPAT) was the instrument used for data collection. It was developed by the researcher, and consisted of 50 objective test items using content on algebraic word problem concepts. This topic is derived from the national curriculum for junior secondary school mathematics and it was selected because it features in (JSS2) mathematics curriculum. It was used to determine the achievement of students in algebraic word problem concept in mathematics. As a multiple choice objective test, AWPAT had four options lettered A-D. The instrument was structured according to level of the cognitive domain. The instrument upon validation was trial tested on 32 JS II students in order to establish the reliability coefficient of the instrument. The internal consistency of AWPAT was found to be 0.82. The data collected was analyzed and interpreted using mean and standard deviation to answer research questions. Analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Results

Research Question 1

What are the mean achievement scores of JS students taught algebraic word problems using SOLVE mnemonic strategy and conventional method?

Table 1: Mean achievement Scores and Standard Deviation of Basic Education Students' taught AWP in Experimental and Control Groups

Strategies	N	Pre-Test		Post-Test	
		Mean	SD	Mean	SD
SOLVE Strategy	42	13.10	1.59	24.12	2.62
Conventional Method	45	10.40	2.35	13.76	1.45
Total	87				

Table 1 showed that the pretest mean score and standard deviation of students in algebraic word problem using SOLVE mnemonic strategy was (13.10, 1.59) and posttest mean score and standard deviation was (24.12, 2.62), while the pretest and posttest mean scores and standard deviation of their counterparts taught using conventional method was (10.40, 2.35) and (13.76, 1.45). Therefore, students taught algebraic word problems with SOLVE strategy had higher achievement mean score than their counterpart in the control group

.Hypothesis 1

There is no significant difference in the mean achievement scores of JS students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

Table 2: ANCOVA Results on Achievement of Basic Education Students Taught AWPAT Using SOLVE Mnemonic Strategy and Conventional Method.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	232.079	2	116.039	12.121	.000
Intercept	358.445	1	358.445	37.440	.000
Pretest	144.214	1	144.214	15.063	.000
strategy	89.665	1	89.665	9.366	.003
Error	804.197	84	9.574		
Total	47891.000	87			
Corrected Total	1036.276	86			

In order to test whether there was a statistical significant mean difference between the groups, ANCOVA was computed. Table 2 shows that p- value of 0.03 is less than the p – value of 0.05 ($F_{(1, 84)} = 15.06$, $P = 0.03$, $\propto = 0.05$). The null hypothesis of no significance was rejected at 0.05 alpha level. The result implies that there is a significant difference between the mean achievement scores of students taught algebraic word problems using Solve mnemonic strategy than those taught using conventional strategy.

Research Question 2

What are the mean achievement scores of JS11 students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?

Table 3: Mean achievement Scores and Standard Deviation of Basic Education Students' taught SOLVE Mnemonic Strategy in Urban and Rural Schools

Location	N	Pre-Test		Post-Test	
		Mean	SD	Mean	SD
Urban	26	13.38	1.81	21.69	2.75
Rural	16	12.63	1.02	23.31	1.74
TOTAL	42				

Table 3 shows the pretest and posttest mean performance score and standard deviation of students taught algebraic word problems using SOLVE mnemonic strategy in terms of location, urban students' mean achievement score and standard deviation was (13.38, 1.81) and posttest mean achievement score and standard deviation was (21.69, 2.75). Also, pretest and posttest mean achievement score and standard deviation for rural students was (12.63, 1.02) and (23.31, 1.74).

Hypothesis 2

There is no significant difference in the mean achievement scores of JS11 students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural school.

Table 4: ANCOVA Results on Achievement of Basic Education Students Taught AWPAT Using SOLVE Mnemonic Strategy in urban and rural school.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	26.362	2	13.181	2.191	.125
Intercept	268.958	1	268.958	44.709	.000
Pretest	.362	1	.362	.060	.808
Location	25.987	1	25.987	4.320	.144
Error	234.614	39	6.016		
Total	21165.000	42			
*Corrected Total	260.976	41			

Table 4 ANCOVA result revealed that there was no statistical significant mean difference between urban and rural students ($F_{(1, 39)} = 4.320$, $p = 0.144$, $\propto = 0.05$). The hypothesis 2 was not rejected at 0.05 level of significance. The result implies that Solve mnemonic strategy enhanced performance of both urban and rural students taught algebraic word problems.

Research Question 3

What are the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy and conventional method?

Table 5: Mean retention Scores and Standard Deviation of Basic Education Students taught AWPAT in SOLVE Mnemonic Strategy and Conventional Method

Strategies	N	Post-Test		Post-Posttest		Retention mean difference
		Mean	SD	Mean	SD	
SOLVE	42	24.12	2.62	26.05	2.14	(1.93)
Conventional Method	45	13.76	1.45	17.36	2.19	(3.60)
Total	87	10.36		8.69		1.67

Table 5 showed the retention scores and standard deviation of experimental group and the control group in the posttest and post-posttest, the retention scores and standard deviation of SOLVE mnemonic strategy was (24.12, 2.62) and (26.05, 2.14), conventional method (13.76, 1.45) and (17.36, 2.19) with retention mean difference of 1.67.

Hypothesis 3

There is no significant difference in the mean retention scores of JS students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

The data presented in Table 6 were used to test hypothesis 3.

Table 6: ANCOVA Results on retention of Basic Education Students Taught AWPAT Using SOLVE Mnemonic Strategy and Conventional Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	46.46576	2	1548.859	398.463	0.000
Intercept	426.782	1	426.782	109.795	0.000
Posttest	41.774	1	41.774	10.747	0.001
Strategies	357.926	2	178.963	4.6041	0.000
Error	470.336	85	3.887		
Total	36067.000	87			
Corrected Total	511.6912	86			

Table 6 ANCOVA result revealed that there was a statistical significant mean difference between SOLVE Mnemonic Strategy and Conventional method ($_{F\ (1,\ 87)}$ = 4.6041, p = 0.000,$\propto = 0.05$). Hypothesis was rejected at 0.05 alpha level.

Research Question 4

What are the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?

Data used to answer research question 4 are presented in Table 7.

Table 7: Mean retention Scores and Standard Deviation of Basic Education Students' taught AWPAT Using SOLVE Mnemonic Strategy Based on location

Location	N	Post-Test		Post-Posttest		Retention mean difference
		Mean	SD	Mean	SD	
Urban	26	20.26	5.53	25.30	6.89	(5.04)
Rural	16	20.41	5.02	25.67	5.69	(5.26)
TOTAL	42	0.15		0.37		0.22

Table 7 showed the retention mean scores and standard deviation in the posttest and post-posttest of SOLVE mnemonic strategy in terms of location. Urban students' retention mean scores was (20.26, 5.53) and (25.30, 6.89) with retention gain of 5.04, while their rural counterparts mean scores was (20.41, 5.02) and (25.67, 5.69) with retention mean gain of 5.04 and 5.26 and retention mean difference of 0.22.

Hypothesis 4

There is no significant difference in the mean retention scores of JS students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools.

Table 8: ANCOVA Results on Basic Education Students' taught AWP using SOLVE mnemonic Strategy Based on Location

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	30.129	2	15.064	3.724	0.033
Intercept	255.797	1	255.797	63.229	0.000
Posttest	18.436	1	18.436	4.557	0.039
Location	21.160	1	21.160	5.230	0.128
Error	157.776	39	4.046		
Total	38108.000	42			
Corrected Total	187.905	41			

Table 8 revealed that there was a statistical significant retention difference between the urban and rural students that were taught algebraic word problems using SOLVE strategy ($F_{(1, 39)} = 5.230$, $P = 0.128$, $\alpha = 0.05$) in favor of rural students with retention mean score of 25.67. The hypothesis was not rejected at 0.05 alpha level of significance

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Discussion of Findings

the finding of the study revealed a significant achievement in algebraic word problems in the experimental group when taught using SOLVE Mnemonic strategy compared to the conventional method of teaching. This study is in agreement with the findings of Akinsola and Odeyemi (2014), since SOLVE mnemonic strategy enhanced students' achievement in algebraic word problems in mathematics, teachers should create mnemonics that link old and new information in the students' memory. The findings of the study further revealed that SOLVE mnemonics strategy enhanced JSII students' achievement in algebraic word problems of urban and rural schools' students' equally. This signifies that both urban and rural school students' benefitted from SOLVE Mnemonic strategy. Obviously, the result in this study is in contrast with that of Olueh

(2016) who found that location of school (urban or rural) appears to affects students' achievement in mathematics.

The findings further revealed that urban and rural students retain differently in algebraic word problems using SOLVE mnemonic strategy, even though, the rural students had higher retention mean scores than the urban students in the retention test. Obviously, the result in this study is in agreement with that of Olueh (2016) who found that location of school (urban or rural) appears to affects students' achievement and retention in mathematics.

Conclusion and Recommendations

Based on the findings of this study, solve mnemonic strategy enhanced and improved

JSII students' achievement in algebraic word problems than the conventional method. Solve Mnemonics strategy influence better understanding in algebraic word problems by students of both urban and rural schools.

Also this study confirmed that students' retention in algebraic word problems depend on the method of instruction. It can be acknowledged that teachers' regular use of this strategy will certainly enhance teaching output to a great extent. Based on the results of the data analysis, the following recommendations are made.

1. Mathematics teachers should be exposed to SOLVE mnemonic in their instructional strategies through seminars or training to improve their inputs during teaching –learning.
2. mathematics teachers should vary their instructional style by using SOLVE as against consistent use of Conventional Learning Strategy. This will increase the academic achievement and retention of mathematics students.
3. Periodic and regular training through seminars and workshops should be organized for in-service teachers to update their knowledge on SOLVE

mnemonic strategy at basic secondary schools by State Government.

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