EFFECT OF SOLVE MNEMONIC STRATEGY AND SCHOOL LOCATION ON BASIC EDUCATION STUDENTS' PERFORMANCE 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' performance 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 Performance 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' performance in Algebraic Word Problems than those taught using conventional strategy (*$F_{(1, 84)} = 15.06$, $P = 0.03$, $\propto = 0.05$*) and irrespective of school location (*$F_{(1, 39)} = 4.320$, $p = 0.144$, $\alpha = 0.05$*). Based on the findings of this study, solve mnemonic strategy enhanced and improved JSII students' performance 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. The following recommendations were made: Teachers should adopt Solve Mnemonic strategy in teaching mathematics in basic secondary schools as to improve students' performance in algebraic word problems. 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.*

Key words: Solve Mnemonic Strategy, performance, Location and Algebraic word problems

Introduction

Mathematics involves calculation, computation, solving of mathematical problems. Nneji and Alio (2017) stated that Mathematics reveals hidden patterns that help us to understand the world around us. Now, much more than arithmetic and geometry, mathematics today is a diverse discipline that deals with data, measurements and observations from science, with inference, deduction, and proof; and with mathematical models of natural phenomena, of human behavior, and of social systems. It may also be defined as, the study of quantity, structure, space and change; it has historically developed, through the use of abstraction and logical reasoning, from counting, calculation, measurement, and the study of the shapes and motions of physical objects. Mathematic is a way to settle in the

mind of children a habit of reasoning Malik (2017). This involvement is as old as mathematics itself and it can be argued that, without mathematics, there can be neither science, technology nor engineering.

More so the National Policy on Education specifies 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). One of the major challenges of mathematics in the school system is how to learn its concepts and effectively retrieve the learned concepts. For learning to take place, students must interact with mathematics ideas in active and constructive way. There is need for students to be proactively involved in their learning, they should not be seen as people with nothing to offer, people who just go to school to receive knowledge from teachers.

Researchers such as Obi, Abugu and Ayogu (2018) observed that despite the practical utilization, scientific, technological and cultural values of mathematics, its teaching and learning is still characterized with lots of challenges. Learning is a process which should produce desired changes in the behaviour of students. Consequently, the learning situations utilized in the classroom are important for the understanding of the concept taught. Learning occurs when insight is gained, and when the processes are understood, in short when interaction has taken place between the teacher and the learner and between learners and their peers. Some teachers still believe that knowledge is transferred to their students but in reality students learn by doing and this is reinforced by the use of innovative teaching strategies. Abdulhamid, Abubakar and Tela (2018) 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 mathematics class.

Algebra according to Adeniji 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. For students to understand and possess the mathematical skills of mnemonic, communication, reasoning and making connections that are necessary in human daily living they need algebra. Algebra is a foundation and language system on which higher order mathematics, sciences, technology and engineering courses are built (Musen, 2010). Algebra being useful in other branches of mathematics, gives compact formulae or generalization to be used in all cases. Algebra has practical value in many of the trades and industries, provides an effective way for expressing complicated relations, inculcates the power of analysis, and is a good instrument for mental training. Kaplan, Fisher and Rogness (2009) stated that algebra often serves as a gate keeper to success in post-secondary education, and many career paths. However, its learning has remained a significant challenge to students all over the world; there are three fundamental understanding in learning algebra which can serve as impediment to mastering it by many students, the abstract reasoning, the language and the structure.

Also 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. In view of the significance of mathematics to the individual's daily life and the society at large, it is anticipated that

the students' performance in the subject should be well above average. However, the persistent poor performance 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) blamed the curriculum and methods of teaching rather than 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 all situations. In addition, every teacher should identify appropriate methodology based on the nature of the subject matter and instruction to be given. Most teachers use irrelevant and ineffective methods of teaching which among other factors contribute to students' poor performance in Mathematics. The need to find reliable ways of improving students' performance in mathematics is becoming an international issue. This is because the Conventional method of teaching mathematics is no longer effective (Bolaji, Kajuru &Timayi, 2015). Also as a result, the external mathematics examinations are 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 (2010 - 2018) 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 that Students should try to read and understand the questions before answering them among others. 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. Hence, knowing and understanding the language of an instruction is an important factor in relation to how successful the student would be, especially those involving word problems (Adams, 2013). The difficulty of these algebraic words may be a major part responsible for poor performance in mathematics. Word problems are simply problems situated in a real life context (Verschaffel, Van Dooren, Greer, & Mukhopadhyay, 2010); it is this characteristic that differentiates them from other types of problems. This context requires students to read and understand in order to solve the problem while at the same time incorporate their mathematical understanding. As word problems are not given in a "plain" mathematical expression, they require complex steps to solve. That is, reading, comprehending, transforming into mathematical expression, processing the mathematics, interpreting result to context given, and evaluating the result (Reys, Lindquist, Lambdin, & Smith, 2008; Ryan & Williams, 2007). Despite their real life context, the context of word problems is "situated" or encoded into syntax and expression, familiar to mathematics (Reed, 2009). The role of students in reading and comprehending the words in word problems thus are affected by this mathematically-situated context.

In addition, memory of factual information is essential for success in addressing inconsistencies in mathematics performance, 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 one of its major components.

Teachers are required to provide students with explicit instruction on the process of word mnemonic, but they are confronted with determining effective instruction to produce the best learning outcomes of their students (Miller, 2007). Mnemonic means are often applied in mathematics instruction to help students remember 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, 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? SOLVE was shown to be a strong starting point for secondary school students to learn building mnemonic skills, such as organizing information and identifying what is important in a problem (Mastropieri & Scruggs, 2013). The explicit instruction, to teach SOLVE in a step-by step format has ensured that students have repeated practice and guidance during the process of learning.

School location is another moderator variable whose choice is based on research reports that there is a variation in the performance of students in mathematics in terms of school location (rural or urban) appears to affect students' performance in mathematics. Olueh (2016) surveyed the works of different researchers on school location and performance and found that there were sharp contrasts between rural and urban schools in terms of staff quality and instructional facilities. Hence, this study investigated effect of SOLVE Mnemonics strategy in Nasarawa state, Nigeria

Research Question

The following research questions guide the study.

1. What are the mean performance scores of JS11 students taught algebraic word problems using SOLVE Mnemonics strategy and conventional method?
2. What are the mean performance scores of JS11 students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?

Statement 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 performance scores of JSII students taught algebraic word problems using SOLVE mnemonic strategy and Conventional Method.

H_{02}: There is no significant difference in the mean performance scores of JS11 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 consists of all the junior secondary school students' studying mathematics in Nasarawa state. The target population of the study comprised of all the JSII students in the public co-education schools that was made of 1853 (1012 male and 841 female) in the 2020-2021 academic Session. The sample for the study consisted of 87 JS II students from two junior secondary schools 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). The study adopted multi-stage random sampling technique. There are 13 local government areas in Nasarawa state which are categorized under 3 senatorial zones. Simple random sampling of lucky dip was employed to select 3 local government areas from which the sample for the study was drawn. Followed this method, purposive sampling technique was used to obtain three co-education schools. Their selection was purposeful in order to have a data that have state representative and based on gender composition. Finally, from the three co-education schools, one intact class each was randomly drawn for the study using simple random sampling technique. Two intact classes from three selected schools were assigned to the experimental group and the other intact class to the control group. Algebraic word problem performance test (AWPAT) was an instrument developed by the researcher consisting 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 performance of students in algebraic word problem concept in Mathematics. The AWPAT was a 50 item multiple choice objective test with four options lettered A-D, with the total score of 50 marks. 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 coefficients 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 for testing the null hypotheses at 0.05 level of significance.

Results

Research Question 1

What are the mean performance scores of JS11 students taught algebraic word problems using SOLVE Mnemonics strategy and conventional method?

Table 1: Mean Performance 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 and posttest mean score and standard deviation of students in algebraic word problem using SOLVE mnemonic strategy were (13.10, 1.59) and (24.12, 2.62) respectively, 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) respectively. Therefore, students taught algebraic word problems had higher performance mean score than their counterparts in the conventional method.

Hypothesis 1

There is no significant difference in the mean performance scores of JS11 students taught algebraic word problems using SOLVE mnemonic strategy and Conventional Method.

Table 2: ANCOVA Results on Basic Education Students' Performances Scores of Experimental and Control Groups.

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 performance scores of students taught algebraic word problems using Solve mnemonic strategy than those taught using conventional strategy.

Research Question 2

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

Table 3: Mean Performance 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 performance score and standard deviation was (13.38, 1.81) and posttest mean performance score and standard deviation was (21.69, 2.75). Also, pretest and posttest mean performance 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 performance scores of JS11 students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural school.

Table 4: ANCOVA Results on Basic Education Students' taught AWP using SOLVE Mnemonic Strategy in Urban and Rural Schools.

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.

Discussion of Findings

The finding of the study revealed a significant performance 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' performance 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' performance 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' performance in mathematics.

Conclusion

Based on the findings of this study, solve mnemonic strategy enhanced and improved JSII students' performance 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.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Teachers should adopt Solve Mnemonic strategy in teaching mathematics in basic secondary schools as to improve students' performance in algebraic word problems.
2. 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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