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INVESTIGATING THE EFFECT OF PROBLEM-SOLVING APPROACH ON SENIOR HIGH SCHOOL STUDENTS' PERFORMANCES IN ALGEBRAIC LINEAR EQUATION WORD PROBLEMS

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Abstract

This study was conducted to investigate the effect of problem-solving approach of teaching on senior high school students' performances in solving algebraic linear equation word problems. A quasi-experimental non-equivalent pretest-posttest control group research design was employed and adopted a quantitative method of data analysis and presentation. The study involved thirty (30) students in the experimental group and twenty-two (22) in the control group in the Kwaebibirem Municipality of the Eastern Region of Ghana. The experimental group was exposed to problem-solving teaching strategies, while the control group was taught using a traditional teaching approach. A pre-test was conducted before the treatment and a post-test after the treatment. The pre-test and post-test scores obtained by the students were analysed using the Statistical Package for Social Sciences (SPSS) software. Upon scrutiny of students' pre-test marked scripts, students' difficulties in solving algebraic linear equation word problems were found to be: (1) Lack of understanding of the problem statement; (2) misinterpretation of the problem statement; (3) computational errors, and (4) inability of students to apply the appropriate mathematical knowledge. The analysis of students' pre-test and post-test scores also showed that students in both control and experimental groups performed better in the post-test than the pre-test, however, the experimental group made more improvement in solving algebraic linear equation word problems as compared to students in the control group. The study, therefore, recommends that Mathematics teachers should employ a problem-solving approach to teaching in their classroom to enhance students' understanding of mathematics concepts.

Keywords: problem-solving approach of teaching, traditional teaching approach, word problems, students performance in mathematics

1.0 INTRODUCTION

Mathematics is a compulsory subject for all students at the Senior High School (SHS) level in Ghana. This is necessitated by the fact that knowledge of Mathematics is crucial for all members of a society to function well. According to Adu, Mereku, Assuah, and Okpoti (2017), a strong background in Mathematics and its applications is essential in many technically oriented work sectors. This is because Mathematics forms the basis of critical, analytical and logical problem solving that is often vital in many fields of work.

At the Senior High School level, Mathematics education is meant to enable all Ghanaian young persons to acquire the mathematical skills, insights, attitudes, and values that they will need to be successful in their chosen careers and everyday lives (Ministry of Education [MOE], 2010). The rationale for teaching Mathematics therefore is to prepare students for life by equipping them with knowledge, skills, ability to think logically and analytically and develop their ability to solve problems in different fields. Mathematics is recognized as an important subject all over the world because of its relevance to science and technology. It has been described as the bedrock and an essential tool for the economic, scientific, and technological progression of any nation (Umameh, 2011; Charles-Ogan & Otikor, 2016).

Notwithstanding the crucial role Mathematics plays in the lives of every individual and the nation in general, students in senior high schools continually register poor results at the West Africa Senior School Certificate Examination (WASSCE). This poor performance is evident in the results in core Mathematics for May/June WASSCE from 2015 to 2018. The percentage of candidates with grades (A1 – C6) in Mathematics increased from 25.29% in 2015 to 32.83% in 2016 and then increased again to 42.73% in 2017. In the subsequent year, this trend did not continue as expected. The performance of the candidates in Mathematics dropped from 42.73% in 2017 to 38.33% in 2018. Mereku (2010) attributed the abysmal performance of students in Mathematics to the inappropriate teaching methods in the traditional Ghanaian classroom. Ampadu (2012) contends that most students in Ghana consider mathematics teachers as the custodians of knowledge, hence, their success in mathematics depends upon their ability to adhere to their teacher's instructions and approach of solving problems. This method of teaching does not promote active participation of students during mathematics lessons. There is therefore the need for an instructional approach that will enhance students' understanding and performance in Mathematics. Problem solving approach (PSA) of teaching is a learner-centered teaching strategy that engages learners actively in the teaching/learning process, enhances their understanding of mathematics concepts, and develops their problem-solving skills. Mereku and Cofie (2008), maintain that a problem-solving approach to teaching Mathematics goes beyond helping students to solve routine problems to non-routine problems. Cai (2010) posits that if students are to become successful problem solvers, problem-solving should be the central part of teaching and learning mathematics In the mathematics curriculum in Ghana, teaching through problem-solving is emphasised in word problems across topics in Mathematics (MOE, 2010). This emphasis is based on the belief that students will develop important mathematical competencies through problem-solving instruction.

1.1 Research problem

A word problem is a verbal description of a problem situation in which one or more questions are asked, and the answer(s) can be obtained by applying mathematical symbols and operations to numerical thedata available in the problem statement (Verschaffel et al., 2000). The solution to a word problem depends on the student's ability to translate the numerical data in the text into mathematical notations. In line with Kersaint, Thompson, and Petkova (2009), solving word problems involves knowledge about semantic construction and mathematical relations, as well as knowledge of basic numerical skills and strategies.

Evidence of poor performance in mathematics in the West African Senior School Certificate Examination (WASSCE) by senior high school (SHS) candidates in Ghana implies that the most desired technological, scientific, and business application of mathematics cannot be achieved. Chief Examiner's reports (WAEC, 2014; 2015; 2017) stated that most candidates could not translate word problems into mathematical statements, hence their inability to solve them. Solving word problems has been one of the students' difficult areas in Mathematics (Rosales, Santiago, Chamoso, Munez, & Orrantia, 2012). The difficulties students encounter in the process of solving algebraic word problems may be attributed to ineffective teaching approaches employed by teachers in their lesson delivery. Most teachers use the traditional teaching approach where students watch passively, listen, and later practice what the teacher taught them (Boaler & Staples, 2008). This type of instructional strategy does not enhance better understanding and problem-solving skills in students. Students develop a deeper understanding of mathematical concepts when they are provided with appropriate learning activities. Problem-solving goes beyond the usual reasoning students assume in the process of solving exercises. It involves thinking deeply about concepts, their related representations, appropriate solution procedures, and creating problem models (Polya, 1945). This study investigates the effect of a problem-solving approach on Asuom Senior High School students' performances in solving algebraic linear equation word problems.

1.2 Research Questions

1. What difficulties do students encounter in solving algebraic linear equation word problems?
2. What is the effect of the traditional teaching approach on students' performances in solving algebraic linear equation word problems?

3. What is the effect of the problem-solving approach on students' performances in solving algebraic linear equation word problems?

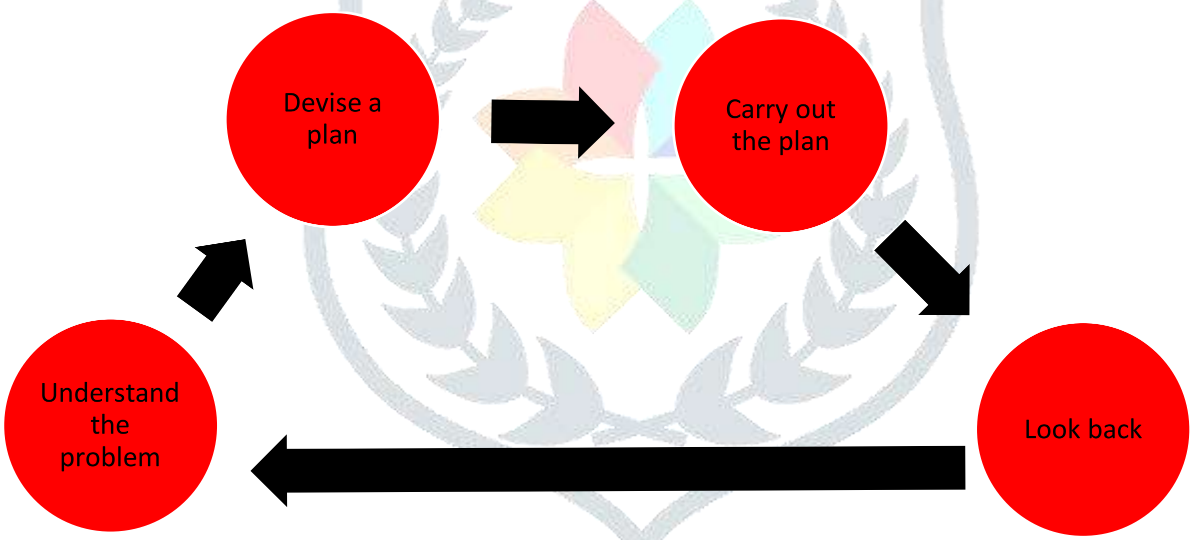
1.3 Research Hypothesis

H_0: There is no difference in performance between students taught algebraic linear equation word problems using a traditional approach and a problem-solving approach.

2.0 Review of related literature

2.1 Theoretical framework

In this study, a problem-solving approach of teaching, and the problem-solving model constructed by Polya (1945) were employed. Problem solving entails defining the problem, collecting relevant information needed to solve the problem, carry out the solution, checking and evaluating the solution. Polya (1945) explained that, a problem solving is the process used to solve problems that do not have a clear solution path. Polya (1945) asserts that successful problem solvers often go through four stages of problem solving. These are:



Polya's (1945) Problem-Solving Model

Understand the problem. At this first stage, the problem solvers read through the problem statement for understanding. As they read, they use comprehension strategies to translate the numerical information in the problem statement into mathematical notations. They identify the important information require to solve the problem.

Devise a plan. At this stage, the problem solvers generates an appropriate solution plan for solving the problem by breaking it down into a series of steps, usually requiring the formulation of mathematical notations or formula from the text.

Carry out the plan. At this stage, arithmetic computations performed. This involves solving the problem step-by-step and if the solution is not found, the strategy is changed.

Look back. At this last stage of Polya's problem-solving model, the problem solver checks the previous steps to ensure that the answer is correct and also make sense. The problem-solving process is repeated when the answer is not found.

2.2 Problem Solving Approach of Teaching Mathematics

According to Schoenfeld (2013), problem-solving is a cognitive process aimed at solving a problem when no obvious solution path is available to the problem solver. Teaching mathematics through a problem-solving approach provides a learning environment for students to learn on their own, to enquire into problems and to find appropriate ways to solve the problem. Mtitu (2014) explained that, for effective and efficient teaching, learner-centered approaches that promote active participation of learners in the teaching and learning process must be employed. You (2014), contends that students' participation and active involvement in the teaching and learning process enhance their understanding of the subject matter. Polya (1945) Problem-solving model involves four stages: Understand the problem, Devise a solution plan, Carry out the plan, and Look back. Mereku and Cofie (2008) maintain that problem-solving approach to teaching Mathematics goes beyond assisting learners to solve routine problems to non-routine. Problem-solving strategies enhances students' mathematical understanding and in turn, support students to become more efficient and effective problem solvers.

2.3 Problem Solving

Oyarole (2012) described problem solving as the procedure taken by a problem solver to search for solution(s) to problem(s). It is a method concerned with the creative thinking of everyday life. Problem solving is a vehicle through which students can achieve the functional, logical and important values of Mathematics (Taplin, 2006). To solve a word problem, learners must manage both the text and the Mathematics encoded within the text (Vilenius-Tuohimaa, Aunola, & Nurmi, 2008). One's reading ability influences how likely an individual will solve a word problem (Vilenius-Tuohimaa et al., 2008) and similarly, one's knowledge of Mathematics influences how well an individual deciphers Mathematics texts (Pape, 2004).

Academic achievement in Mathematics is greatly influenced by students' active participation in the teaching/learning process. Problem solving is critical for success in learning Mathematics. Learning to solve word problems involves knowledge of semantic construction and mathematical relations as well as knowledge of basic numerical skills and strategies. Yet, story problems pose difficulties for many students because of the complexity of the solution process. Anderson, Sullivan, and White (2004), described problem solving as the process by which students use different strategies to solve unfamiliar task. Problem solving is tackling a problem that does not have a known solution path. Montague (2003) asserts that, good problem solvers use a variety of processes and strategies as they read and represent the problem before they make a plan to solve it. First, they read the problem for understanding. As they read, they used comprehension strategies to translate the linguistic and numerical information in the problem into mathematical notations. They paraphrase the problem by putting it into their own words. They identify the important information and may even underline parts of the problem.

2.4 Students' Difficulties in Solving Word Problems

In order for students to acquire learning gains in mathematics, teachers need to know the challenges that impede students from solving mathematics successfully. Ilany and Margolin (2010) indicated that students' difficulties in solving Word Problems were due to the existence of the knowledge gap between Mathematics language and natural language, and knowledge gaps between the textual unit and the hidden mathematical structure. Ilany et al. (2010) further stated that the difficulty with the solution of mathematical word problems is the need to translate the event described in natural language to arithmetic operations expressed in mathematical language. The translation from natural language includes the syntactic, semantic, and pragmatic understanding of the discourse. The vocabulary aspect of the problem can be challenging. Sometimes, students do not comprehend the meaning of some words in text and this makes them feel frustrated and think that the problem is difficult to solve. The difficulty of translation highlighted the necessity that the student should be able to identify the textual clues suggesting specific mathematical operations and be able to understand the 'literal clues', that is the words that support (*helpful clues*) or the words that deceive (*misleading clues*), as clues for choosing the arithmetic operations needed to solve the problem (Ilany et al. 2010, p. 143). Correct identification of the mathematical operations in the Algebraic Word Problem (AWP) text is fundamental to the subsequent creation of the equation(s) to be solved in the complete algebraic word problem solution process. Students fail at problem solving because they are not equipped with the needed tools to learn how to solve word problems. Hence, students need mathematics strategies, reading and comprehension techniques.

Bishop et al. (2008) indicates that, the difficulties students encounter when translating word problems from natural language to algebra and vice versa. Portal and Sampson (2001) stated that students find it difficult to solve word problems because they are not sure and cannot decide on what operation to use.

Yeo (2009) indicated that students have difficulties in solving word problem because they do not understand the problem as they find it confusing. The difficult part of solving mathematics word problems appear to be the process of understanding the problem and deciding what operation(s) need(s) to be carried out in a certain problem (Sepeng & Madzorera, 2014). This implies that success in solving algebraic word problems require students to gain familiarity with the vocabulary of Mathematics before they can solve word problems effectively. Sepeng (2013) observes that solving algebraic word problems is difficult for many students because of the unrealistic strategies that they tend to employ in solving these problems. Lumpkin and McCoy (2007) observed that students' incorrect responses to word problems could be attributed to an error in one of three places along the problem solving process: an incorrect interpretation of or inability to understand the problem, flaws in the setup of the problem, and/or errors in computation.

A study conducted by Aniano (2010) revealed that the level of difficulties in translating phrases to mathematical symbols was one of the factors that determine the problem solving skills of students. This view was supported by Vista (2010), that students' comprehension in translating phrases into mathematical symbols affects their performance in solving word. Students make errors in translating word problems from the natural to the mathematical language due to lack of command of the English language, that is, they are not able to construct a meaningful body of knowledge from the information in the question, including data and a solution scheme (Ilany et al., 2010)

2.5 Traditional Teaching Approach

Traditional teaching approach is an instructional strategy where lessons are delivered by given a set of rules to students to be followed without the students knowing how those rules came about (Akyeampong et al., 2013). In this approach, active participation of students during teaching and learning is not encouraged. Hence, turn students to passive receivers of information. According to Bello (2014), traditional teaching method is an instructional strategy where the teacher's role is to present information that is to be learned to the students. It is described as a one-way flow of information from the teacher who is always active, and the students are passive receivers of the information. In traditional teaching strategy, concepts and procedures are usually taught first, then the students practice what they learned through solving routine problems (English, Lesh, & Fennewald, 2008). The traditional teaching strategy focuses more on direct instruction and lectures, students learn through listening and observation. This instructional approach emphasises more on getting facts rather than understanding mathematics concepts. The idea is that, there is a fixed body of knowledge that the students must come to know. The teacher seeks to impart mathematics knowledge to the passive students, leaving little room for students initiated questions. This approach of teaching is often boring because the job of student in the classroom is to sit and watch the teacher solve mathematics problems on the chalkboard and then copy the teacher's solution.

Students' understanding of Mathematics concepts is improved when they make connections, organise, clarify and reflect on their thinking, and with traditional Mathematics instruction, these do not happen. Presentation of lecture without given opportunity for students to interact among themselves and with the teacher can be ineffective regardless of the skill of the teacher. Traditional teaching strategy has been reported to be less effective to the demands of high rates of cognitive and affective outcomes (Slavin, 2011). This view was supported by Clement (2013) that the traditional teaching approach in classroom has limited effectiveness in the teaching and learning process.

2.6 Problem Solving Approach of Teaching Mathematics

According to Schoenfeld (2013), problem solving is a cognitive process directed to achieve a goal when no clear solution path is available to the problem solver. Teaching mathematics through a problem-solving approach provides a learning environment for students to learn on their own, to explore problems and to find new ways to solve problems. According to D'Ambrosio (2003), teaching Mathematics through a problem-solving approach is based on the notion that students who encounter problematic situations can use their prior knowledge to solve them.

Polya (1945) problem-solving model involves four stages: Understand the problem, Devise a solution plan, Carry out the plan, and Look back. Mereku and Cofie (2008) maintain that problem-solving approach to teaching Mathematics goes beyond helping students to solve routine problems to non-routine problems. Problem-solving strategies help improves students' mathematical understanding and in turn, support students to become more efficient and effective problem solvers.

Kousar (2010) conducted a study to determine the effect of a problem-solving approach on students' performances in Mathematics at the secondary school level. A sample of 48 students was selected and divided into experimental and control groups based on an assessment he conducted. The experimental group was taught using the guidelines of Polya's (1945) heuristic steps of a problem-solving approach. The control group was taught using the traditional teaching approach. After the treatment, an assessment was carried out to determine the effect of the intervention. It was revealed that both experimental and control groups were almost equal in Mathematics knowledge before the treatment. However, the experimental group's performance in the assessment was significantly higher than the control group. Mwelese and Wanjala (2014) researched to examine the effect of problem solving strategy on secondary school students' performances in geometry. Two Mathematics teachers with equal qualifications, teaching experience were selected and trained to teach the two groups. The experimental group was taught using the problem-solving method and the control group was taught using the traditional teaching approach. A post-test was conducted after treatment. The analysis of the results indicate that students who received problem-solving instruction had higher achievement scores than their peers who were taught using the traditional teaching approach.

The current study therefore investigated the effect of a problem solving approach of teaching on Asuom Senior High School students' performances in solving algebraic linear equation word problems.

3.0 Research Method

This study employed a quasi-experimental non-equivalent pre-test and post-test control group research design using a mixed method. Gay, Mills, and Airasian, (2011) defined a non-equivalent control group design as a type of quasi-experimental research design that lacks random assignment of subjects to the control and experimental groups. The non-equivalent pre-test and post-test control group research design was chosen because it would offer practical options to work with intact classes in both control and experimental groups, and also ensure that participating students continued learning other subjects according to their school's time-tables and also take part in activities in their respective schools. It also allowed the researchers to evaluate the effect of the treatment (Problem Solving Approach) on participants in their school. The independent variable was the teaching approaches in both control group and experimental groups, and the dependent variable was the post-test scores of students. The researcher taught the experimental group using problem-solving approach whilst the control group was taught by their incumbent mathematics teacher using the traditional teaching strategy. The pre-test scores obtained from both groups were used to establish a baseline for measuring the effects of each of the teaching approaches.

3.1 Sample and Sampling Technique

Sampling is the process through which a portion of the population of a study is chosen to represent the entire population (Seidu, 2015). Purposive sampling technique was used to select two senior high schools in the Kwaebibirem Municipality of Eastern Region of Ghana. Simple random sampling technique was used to select one intact class from each of the participating schools. The sample size for the present study consisted of fifty-two (52) students of which twenty-two (22) were in the control group and thirty (30) in the experimental group. The control group was made up of eight (8) boys and fourteen (14) girls while the experimental group consisted of seventeen (17) boys and thirteen (13) girls.

3.2 Research Instruments

Annum (2017) described research instruments as tools such as a test, questionnaire, or interview guide used for data collection in a study. The instruments used for data collection in this study were: pre-test and post-test.

3.3 Validity

Validity of a research instrument evaluates the extent to which the instrument measures what it is designed to measure (Robson, 2011). The research instruments were given to experienced Mathematics educators to ascertain the content, construct and face validity of the items.

3.4 Reliability

The researchers used the split-half method to compute the Spearman-Brown reliability value of the test items. In this method, the test scores were divided into two halves, using scores for odd-numbered items and scores for even-numbered items. Then, the correlation between the two halves was determined. According to Cohen, Manion and Morrison (2011), Spearman-Brown split-half coefficient is high when its absolute value is at least 0.7. Spearman-Brown values of 0.81 and 0.76 were obtained for the pre-test and post-test items respectively and therefore a good reliability of the tests. The pre-test that was administered during the pilot study was used to calculate the reliability value of the test.

3.5 Treatment

The treatment lasted for three weeks with each week consisting of four periods (60 minutes per period). The treatment was designed in the form of lessons delivery in the classroom. The lesson plans during the treatment sessions were based on Polya's (1945) heuristic steps of problem-solving. According to Polya (1945), problem-solving involves four stages, these are:

- Understand the problem
- Devise a plan
- Carry out the plan
- Look back

Understand the problem, at this stage, students are expected to read through the problem statement for understanding, as they read, they use comprehension strategies to translate the linguistic and numerical information in the problem into mathematical notations. *Devise a plan,* at this stage, students generate a suitable solution plan for solving the problem by breaking it down into a series of steps, involving sketching a diagram or creation of notations/formula from the text. *Carry out the plan,* mathematical computations are performed at this stage. This involves solving the problem step-by-step and if the solution is not found, the strategy is revised. *Look back,* at this last stage, the student checks the answer by substituting it into the original equation to make sure it is correct and make sense.

Week 1

Translating algebraic word problems into mathematical symbols

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems

Objectives: By the end of the one hundred and twenty (120) minute lesson, students should be able to translate word problems involving linear equations into algebraic expressions.

Activity One

Students were asked to solve the question below

Musah is four years older than Anthony. The sum of their ages is 42 years. Find their ages.

The following equations were presented by some of the students

Let $\boldsymbol{x}$ represent Anthony's age

Student S1 wrote

Let $\boldsymbol{x}$ represent Anthony's age

Musah's age $= \boldsymbol{x+4}$

Hence, the equation $\boldsymbol{x + x + 4 = 42}$

Another student S2 wrote $\boldsymbol{4x = 42}$

Student S3 wrote $\boldsymbol{x + 4 = 42}$

Other students also wrote the following equations

Let y represent Anhony's age

Student S4 wrote $\boldsymbol{y + 4 = 42}$

Student S5 wrote $\boldsymbol{y = 42 + 4}$

Student S6 wrote 4y+$\boldsymbol{4 = 42}$

Student S7 wrote $\boldsymbol{y - 4 = 42}$

Another student S8 presents the equation as

Let $\boldsymbol{k}$ represent Anthony's age and $\boldsymbol{m}$, Musah's age

$$\boldsymbol{k + 4m = 42}$$

The students presented equations they formed on a marker board.

Upon discussion, the class agreed on the correct equation, thus, the equation presented by student S1

$$x + x + 4 = 42$$

$$2x + 4 = 42$$

$$2x = 42 - 4$$

$$2x = 38$$

$$\frac{2x}{2} = \frac{38}{2}$$

$$x = 19$$

$$\textit{Anthony is } 19 \textit{ years old, and Musah's age} = 19 + 4 = 42 \textit{ years}$$

The researcher then assisted the students to come out with the following guidelines for solving word problems.

1. Read the question thoroughly for understanding (reading the question more than once may enhanced your understanding). Identify the important information(s) present in the question. Assign a letter, say $\boldsymbol{x, y, p, q}$ or any alphabet of your choice to represent the unknown quantity or quantities in the question. Sketch a diagram where necessary.

2. Write an equation.

3. Solve the equation

4. Check the solution by substituting the answer into the original equation to verify whether it is correct and make sense.

Students were guided to identify the words/phrases that suggest the four basic operations (Addition, Subtraction Multiplication, and Division). Words/phrases such as ‘add’, ‘sum’, ‘more than’, ‘increased by’, ‘total of’, ‘combined’, ‘plus’, etc. indicate ADDITION. Phrases or words such as ‘less than’, ‘reduced by’, ‘decreased by’, ‘difference between’, ‘fewer than’, ‘difference of’, etc. indicate SUBTRACTION. Phrases or words such as ‘of’, ‘product’, ‘times’, ‘multiplied by’, ‘double’, ‘twice’, ‘thrice’ etc. indicate MULTIPLICATION. Words/phrases such as ‘divide’, ‘out of’, ‘ratio of’, share ‘quotient’, ‘percent’ (divided by 100), etc. signify DIVISION.

Activity Two

The researcher guided the students to translate algebraic word problems into algebraic expressions. With this, the researcher emphasized on reading and understanding the problem before attempting to translate it into algebraic expression or equation.

These are the examples the researcher went through with the students. The students are required to write an algebraic expression for each of the phrases.

1. Five more than a certain number

   Let $\boldsymbol{x}$ represents the unknown number

   The phrase ‘more than’ implies addition

   Students’ response: $\boldsymbol{x+5}$ or $\boldsymbol{5+x}$

   A number more than 14

   Let $\boldsymbol{y}$ represent the unknown number

   Students’ response: $\boldsymbol{14+y}$ or $\boldsymbol{y+14}$
2. Ten less than a number.

   Let $\boldsymbol{k}$ represent the unknown number.

   I asked the students to write an expression for ‘$\mathbf{10}$ less than k’.

   Students’ response: $\boldsymbol{k-10}$

3. A number less than 17

   Let $\boldsymbol{m}$ represents the unknown number

   Students’ response: $\boldsymbol{17 - m}$

4. A number decreased by $\mathbf{25}$

   Let $\boldsymbol{q}$ represents the unknown number

   Students’ response: q – 25

5. The product of nine and a number

   Let $\boldsymbol{y}$ represent the unknown number

   Students’ response: $\boldsymbol{9y}$

After Activity Two, the researcher realised that the students were happy and showed interest in translating word problems into algebraic expressions. This was as a result of their active participation in the lesson.

Week 2

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems

Objectives: By the end of the one hundred and twenty (120) minutes lesson, students should be able to: translate algebraic word problems into algebraic expressions.

Activity Three

1. Twice a number

   Let $\boldsymbol{x}$ represents the unknown number

   Students' response: $\mathbf{2}\boldsymbol{x}$

2. One-third of a number

   Let $\boldsymbol{q}$ represents the unknown number

   Students' response $\frac{\mathbf{1}}{\mathbf{3}}\boldsymbol{q}$

3. The quotient of 8 and a number.

   The word 'quotient' implies division

   Let $\boldsymbol{y}$ represents the unknown number

   Students' response $\frac{\mathbf{8}}{\boldsymbol{y}}$

4. The sum of a number and nine times the same number.

   Let $\boldsymbol{q}$ be the unknown number

I asked the students to write an expression for '9 times $\boldsymbol{q}$'

Students' response: $\mathbf{9}\boldsymbol{q}$

I then asked the students to write an expression for the sum of $\boldsymbol{q}$ and $\mathbf{9}\boldsymbol{q}$

Students' response: $\boldsymbol{q} + \mathbf{9}\boldsymbol{q} = \mathbf{10}\boldsymbol{q}$

5. Ten less than the product of a number and 4.

Let $\boldsymbol{k}$ represents the unknown number

I asked the students to write an expression for the product of $\boldsymbol{k}$ and $\mathbf{4}$.

Students' response: $\boldsymbol{4k}$

I then asked them to write an expression for $\mathbf{10}$ less than $\boldsymbol{4k}$

They response: $\boldsymbol{4k - 10}$

7. Twenty less than 14 percent of a number.

Let $\boldsymbol{x}$ be the unknown number

Students were asked to write $\mathbf{14}$ percent of $\boldsymbol{x}$

Students' response: $\frac{\mathbf{14}}{\mathbf{100}}\boldsymbol{x}$

The students were then asked to write an expression for $\mathbf{20}$ less than $\frac{\mathbf{14}}{\mathbf{100}}\boldsymbol{x}$

Students' response: $\frac{\mathbf{14}}{\mathbf{100}}\boldsymbol{x} - \mathbf{20}$

8. The quotient of 6, and 2 increased by a number.

Let $\boldsymbol{k}$ represents the unknown number

2 increased by $\boldsymbol{k}$ implies $\boldsymbol{2 + k}$

Answer: $\frac{\mathbf{6}}{\boldsymbol{2+k}}$

9. A number less than seven

Let c represents the unknown number

Students' response $\boldsymbol{7 - c}$

10. The difference of half a number and $\mathbf{33}$

Let $\boldsymbol{x}$ represents the unknown number

I asked the students to write an expression for half of $\boldsymbol{x}$

Students' response: $\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{x}$

I then asked the students to write an expression for the difference of: $\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{x}$ and $\mathbf{33}$ Students' response: $\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{x} - \mathbf{33}$

11. Write each of the following phrases as an algebraic expression:

i) The difference of four times a number and 12

Let $\boldsymbol{m}$ represents the unknown number

I asked the students to write an expression for the phrase $\mathbf{4}$ times $\boldsymbol{m}$

Students' response: $\boldsymbol{4m}$

I asked the students to write an expression for the phrase 'the difference of $\boldsymbol{4m}$ and $\mathbf{12}$

Students' response: 4m – $\mathbf{12}$

ii) Twice a number less than $\mathbf{54}$

Let $\boldsymbol{x}$ be the number.

Students' response: $\boldsymbol{54 - 2x}$

iii) $\mathbf{2}$ times the difference of $\boldsymbol{n}$ and $\mathbf{9}$

I asked the students' to write an expression for the phrase "the difference of $\boldsymbol{n}$ and 9

Students' response: $\boldsymbol{n - 9}$

I asked the students to write an expression for the phrase '2 times the difference of $\boldsymbol{n}$ and $\mathbf{9}'$.

Students' response: $\mathbf{2}(\boldsymbol{n - 9})$.

iv) When a certain number is added to 87 and the result is multiplied by four.

Let $\boldsymbol{y}$ represents the unknown number

1 asked students to write an expression for 'a number added to 87'

Students' response: $\boldsymbol{87 + y}$

I then asked the students to write an expression for the phrase '$\mathbf{4}$ multiplied by $\boldsymbol{87 + y}$'

Students' response: $\mathbf{4}(\boldsymbol{87 + y})$

v) Eight less than twice a number

Let $\boldsymbol{x}$ represents the unknown number

I asked the students to write for twice $\boldsymbol{x}$

Students' response: $\mathbf{2}x$

I then asked the students to write an algebraic expression for 8 less than $\mathbf{2}\boldsymbol{x}$

Students' response: $\mathbf{2}\boldsymbol{x} - \mathbf{8}$

Week 2 Continued

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems

Objectives: By the end of the one hundred and twenty (120) minutes lesson, students should be able to solve algebraic linear equation word problems.

Activity Four

In this activity, I made the students to work in groups of five so that they will work together in order to maximize their learning activities. I guided the students to solve the prepared questions on algebraic word problems. I explained to the students that, when solving an equation, all terms containing 'letters' terms should be grouped on one side of the equal sign and all 'number terms or constants' on the other side of the equal sign. To obtain this,

1. Add the same quantity to each side of the equation

2. Subtract the same quantity from each side of the equation

3. Multiply each side of the equation by the same non-zero quantity

4. Divide each side of the equation by the same non-zero quantity

5. Check the solution to make the answer is correct and also make sense

Having taken the students through the steps involved in solving linear equations, I then guided them to solve the questions below.

1. The sum of two numbers is $\mathbf{147}$. The larger number exceeds the smaller by $\mathbf{55}$. Find the numbers.

I asked the students to read the question carefully and write down an equation which conforms to the given information and then solve for the unknown numbers.

The students came out with the following patterns and formula;

Let $\boldsymbol{m}$ represents the smaller number

Then, the larger number is $\boldsymbol{m + 55}$.

The students' agreed on the equation below

$\boldsymbol{m + (m + 55) = 147}$

$\boldsymbol{m + m + 55 = 147}$

$\boldsymbol{2m + 55 = 147}$

$\boldsymbol{2m + 55 - 55 = 147 - 55}$ (Subtract $\boldsymbol{55}$ from both sides of the equation)

$\boldsymbol{2m = 92}$

$\boldsymbol{\frac{2m}{2} = \frac{92}{2}}$ (Divide both sides of the equation by $\boldsymbol{2}$)

$\boldsymbol{m = 46}$

I then asked the students to check the solution by plugging the answer into the equation.

$\boldsymbol{m + (m + 55)}$ = 34, but $\boldsymbol{m = 46}$

$\boldsymbol{146 + (46 + 55) = 147}$

2. A father is three times as old as his son. In eight years' time, the father will be twice as old as the son. Determine the present ages of the father and the son. 114

Solution:

Step 1: read the well for understanding and use a letter to represent the son's age, let $\boldsymbol{x}$ = the son's present age,

Step 2: determine the father's present age using the son's age, thus $\boldsymbol{3x}$

Step 3: determine their ages in eight years from now:

The son will be $(x + 8)$ years

The father will be $(3 + 8)$ years

Step 4: form an equation from the statement, thus

In eight years' time, father's age = two times the son's age

$$3x + 8 = 2(x + 8)$$

Step 5: Solve the equation

$$3x - 2x = 16 - 8$$

$$x = 8$$

Thus the son is 8 years now and the father is 24 years now.

3. When a certain number is subtracted from 14 and the result is multiplied by 5, the final result is 20. Find the number

Let y be the unknown number

I asked the students to write an expression for y subtracted from 14

Students' response: $14 - y$

I asked the students to multiply $(14 - y)$ by 5

Students' response: $5(14 - y)$

I asked the students' to write an equation for the question and solve it

Students' response: $5(14 - y) = 20$

$$70 - 5y = 20$$

$70 - 70 - 5y = 20 - 70$ (Subtract 70 from both sides of the equation)

$-5y = -50$

$\frac{-5y}{-5} \frac{-50}{-5}$ (Divide both sides of the equation by -5)

$y = 10$

4. The sum of three consecutive odd numbers is $\mathbf{345}$. Find the numbers.

I asked the students to read the question carefully and come out with a pattern or formula to solve the problem.

Let *x* represents the first odd even number

Then, the three odd numbers are: $\boldsymbol{x},\ (\boldsymbol{x}+\mathbf{2}),\ (\boldsymbol{x}+\mathbf{4})$

$\boldsymbol{x}+(\boldsymbol{x}+\mathbf{2})+(\boldsymbol{x}+\mathbf{4})=\mathbf{345}$

$\boldsymbol{x}+\boldsymbol{x}+\mathbf{2}+\boldsymbol{x}+\mathbf{4}=\mathbf{345}$

$\mathbf{3}\boldsymbol{x}+\mathbf{6}=\mathbf{345}$ (Add like terms)

$\mathbf{3}\boldsymbol{x}+\mathbf{6}-\mathbf{6}=\mathbf{345}-\mathbf{6}$ (Subtract $\mathbf{6}$ from both sides of the equation)

$\mathbf{3}\boldsymbol{x}=\mathbf{339}$

$\frac{\mathbf{3}\boldsymbol{x}}{\mathbf{3}}=\frac{\mathbf{339}}{\mathbf{3}}$ (Divide both sides of the equation by $\mathbf{3}$)

$\boldsymbol{x}=\mathbf{113}$

The three odd numbers are: $\mathbf{113},\ \mathbf{115},\ \mathbf{117}$

5. The sum of one-third of a number and six is $\mathbf{132}$. Find the number

I asked the students to translate the question into equation and solve the equation as well

Students' response: let q represents the unknown number

One-third of q: $\frac{\mathbf{1}}{\mathbf{3}}\boldsymbol{q}$

Then, $\frac{\mathbf{1}}{\mathbf{3}}\boldsymbol{q}+\mathbf{6}=\mathbf{132}$

$\mathbf{3}\times\frac{\mathbf{1}}{\mathbf{3}}\boldsymbol{q}+\mathbf{3}\times\mathbf{6}=\mathbf{3}\times\mathbf{132}$ (Multiply through by LCM, $\mathbf{3}$)

$$\boldsymbol{q}+\mathbf{18}=\mathbf{396}$$

$\boldsymbol{q}+\mathbf{18}-\mathbf{18}=\mathbf{396}-\mathbf{18}$ (Subtract $\mathbf{18}$ from both sides of the equation)

$$\boldsymbol{q}=\mathbf{114}$$

5. If $\frac{1}{5}$ of a certain number is added to two-third of the same number, the result is 26. Find the number.

The students were tasked to read the questions carefully and come out with patterns or formula for solving it.

Students' response:

Let k represents the unknown number,

Then, $\frac{1}{5}$ of $\boldsymbol{k}$ = $\frac{1}{5}\boldsymbol{k}$ and

Two-third of $\boldsymbol{k}$ = $\frac{2}{3}\boldsymbol{k}$

Hence, the equation: $\frac{2}{3}\boldsymbol{k} + \frac{1}{5}\boldsymbol{k} = \mathbf{26}$

$15\times\frac{2}{3}\boldsymbol{k} + \mathbf{15}\times\frac{1}{5}\boldsymbol{k} = \mathbf{15}\times\mathbf{26}$ (Multiply through by L.C.M, 15)

$\mathbf{10}\boldsymbol{k} + \mathbf{3}\boldsymbol{k} = \mathbf{390}$

$\mathbf{13}\boldsymbol{k} = \mathbf{390}$

$\frac{\mathbf{13}\boldsymbol{k}}{\mathbf{13}} = \frac{\mathbf{390}}{\mathbf{13}}$ (Divide both sides of the equation by $\mathbf{13}$)

$\boldsymbol{k} = \mathbf{30}$

6. The sum of four consecutive odd numbers is 404. Find the numbers

Students' response:

Let $\boldsymbol{m}$ be the smallest even number, the numbers are:

$$\boldsymbol{m}, \quad (\boldsymbol{m} + \mathbf{2}), \quad (\boldsymbol{m} + \mathbf{4}), \quad (\boldsymbol{m} + \mathbf{6})$$

Then,

$\boldsymbol{m} + (\boldsymbol{m} + \mathbf{2}) + (\boldsymbol{m} + \mathbf{4}) + (\boldsymbol{m} + \mathbf{6}) = \mathbf{404}$.

$\boldsymbol{m} + \boldsymbol{m} + \mathbf{2} + \boldsymbol{m} + \mathbf{4} + \boldsymbol{m} + \mathbf{6} = \mathbf{404}$

$\mathbf{4}\boldsymbol{m} + \mathbf{12} = \mathbf{404}$ (Add 'like terms')

$\mathbf{4}\boldsymbol{m} + \mathbf{12} - \mathbf{12} = \mathbf{404} - \mathbf{12}$ (Subtract $\mathbf{12}$ from both sides of the equation)

$\boldsymbol{4m = 392}$

$\frac{\boldsymbol{4m}}{\boldsymbol{4}} = \frac{\boldsymbol{392}}{\boldsymbol{4}}$ (Divide both sides of the equation by $\boldsymbol{4}$)

$\boldsymbol{m} = 98$

The numbers are: $\boldsymbol{98, 100, 102, 104.}$

7. Jude is four times as old as Irene. In 8 years time, Jude will be twice as old as Irene. Find their ages.

Students' response:

Let $\boldsymbol{x}$ represents Irene's age

Jude's age: $\boldsymbol{4x}$

$$\boldsymbol{2(x + 8) = 4x + 8}$$

$$\boldsymbol{2x + 16 = 4x + 8}$$

$$\boldsymbol{2x - 4x = 8 - 16}$$

$$\boldsymbol{-2x = -8}$$

$$\boldsymbol{\frac{-2x}{-2}\frac{-8}{-2}}$$

$$\boldsymbol{x = 4}$$

$$\textbf{Irene is 4 years old, and Jude's age}: \boldsymbol{4 \times 4 = 16} \textbf{ years}$$

Week 3

Week 3 was used for revision. It was characterised by solving questions on algebraic linear equation word problems. The post-test was conducted the next day after the revision.

4.0 Results and Discussion

4.1 Research Question 1: What difficulties do students encounter in solving algebraic linear equation word problems?

In order to respond to research question 1, a pre-test was administered to students in both control and experimental groups. The test comprised of ten (10) questions involving algebraic linear equation word problems. Each question correctly answered was awarded a maximum of 4 marks, given a maximum total score of 40 marks in the entire test.

Table 1 Frequency Distribution of Pre-Test Scores in Percentages of Students in the Experimental Group

Scores	Number of Students	Percentage (%)
Below Average (0-19)	29	97%
Average (20-29)	1	3%
Above Average (30-40)	0	0%
Total	**(30) 100%**	**100%**

The results in Table 1 indicates that out of the 30 (thirty) students who wrote the pre-test, 29 of them, representing 97% scored mars between 1 and 19, only 1 (one) student representing 3% scored a mark between 20 and 30 and no student scored between 30 and 40. This indicates that 29 (97%) of the students in the experimental group scored below the minimum average mark of 20, only one student obtained an average score and no student scored within the above average.

The pre-test marked scripts were scrutinized in order to obtain the challenges students' faced in the process of solving algebraic linear equation word problems. Upon scrutiny of the pre-test marked scripts, students' difficulties were found and put into four categories as shown in Table 2

Table 2 Students' Difficulties in Solving Algebraic Linear Equation Word Problems

Difficulty	Number of students	Percentage (%)
Lack of understanding of the problem	16	53 %
Misinterpretation of the problem	6	20 %
Computational errors	3	10 %
Application of Inappropriate Mathematical Knowledge	5	17 %

The analysis of students' pre-test marked scripts indicate that, 16(53%) of the students did not understand the word problems statement hence, could not translate the sentences into correct equations in order to solve them. Six students (20 %) also misinterpreted the problem statement and therefore modeled wrong equations out of the verbal discerptions. Again, 3 (10%) of the students committed computational errors during the solution process and 5 (17%) misapplied mathematics knowledge, hence, presented incorrect solutions. Studies such as Sepeng et al., (2014) indicated that the difficult part of solving mathematics word problems appear to be comprehending the problem statement and deciding on the appropriate operation(s) needed to solve the problem. The results of this study are in line with the findings of Aniano (2010) who observed that, students' inability to translate verbal descriptions into mathematical symbols and operations is one of the contributing factors that hinder their problem solving capabilities. Studies such as Egodawatte (2011) have noted that, challenges students faced during word problems solving usually entail students' inability to translate the problem into equation and failure to use the correct representations. The vocabulary aspect of the problem is very difficult for many students to comprehend. Sometimes, students do not understand the meaning of specific words in the problem statement and this hinder their progress in solving the problem. This finding of the study agrees with earlier findings in the research of Adu (2013) who found that students made errors in the process of translating word problems into expressions or equation because they did not comprehend the problem

4.2 Research Question 2: What is the effect of traditional teaching approach on students' performances in solving algebraic linear equation word problems?

To answer research question 2, A pre-test was administered the control groups to determine their level of knowledge and skills in translating linear equation word problems into equations and solving the equations as well. After administering the pre-test, the traditional teaching approach was used to teach students in the control group for three weeks. A post-test was then administered after the treatment in order to determine the effect of the traditional teaching strategy. Table 3 presents the pre-test and post-test scores of the twenty-two (22) students in the control group. The numbers in brackets under the pre-test and post-test columns are the frequencies with their corresponding percentage (%).

Table 3 Frequency Distribution of Pre-Test and Post-Test Scores in Percentages of the Control Group

Scores	Pre-test (Freq.) %	Post-test (Freq.) %
Below average (0-19)	(21) 95%	(5) 23%
Average (20-29)	(1) 5%	(9) 41%
Above average (30-40)	(0) 0%	(8) 36%
Total	**(22) 100%**	**(22) 100%**

The results in Table 3 showed that out of the twenty-two (22) students who wrote the pre-test, 21 representing 95% of the students scored below the minimum average mark of 20. Only one (1) student representing 5% of the students scored a mark between 20 and 29 inclusive and no student had a mark between 30 and 40. The results indicate that the performance of students in the pre-test was low as 95% of the students scored below the minimum average mark. In order to determine the effect of the traditional teaching strategy on students' performances in solving algebraic linear equation word problems, a pre-test was conducted before the treatment a post-test was administered after teaching the students for three weeks, using the traditional teaching approach. The post-test results in Table 3 show that five (5) students representing 23% scored marks between 0 and 19.

Nine (9) students representing 41% obtained marks between 20 and 29 whilst eight (8) representing 36% of the students scored marks between 30 and 40 inclusive. The post-test results in Table 3 indicate that 23% of the students obtained marks below the minimum average mark as compared to 95% in the pre-test. In the pre-test, only one student representing 5% obtained an average mark as compared to 41% in the post-test. Also, no student had a mark within the "above average" in the pre-test compared 36% in the post-test. Comparatively, the results in Table 3 showed that students performed better in the post-test than in the pre-test. Table 4 shows the mean and standard deviation of the paired samples.

Table 4 Paired Samples Statistics of Pre-Test and Post-Test Scores for the Control Group

		Mean	N	Std. Deviation
Pair 1	Pretest	7.27	22	5.692
	Posttest	26.41	22	6.486

The post-test results in Table 4 shows an improvement in students' performance in solving algebraic linear equation word problems. The post-test mean score and standard deviation ($M = 26.41,\ SD = 6.486$) were higher than the pre-test mean score and standard deviation ($M = 7.27, SD = 5.692$). The difference between the post-test and pre-test mean scores is ($26.41 - 7.27 = 19.14$). This improvement of students' performances in the post-test could be attributed to the traditional teaching strategy that was used to teach the students during treatment. This suggests that the traditional teaching approach has a positive effect on students' understanding and performances in solving algebraic linear equation word problems. This finding implies that a well-organised traditional teaching approach can enhance students' understanding and performances in mathematics to some extent. Inferential analysis was carried out using the paired samples t-test to determine if the difference observed in students' pre-test and post-test scores is significant.

Table 5 presents the paired sample t-test results of the pre-test and post-test scores of students in the control group.

Table 5 Paired Sample T-Test

					Difference				
		Mean	Std. Deviation	Std. error Mean	Lower	Upper	T	DF	Sig. (2tailed)
Pair 1	Pretest - posttest	19.136	7.337	1.564	-22.390	-15.883	12.233	21	0.000

A paired samples t-test was conducted to compare the pre-test and post test scores of the students taught using traditional teaching approach. This was done to ascertain the effect of traditional teaching approach on students' performance in solving algebraic linear equation word problems. From Table 5, the paired samples t-test analysis of the data resulted in the value of $P = 0.000$, which implied that there is a significant difference between the pre-test and post-test mean scores. The test statistic was set at $P < 0.05$. Since $P < 0.05$ (level of significance), It is therefore concluded that there is a significant difference in performance between the pre-test and post-test scores. This finding implied that a well-structured traditional teaching approach can enhanced students' learning and performance in mathematics.

4.3 Research Question 3: What is the effect of problem solving approach on students' performances in solving algebraic linear equation word problems?

In order to respond to research question 3, a pre-test was conducted to the thirty (30) students in the experimental group to determine their level of performance in solving algebraic linear equation word problems. After administering the pre-test, a problem solving approach was used to teach algebraic linear equation word problems for three weeks. A post-test was conducted after the treatment to determine the effect of the problem solving instructional strategy. Both pre-test and post-test scripts were marked out of 40 marks. Table 7 presents the summary of pre-test and post-test scores of students in the experimental group. The numbers in brackets under the pre-test and post-test columns are the frequencies with their corresponding percentages.

Table 6 Frequency Distribution of Pre-Test and Post-Test Scores in Percentages of Students in the Experimental Group

Scores	Pre-test	Post-test
Below average (0-19)	(29) 97%	(0) 0%
Average (20-29)	(1) 3%	(9) 30%
Above average (30-40)	(0) 0%	(21) 70%
Total	**(30) 100%**	**(30) 100%**

The results in Table 6 showed that out of the thirty (30) students who wrote the pre-test, twenty-nine (29) students, representing 97% scored marks between 0 and 19, only one (1) student representing 3% scored a mark between 20 and 30 and no student had a mark between 30 and 40. This indicates that 97% of the students scored below the minimum average score of 20, and only one student representing 3% obtained an average mark. However, the post-test scores showed an improvement compared to the pre-test. In the post-test, no student scored a mark between 1 and 19 as compared 97% in the pre-test. Thirty percent of the students obtained marks between 20 and 29 in the post-test as compared to only 3% in the pre-test. Also, the number of students who scored marks between 30 and 40 showed a remarkable improvement from 0% in the pre-test to 70% in the post-test. This implies that students performed better in the post-test than the pre-test. The higher scores achieved by students in the post-test can be attributed to the problem solving approach that was used to teach the students.

Table 7 Paired Samples T-Test of Pre-Test and Post-Test Scores of Students in the Experimental Group

		Mean	N	Std. Deviation
Pair 1	pretest	6.90	30	5.248
	posttest	31.43	30	4.939

The results in Table 7 shows that the mean (M) score and standard deviation (SD) of students in post-test (M = 31.43, SD = 4.939) were significantly higher than the mean score and standard deviation of students in the pre-test (M = 6.90, SD =5.248). The difference in the means between the pre-test and post-test scores is (31.43 - 6.90 = 24.53}. Students learn more when they work as a team. It is worth mentioning that learning in small groups is crucial in every mathematics lesson as students enjoy working together and this builds trust among the students. The performance of students in the post-test can be attributed to the problem solving instructional strategy employed and the series of problem solving activities that the researcher exposed the students to during the treatment processes.

Further inferential analysis was conducted using the paired samples t-test to determine if the difference observed between the pre-test and post-test scores was significant.

A paired samples t-test was conducted to determine the effect problem solving approach on students' performances in solving algebraic linear equation word problems.

Table 8 Paired Samples T-Test of the Pre-Test and Post-Test Scores of students in the experimental group

					Difference				
		Mean	**Std. Deviation**	**Std. error Mean**	**Lower**	**Upper**	**T**	**DF**	**Sig. (2 tailed)**
Pair 1	Pretest - posttest	24.533	8.212	1.499	-27.600	-21.467	16.467	29	0.000

The paired samples t-test analysis of pre-test and post-test scores in Table 8 resulted in the value of P= 0.000, which implies that, there is a significant difference in the means of the pre-test and post-test scores. The test statistic was set at $P < 0.05$. Since $P < 0.05$ (level of significance), the study concludes that there is a significant difference between the pre-test and the post-test scores, which is in favour of the post-test. This implies that problem solving approach of teaching had a positive effect on students' performances in solving algebraic linear equation word problems.

4.4 Null hypothesis H_0: There is no difference in performance between students taught algebraic linear equation word problems using traditional approach and problem solving approach.

To find out whether there is any difference in performance between students taught algebraic linear equation word problems using traditional approach and those taught through problem solving approach, a pre-test comprising ten test items involving algebraic linear equation word problems was administered to students in both control and experimental groups before the treatment, and a post-test after the treatment. Table 9 presents the means and standard deviations for pre-test and post-test scores of students in both control and experimental groups.

Table 9 Paired Samples T-Test of Pre-Test and Post-Test Scores for the Control and Experimental Groups

Tests	groups	N	Mean	Std. Deviation
pretest	Control	22	7.27	5.692
	Experimental	30	6.90	5.248
posttest	Control	22	26.41	6.486
	Experimental	30	31.43	4.939

The results in Table 9 shows that, the mean (M) score of the pre-test and standard deviation (SD) of students in the control group (M = 7.27, SD = 5.692) were approximately the same as the mean and standard deviation for the experimental group (M = 6.90, SD = 5.248). This implies that, both groups started with the level of knowledge in terms of solving algebraic linear equation word problems. However, the post-test mean score and standard deviation (M = 31.43, SD = 4.939) of the experimental group were higher than the post-test mean score and standard deviation (M = 26.41, SD = 6.486) of the control group. The difference between the mean scores for the control and experimental groups in the post-test was $(31.43 - 26.41 = 5.02)$. The mean score of the experimental group increased more than that of the control group indicating that students' performance in the experimental group improved more than in the control group.

Further inferential analysis of post-test scores for both control and experimental groups was conducted using the Independent Samples T-test.

Table 10 Independent Samples Test of Post-Test Scores for the Control and Experimental Groups

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
		SF	Sig.	t	df	Sig. (2tailed)	Mean Dif	Std. Error Dif	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test	Equal variances assumed	1.451	.234	-3.173	50	.003	-5.024	1.583	-8.204	-1.844
	Equal variances not assumed			-3.044	87.719	.004	-5.024	1.651	-8.367	-1,682

An independent samples t-test was conducted to verify if there is any difference in performance between the control and experimental groups in the post-test. The analysis of the post-test scores in Table 12 resulted p = .003, which is less than .05 level of significance. This implies that there is a significant difference in the mean scores between the control and experimental groups. The results in Table 12 show that, the experimental group was more successful than the control group after the treatment. Hence, the null hypothesis that "there is no significant difference in performance between students taught algebraic linear equation word problems using traditional approach and problem solving approach" was rejected. Students' success in Mathematics is greatly influenced by the instructional strategy employed by their teacher. Effective teaching method enhances students' understanding and performances in Mathematics. This study therefore concludes that students taught algebraic linear equation word problems through problem solving approach performed better than their peers who were taught using the traditional teaching method.

5.0 Conclusion

Analysis of students' pre-test and post-test scores indicate that, entry level for both control and experimental groups were similar before the treatment. However, students in the experimental group performed better in the post-test than their counterparts in the control group. This implies that the active participation of students in problem-solving instruction has helped to improve students' competencies in solving algebraic linear equation word problems. Problem problem-solving approach allows students to build on their translational competencies, representational skills, and computational powers thereby optimizing their performance in solving algebraic word problems. The study therefore concludes that a problem-solving approach has the potential to increase students' performance in mathematics.

5.1 Recommendation

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

1. Mathematics teachers at the senior high school level should try as much as possible to adopt problem solving approach of teaching in their lessons in order to enhance students' understanding and performance in mathematics.
2. Ghana Education Service (GES) should organise regular In-service training workshops on problem solving approach of teaching to all mathematics teachers at the senior high school level.
3. A teacher's experience of learning mathematics has an impact on his/her teaching approach. The study recommends that teacher training institutions in Ghana should train mathematics teachers with problem-solving method to qualify them as professional teachers.
4. The study recommends that Ministry of Education (MoE) in collaboration with the Ghana Education Service (GES) should introduce a comprehensive programme in the form of an implementation model lasting for at least a period of three years to promote full compliance and implementation of a problem-solving approach of teaching by all mathematics teachers at the senior high school level in Ghana in order to improve students' understanding and performances in mathematics.

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