Using Problem-Based Learning to Enhance Junior High School Students' Understanding and Attitude Towards Linear Equations Word Problems

Hamidu Ibrahim Bukari
Department of Mathematics/ICT, Bagabaga College of Education, P.O. Box 35 ER, Tamale-Ghana

Abstract
The study was a Quasi-experimental research project conducted to investigate on using problem-based learning to enhance the understanding of Junior High School students at Winneba University Practice Junior High School, Unipra, Winneba-Ghana on linear equation word problems solving. Two form 3 intact classes of 3A and 3B were used for the study and were assigned as control and experimental groups. The control group consists of thirty-two students and the experimental group thirty-eight students. Data was collected through pre-test and post-test essay typed questions and a questionnaire on students' attitude to linear equations word problems. The questionnaire contained twenty likert-type questions. The independent samples t-test was used to find the differences between the groups. The experimental group differed statistically significantly on post-test scores from the control group. This study identified that problem-based learning improved students problem-solving abilities and increased students' confidence in doing linear equation word problems because the felt more competent in working word problems in linear equations. The study also explored students' attitude to linear equations word problems through the use of a Likert-type questionnaire. The findings showed that students' attitude toward word problems in linear equations were generally positive. It is therefore recommended that Ghana Education Service should provide in-service training for Mathematics teachers on the use of Problem-Based learning and Mathematics teachers should also integrate problem-based learning approach in their students.
Keywords: Problem-Based Learning, Attitude
DOI: 10.7176/JEP/10-3-14

1. Introduction

Mathematics is an important tool in many fields, including the natural sciences, medicine, engineering and social sciences. It plays a vital role in the scientific development of a nation and the overall personal and intellectual development of every individual in a society. It is therefore not surprising that the government of Ghana made Mathematics a core subject of the study at the basic and secondary levels of education in the country (Ministry of Education, 2010). Every Ghanaian child must pass in Mathematics before he/she can proceed in the next level of education.

In the Junior High School level in Ghana, Mathematics education is to enable students use Mathematics in their daily life and to recognize situation that require Mathematical problem-solving strategies and apply Mathematics to resolve them (Ministry of Education, 2010). To many Mathematics literates, Mathematics is all about solving problems (Sarfo, Eshun, Elen & Impraim, 2014). Mathematics educators have agreed that problem solving plays a central role in the Mathematics curriculum (Nabie, Akayuure & Seidu, 2013; Atteh, Appoh,Obeng-Denteh, Okpoti & Johnson, 2014; NCTM, 1989). Certain basic attitudes like problem solving as a result of patience, confidence and willingness have good relation with students Mathematics achievement; however, the bad perception of students and people who do not like Mathematics in Ghana and other parts of the world has created quite unfortunate and bad public image, describing Mathematics as difficult, cold, abstract, theoretical and uninterested subject (Yarhands, Aseidu-Addo & Assuah, 2017).

One of the primary goals of Mathematics education in Ghana is to develop students' ability to solve everyday problems. Problem solving in Mathematics is a complex process which calls for problem solver. Lorenzo & Ana (2013) stated that problem solving is one of the essential methodologies in Mathematics that enhances skills analysis, conceptual understanding, reasoning and application in real life.

Even though, problem solving is the heart of Mathematics curriculum, Ghanaian students still face difficulties in dealing with mathematical word problems. The chief examiners report for Basic Education Certificate Examination (2012, 2015, 2017), consistently indicate that students have difficulty in translating word problems into Mathematical sentences. The reports point out that, students answer word problems usually perform poorly because they lack basic mathematical knowledge that inhibits their problem-solving ability. Most students could not write relevant equations from given word problems.

To overcome students' challenges, difficulties, poor performance and poor attitudes towards Mathematics, especially word problems, a variety of teaching and learning strategies have been advocated for use in Mathematics classroom moving from the teacher-centered approach to student-centered approach, thus problem-based learning is one of the best instructional strategies that allow each learner to construct his/her own knowledge. Hence, this study examined teaching using problem-based learning on Junior High School students at Winneba University Practice school, UNIPRA on their understanding of linear equations word problems.

Problem-based learning is a constructivist pedagogical approach to learning in which students work in smaller groups to find solution to complex problems. A study carried on by (Aja, Imoko & O'kwu, 2013) to investigate the effect of problem-based on Senior High School in algebra also revealed that those taught using problem-based learning excel more than those taught using the conventional approach.

1.1 Statement of the Problem

The Mathematics syllabus in Ghana recommends the use of Mathematics in our daily life by recognizing and applying appropriate Mathematical problem-solving strategies (Ministry of Education, 2010). Problem solving approach is the heart of the Mathematics curriculum in Ghana. The West Africa Examination Council of Ghana Chief examiners report on Basic Education Certificate Examination (2012, 2015, 2017) stated challenges and difficulties students face on the aspect of word problems of linear equation.

The lack of understanding of the meaning of algebraic symbols; the barriers to acutely change the data provided by natural language into mathematical equations; the incorrect interpretation of the semantic structures of texts and as a result the misunderstanding of the relationships between quantities.

Asante and Mereku (2012) have enumerated that Mathematics pedagogy courses should be made more practical, that is, pre-service teachers given enough opportunity to practice what they are going to teach at the basic level.

Currently, Akyeampong *et al*., (2013) have pointed out that, pre-service teachers in most African colleges of education lack professional practicum and experience to make them construct and practice teaching as a problem-solving with learners at the centre of activities. They added that tutors from colleges of education are to provide the "know how" to trainee teachers to teach at the Junior High Schools, however, this did not reflect on the practice of teaching basic school Mathematics and reading for lower grades for the development of practical knowledge. It is in this view that this study focused on using problem-based learning on Junior high School students to enhance their understanding on linear equations word problem solving.

1.2 The Purpose of the Study

The purpose of this study was to find out the effect of using problem-based learning to enhance Junior High School students' understanding and attitude toward linear equations word problems.

1.3 Hypotheses

The following two hypotheses guided the study.

1. H_0: There is no statistically significant difference in the understanding of linear equations word problems of students who are taught with problem-based learning (experimental group) and students' who are taught using the traditional approach (control group).
2. H_0: There is no statistically significant difference in attitude to linear equation word problems between students who are taught with problem-based learning (experimental group) before and after the instruction.

1.4 Significance of the Study

The study was to provide better insight into the relationship between the instructional strategies (Problem-based learning and traditional approach) and students' understanding in linear equation word problems. This will encourage Mathematics teachers to refocus their teaching to be more student-centred collaborative, communicative and cooperative learning. The study was also concerned with the effect of Problem-based learning on students' attitudes towards the learning of linear equations word problems.

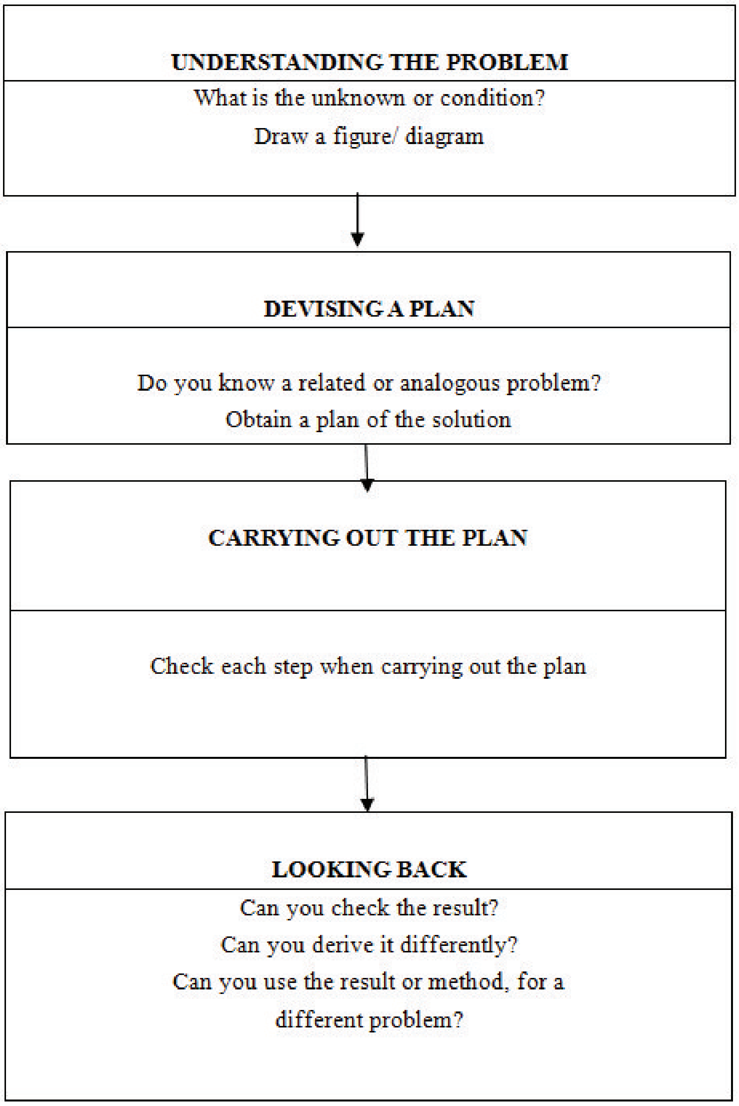
2.0 Theoretical Framework

The theoretical framework of this study was based on George Polya's problem-solving technique. Polya (1945) in his book "How to solve it", identified four basic stages of problem solving which had become the framework recommended for teaching and assessing problem-solving skills. The four steps are:

1. Understanding the problem,
2. Devising a plan to solve the problem,
3. Implementing the plan, and
4. Reflecting on the problem.

Although these four stages of problem-solving are listed in order of progression, for difficult problems it may not be possible to simply move through them consecutively to produce an answer. It is obvious that students move backwards and forwards between and across the steps in a problem-solving process. The student may be obliged to consider auxiliary problems if immediate connection cannot be found for a given situation. This allows students to work in groups in problem-based learning situation in Mathematics classroom, thereby helping them to analyse, pose questions, check for correct or accurate results and try different strategies. Students should therefore be encouraged to actively participate in Mathematics classrooms in order to develop self-confidence and use Mathematics appropriately in their real life (Atteh, *et al*., 2014).

The theoretical framework of Polya provides best practices in cognitive development and effective problem-based learning environment for Mathematics teachers to move students from teacher-centred approach to an active problem-based learning approach Mathematics classroom. This will indeed reduce most of the talking, questioning and thinking done by teachers. The diagram below showed the summary of the stages of Polya's problem-solving techniques.



Abdullah, Tarmizi and Abu (2010) investigated the effect of problem-based learning on Mathematics performance and affective attributes in learning Statistics at form four secondary level using Polya's problem-solving heuristic approach and the results showed that problem-based learning was more effective approach in concept learning but the difference between problem-based learning group and control group of Mathematics performance was not statistically significant.

3.0 Method

3.1 Research Design

The study conducted was a quasi-experimental nonrandomised control group, pre-test post-test design. Quasi-experiment is an empirical study used to estimate the causal impact of an intervention on its target population (Vanderstoep & Johnson, 2009). Quasi-experimental researches are widely used in the evaluation of teaching interventions because it is not practical to justify assigning students to experimental and control groups by random assignment (Creswell, 2014). According to Privitera (2014), the design is chosen when one wants to compare scores before and after treatment. The study compared the students' scores in linear equation word problems achievement tests before and after treatment in both the experimental and control groups. The quasi-experimental design was used for this particular study because in a typical school situation it is very difficult to reorganise classes to accommodate a randomised controlled trial. It was, therefore, necessary to use intact classes especially form three in order to prepare them toward the Basic Education Certificate Examination (BECE). A coin was tossed and the head was assigned to the control group and tail to the experimental group. The notational paradigm of the quasi-experimental design, which is nonrandomised control group, pre-test post-test, is as follows.

Experimental Group O_1 A O_3
……………………
Control Group O_2 B O_4

Key: O_1 and O_2 represent the pre-test observations, A-Treatment, B-No treatment, O_3 and O_4 represent post-test observations for the experimental and control groups respectively. The dotted line separating the parallel rows indicates that the experimental and control groups have not been equated by randomization (Cohen, Manion & Morrison, 2011:323).

In this design, the two groups of students were given a pre-test, then the experimental group was given a treatment and after the treatment, a post-test was administered to the two groups. The control group was also given a form of treatment (traditional) but this was different from that of the experimental group in terms of teaching strategy during the period of administering the treatment. Ary *et al*., (2002) stated that the use of pre-test enables one to check on the equivalence of the groups on the dependent variable before the experiment begins. If there are no significant differences in the pre-test, then selection as a threat to internal validity is eliminated and therefore one can proceed with the study. However, if there are some differences, then the researcher can use ANCOVA to statistically adjust the post-test scores for the differences.

3.2 Population

The population for the research consisted of all third-year junior high school students in Effutu Municipality. The accessible population was all the 125 third year students of University Practice school at Winneba.

3.3 Sample and Sampling Procedure

Third year classes were allowed by the school authorities to take part in the research. Two of these classes were randomly selected from the three third-year classes from different blocks for the study. A total of seventy students took part. Convenience sampling technique was used to select the University Practice because of proximity, accessibility and availability of students for the study (Etikan, Musah & Alkassim, 2015).

3.4 Instruments

Problem-based learning items require students to think deeply, analysis, synthesis and evaluate a concept and demonstrate their understanding. For the purposes of this study, the test developed was meant to be completed individually. Two equivalent problem-based learning tests were developed by the researcher. Test items were developed based on the selected topics to reflect the purpose of the study by the researcher. Answers to the equivalent problem-based learning tests were developed with the help of a Mathematics educator and a lecturer at the University of Education, Winneba. Regarding attitude, a five-point Likert-type questionnaire consisting of twenty questions on students' attitude towards linear equations word problems were developed for the study. The questionnaire was adapted from a questionnaire on modified Fennema-Sherman Mathematics Attitude scales by Doepken, Lawsky and Padwa (1993).

3.5 Validity and Reliability

The reliability estimates for pre-test and post-test were 0.63 and 0.71, respectively, using KR21 formula. The reliability estimate of the Likert-type questionnaire was 0.67 using KR20 formula. The content validity was also established by matching the test questions to specific objectives as required by the Mathematics syllabus in Ghana.

3.6 Data Collection Procedure

The two groups were pre-tested at the beginning. They had 6 periods of mathematics each week and a period were 40 minutes. This means that a total of 240 minutes was used each week to administer the treatment. The focus of the treatment was on the use of problem-based learning test items in learning linear equations word problems. Five weeks were used to administer the treatment. After the treatment the two groups took a post-test.

3.7 Data Analysis
The independent samples t-test was used to test hypothesis 1 and the paired sample t-test was used to test hypothesis 2 at $\alpha = 0.05$

3.8 Problem-based learning on linear equation word problems
The objective here, was to guide students to gain better understanding of mathematical linear equation word problems. This involved the identification of key words in the mathematical word problems. Understanding the problem as it sounds, is often the most overlooked step in the problem-solving process. This may seem like an obvious step that does not need mentioning, but in order for students to find a solution, they must first understand what they are being asked to find. Below are examples that, students can go through for better understanding of word problems using the Algorithm for problem-based learning. Guide students in groups to solve word problems involving linear equation in one variable using **RSTUV** algorithm for solving word problems.

1. **Read** the problem carefully and decide what is ask for (unknown).
2. **Select** a variable to represent this unknown.
3. **Think** of a plan to help you write an equation.
4. **Use** the properties of equality to solve the resulting equation.
5. **Verify** the answer.

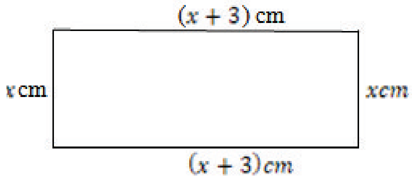
Question 1: Integer Word Problem.
The sum of three consecutive odd numbers is 21. Find the numbers.
Analysis: The students were given enough time by the teacher to read the question carefully and come up with a method or strategy to solve the problem based on their understanding. The response was:
Let x be the first odd number and the other numbers were given as follows; $(x+2),(x+4)$. With the guidance of the teacher the students again came out with the method for finding the solution to the question based on the key word "sum" which means "+".

solution:

Let: x be the first odd number (Defining Variable)
$x+2$ be the second odd number,
$x+4$ be the third odd number.
$x+(x+2)+(x+4)=21$ (Writing the Mathematical Equation)
$x+x+2+x+4=21$ (Removing of Brackets)
$x+x+x=21-2-4$ (Grouping of Like terms)
$3x=15$
$\frac{3x}{3}=\frac{15}{3}$ (Dividing both sides by 3)
$x=5$
The first odd number is 5
The second odd number is $(5+2)=7$
The third odd number is $(5+4)=9$
Thus, the consecutive odd numbers are $5, 7\ and\ 9.$

Question 2: Mensuration Word Problem
The length of a rectangle is $3cm$ greater than its width. The perimeter of the rectangle is $34cm$. Find the length of the rectangle.
Analysis: The teacher guides the students to read the question carefully and come out with a methods or strategies for solving the problem based on their understanding. The students in groups all together agreed to sketch a diagram for the question for better understanding and with the guidance of the teacher students sketch the diagram as shown below.

Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) DOI: 10.7176/JEP
Vol.10, No.3, 2019



Solution

Let: $x = width\ (w) of\ the\ rectangle$ (Defining Variable)

$x + 3 = length\ (l)\ of\ the\ rectangle$

Students explained that the perimeter of a plane figure is the total distance around the figure.

$(x + 3) + x + (x + 3) + x = 34$ (Writing the Mathematical Equation)

$x + 3 + x + x + 3 + x = 34$ (Removing of Brackets)

$x + x + x + x = 34 - 3 - 3$ (Grouping of Like Terms)

$4x = 28$

$\frac{4x}{4} = \frac{28}{4}$ (Dividing both sides by 4)

$x = 7$

Thus, the length of the rectangle is $(3 + 7) = 10cm$

Alternative Solution

Perimeter of a rectangle $= 2(w + l) = 34$

$2[x + (x + 3)] = 34$ (Writing Mathematical Equation)

$2[x + x + 3] = 34$

$2x + 2x + 6 = 34$ (Removing of Brackets)

$2x + 2x = 34 - 6$ (Grouping of Like Terms)

$4x = 28$

$\frac{4x}{4} = \frac{28}{4}$ (Dividing both sides by 4)

$x = 7$

Hence, the length of the rectangle is $(x + 3), ie\ (7 + 3) = 10cm$

Question 3: Age Word Problem

A woman is four times as old as her son. Nine years ago, the sum of their ages was 42. Find their present ages.

Analysis: The teacher guides the students to read the question carefully and come out with method for solving the question based on previous solutions. With the guidance from the teacher, the students were able to define the variable and find solution to the question based on the key word "Sum".

Solution

Let x represent the son's present age (Defining Variable)

Mother's present age will be $4x$

Nine years ago,

Son's age $= x - 9$

Mother's age = $4x - 9$

$(x - 9) + (4x - 9) = 42$ (Writing Mathematical Equation)

$x - 9 + 4x - 9 = 42$ (Removing of Brackets)

$x + 4x = 42 + 9 + 9$ (Grouping of Like Terms)

$5x = 60$

$\frac{5x}{5} = \frac{60}{5}$ (Dividing both sides by 5)

$x = 12$

Thus, son's age = 12 years and mother's age will be 4(12) = 48 years.

3.9 Checking the Correctness or Accuracy of the Solution

Teacher guides students on how to check whether the solution found, accurately answers the mathematical problem given or not based on the information available to the question. This step will help students adapt better ways in identifying methods or strategies since it gives them the opportunity to check its accuracy at all times. In a situation, where the methods identified are inaccurate for the question, different methods will be introduced until one of them is correct for providing accurate solution to the question.

This step is very important and purposely teaches students how to check the accuracy or correctness of appropriate problem-solving methods or strategies like diagrams, formulae and patterns on finding solution to mathematical problems. Here are some examples for further elaborations on solutions from examples already solved.

Question 1: The sum of three consecutive odd numbers is 21. Find the numbers.

Analysis: The students came up with the solutions for the three consecutive odd numbers as 5, 7 and 9.

The teacher asks the students to substitute the value of the first odd number into the method or add all the three odd numbers to check the accuracy of the method applied for the solution to the question. The students came up with the solution below:

$$x + (x + 2) + (x + 4) = 21 \text{, first odd number } x = 5$$
$$5 + (5 + 2) + (5 + 4) = 21$$
$$5 + 7 + 9 = 21$$
$$21 = 21$$

The students concluded that the method used was appropriate for given accurate solution which showed that the right-hand side of the equal sign was the same as the left-hand side.

Question 2: The length of a rectangle is 3cm greater than its width. The perimeter of the rectangle is 34cm. Find its length.

Analysis: Students in various groups came up with the values for the width as 7cm and the length as 10cm respectively from previous solution. The teacher asked students to substitute the values into the perimeter (P) formula of rectangle.

$$P = 2(w + l)$$
$$= 2(7 + 10)$$
$$= 2(17)$$
$$= 34cm$$

But given perimeter = 34cm

$$\Rightarrow 34 = 34$$

The students concluded again that, the method used was accurate for the given solution. Following the same procedure, it was concluded that, the width 7cm and length 10cm was an accurate or correct answer to the question.

4.0 Results and Discussion

The pre-test result for both experimental and control groups are presented in Table 1. Table 1 displays the descriptive statistics and the independent samples t-test values of the pre-test scores of the students who participated in the study.

Table 1: Means, Standard deviations and independent samples t-test values of pre-test scores of students in the experimental and control groups.

Group	N	Mean	SD	Df	t-value	P-value
Experimental	38	16.89	12.68			
				68	1.99	0.57
Control	32	15.16	12.77			

The independent samples t-test results indicated that there was no significant difference between the experimental (M = 16.89, SD = 12.68) and control (M = 15.16, SD = 12.77) groups at t (68) = 1.99,. P> 0.05.

Table 2: Means, standard deviations and independent samples t-test values of post-test scores of experimental and control groups.

Group	N	Mean	SD	Df	t-value	P-value
Experimental	38	66.21	18.82			
				68	2.00	.00
Control	32	38.25	19.28			

The independent samples t-test indicates that there was a statistically significant difference between the post-test mean scores of the experimental group (M = 66.21, SD = 18.82) and the control group (M = 38.25, SD = 19.28), t (68) = 2.00, P = .00. Therefore, the two groups were statistically significantly different in their understanding of linear equations word problems after the introduction of problem-based learning to the experimental group. The null hypothesis was therefore rejected. The results indicated a statistically significant difference in the post-test scores of the students from the two groups: the students in the intervention classroom of the experimental group achieved higher scores than that of the students from the control group.

In addition, their mean score was substantially higher than that of students in the control group. Problem-based learning approach had helped the experimental group a lot of teacher guided discussions in the classroom. These discussions among students generated lots of ideas and therefore, enhance the students understanding of word problems in linear equations. Students were motivated and enjoyed working towards their lesson where problem-based learning was used. This result confirms Uygun and Tertemiz (2014) when the studied the effects of problem-based learning on students' attitudes, achievement and retention of learning a Math course. They found that students performance increase in the use of problem-based learning approach on the experimental group compared to the control group.

Hypothesis 2

A Likert-type questionnaire of twenty statements was administered to the experimental group to elicit their responses on their attitude to linear equations word problems. There were thirty-five students who responded to the questionnaire on both occasions of before and after the treatment. The findings are shown below in table 3.

Table 3: Means, standard deviations and paired samples t-test values of experimental group attitudes to linear equations word problems.

Group	N	Mean	SD	Df	t-value	P-value
Before	35	32.60	6.40			
				34	10.52	.00
After	35	52.16	8.62			

The purpose of **hypothesis two** was to find out if there existed any significant difference in the experimental group's attitude to linear equations word problems before and after the treatment. A mark of 85 was obtained if a student 'strongly agree' with all the statements then a mark of 25 was obtained if a student 'strongly disagree'. Based on this a cut-out point of 50 was used as a measure for positive attitude to linear equations word problems. The experimental group showed a more positive to linear equation word problems after the treatment than before ($52.16 > 32.60$). The paired samples t-test results indicated that there was a statistically significantly difference in attitudes of students to linear equations word problems before and after the treatment. The null hypothesis is therefore rejected. The experimental group showed a more positive attitude to word problems in linear equations after the treatment than before.

Problem-based learning problems related to real life appeal most or all forms of intelligence to cater for different individuals. Results of hypothesis two indicated a statistically significant difference in the attitude of experimental group students after they had been taught using problem-based learning approach. The three highest-rated statements on the Likert-type questionnaire were " problem-based learning approach makes me an independent thinker" (M = 5), "I understand the concept better when my teacher guides me to solve it myself with more examples", (M = 4.5) and "I think I can handle more challenging and complex problems in word problems in Mathematical word problems especially linear equations when I collaborate, communicate and cooperate with my group members and the teacher comes in to scaffold concepts/ideas to our understanding", (M = 4). The lowest rated statement was "the use of different instructional strategies offers me greater flexibility for solving word problems", (M = 2). This low score can be attributed to the conventional/traditional method of teaching Mathematics is taught in most classes where students are presented with facts or formulas, they are to memorise them. This mode of teaching had the potential of preventing creativity in students. Solving word problems or Mathematical problems should put to task the creative abilities of students.

Even though, the experimental group showed a positive attitude to mathematical word problems after the treatment with the mean value of 52.16 is just above the cut-off mean mark of 50. Results of this study generally supports previous research regarding the value of problem-based learning approach.

5.0 Implications of the Findings for Mathematics education

Problem-based learning increase the interest of students to learning when teachers give careful consideration to modern instructional strategies that move students prior to viewing this particular approach to teaching and learning process. Implementing problem-solving through problem-based learning and Polya heuristic require a strong commitment to a student-centred learning which may be unfamiliar to both teachers and students. Application of problem-based learning can be successful in Mathematics education through innovation, creativity and proper planning.

Although, large class size may limit the frequency and duration of techniques that encourage problem-solving; however, it was still plausible to engage students in groups. Problem-based learning can be achieved in any mathematical classroom by incorporating active learning techniques and modifying teaching strategies.

5.1 Conclusions

The use of problem-based learning instructional approach in the teaching and learning of mathematical word problems in linear equations in this study had better effect on students' attitude toward mathematical word problems especially on motivation, independent thinking, self-directed learning and understanding in solving mathematical word problems in linear equations. To enhance students' positive attitudes to mathematical word problems it is deem necessary to provide positive experiences in the classroom to portray positive values associated with mathematical word problems and its importance to the society or global community. Students' understanding in mathematical word problems had also improved, hence problem-based learning encouraged the students to be in-charge of the process of solving the given problem. The results indicated that students in the experimental group through problem-based learning out performed more than those in the control group of traditional approach. Using Polya's heuristics helped students acquired problem-solving skills and brought fundamental change in instructional techniques which resulted in learning experience which was more self-directed, valuable and enjoyable.

5.2 Recommendations

The following recommendations were made based on the findings:

- Mathematics teachers at the basic level of our Ghanaian system of education should make problem-based learning approach problems part of their lesson plan. In-service training should be given to Mathematics teachers to equip them with knowledge and skills to enable them use problem-based learning approach in their Mathematical lessons.
- Mathematics teachers should choose activities and mathematical problems which will engage the creative thinking ability of their students.

References

Abdullah, N. I., Tarmizi, R. R., & Abu, R. (2010). The effect of problem-based learning on Mathematics performance and affective attributes in learning Statistics at form four secondary level. *Procedia Social and Behavioral Sciences, 8*, 370-376.http://dx.doi.org/10.1016/j.sbspro.2010.12.052

Ajai, J. T., Imoko, B. I., & O'kwu, E. I. (2013). Comparison of the Learning Effectiveness of Problem-Based Learning (PBL) and Conventional Method of Teaching Algebra. *Journal of Education and Practice, 4*(1), 131-136.

Akyeapong, K., Lussier, K., Pryor, J., & Westbrook, J. (2013). Improving teaching and learning of basic Maths and reading in Africa. Does teacher preparation count*? International Journal of Educational Development,* 33(3), 272-282. Retrieved from www.academia.edu. Doi: 10.1016/j.ijedudev.2012.09.006

Arthur, Y. D., Asiedu-Addo, S., & Assuah, C. (2017). Students' Perception and Its Impact on Ghanaian Students' Interest in Mathematics: Multivariate Statistical Analytical Approach. *Asian Research Journal of Mathematics,* 2456-477X, 4(2). DOI: 10.9734/ARJOM/2017/33023.

Ary, D., Jacobs, C. L., & Razavieh, A. (2002). Introduction to Research in Education (6 ed.), Belmont: Wadsworth/Thomson Learning.

Asante, J. N., & Mereku, D. K. (2012). The effect of Ghanaian Pre-service teachers' content knowledge on their Mathematical knowledge for teaching basic school Mathematics. *African Journal of Educational Studies in Mathematics and Sciences* Vol. 10, p.23.

Atteh, E., Appoh, A. E., Obeng-Denteh, W., Okpoti, A. C., & Johnson, A. (2014). The Problem Solving Strategy of Solving Mathematical Problems: The Case Study of Esaase Bontefufuo Senior High Technical School, Amansie West District of Ghana. *International Journal of Applied Science and Mathematics, 1*(2), 40-45.

Cohen, L., Manion, L, & Morrison, K. (2011). *Research Methods in Education* (7 ed.). London: Routledge.

Creswell, W.J. (2014). *Research design: qualitative, quantitative and mixed method approaches (5 ed.)*. thousand Oaks, California: SAGE Publication, Inc.

Etikan, I., Musa, S.A., & Alkassim, R.S. (2015). Comparison of Convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 2016; 5(1): 1-4. DOI: 10.11648/j.ajtas.20160501.11

Lorenzo, J. B., Eloisa, G. B., & Ana, C. C. (2013). Cognition and Affect in Mathematics Problem Solving with Prospective Teachers. *The Mathematics Enthusiast, 10*(1&2), 335-364.

Ministry of Education. (2010). *Teaching Syllabus for Core Mathematics (Senior High School 1-3).* Accra: Ministry of Education.

Nabie, M. J., Akayuure, P., & Seidu, S. (2013). Integrating Problem Solving and Investigations in Mathematics: Ghanaian Teachers' Assessment Practices. *International Journal of Humanities and Social Science, 3*(15), 46-56.

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. (1989). *Curriculum and Evaluation Studies for School Mathematics.* Reston VA: NCTM.

Polya, G. (1945). *How to solve it.* Princeton, New Jersey: Princeton University Press.

Privitera, G. J. (2014). *Research Methods for the behavioural Sciences.* California: SAGE.

Sarfo, K. F., Eshun, G., Elen, J., & Impraim, A. K. (2014). Towards the Solution of Abysmal Performance in Mathematics in Junior High Schools: Comparing the Pedagogical Potential of two Designed Interventions. *Electronic Journal of Research in Educational Psychology, 34*, 763-784. Retrieved from http://www.redalyc.org/articulo.oa?id=293132659010

Savery, J. R. (2006). Overview of Problem-Based Learning:Definitions and Distinctions. *International Journal of Problem-Based Learning, 1*(1), 9-20.Doi: 107771/1541-5015.10

Uygun, N., & Tertemiz, N. (2014). Effects of problem-based learning on students' attitudes, achievement and retention of learning Math course. *Education and Science*, 39(174), 75-90. Doi: 10.15390/EB.2014.1975.

Vanderstoep, S., & Johnson, D. (2009). *Research Methods for Everyday Life. Blending Qualitative and Quatitative Approaches.* San Francisco: Jossey Bass.

West Africa Examination Council. (2012). *April/May Basic Education Certificate Examination, Chief Examiner's Report.* Accra: West Africa Examination Council.

West Africa Examination Council. (2015). *April/May Basic Education Certificate Examination, Chief Examiner's Report.* Accra: West Africa Examination Council.

West Africa Examination Council. (2017). *April/May Basic Education Certificate Examination, Chief Examiner's Report.* Accra: West Africa Examination Council.