UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF PROBLEM-BASED LEARNING ON JUNIOR HIGH SCHOOL LEARNERS' ACHIEVEMENTS AND ATTITUDES IN SOLVING LINEAR EQUATION WORD PROBLEMS IN ONE VARIABLE

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DECLARATIONS

Student's Declaration

I, Majeed Imoro, declare that this thesis, except quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: ……….………………………….………

Date: …………………..……………………….

Supervisors' Declaration

We hereby declare that the preparation and presentation of this work were supervised in accordance with the guidelines for supervision of the thesis as laid down by the University of Education, Winneba.

Prof. Jones Apawu (Principal Supervisor)

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Date: …………………..……………………….

Mr. Kobina Ahmed Amihere (Co-Supervisor)

Signature: ……….………………………….………

Date: …………………..……………………….

DEDICATIONS

This thesis is dedicated to all my family members and friends for their care and support in kind and cash.

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LIST OF ACRONYMS

BECE	Basic Education Certificate Examination
JHS	Junior High School
MoE	Ministry of Education
PBL	Problem-Based Learning
TM	Traditional Method
TTA	Traditional Teaching Approach
WAEC	West Africa Examination Council

ABSTRACT

The study investigated the effects of Problem-Based Learning (PBL) on Junior High School learners' achievements and attitudes toward solving linear equation word problems in one variable. The study employed a quasi-experimental research design in which 100 learners in two Junior High School classes were randomly sampled and assigned to a control group (N=50) and an experimental group (N=50). Data were gathered using tests (pre-test and post-test), interview, and questionnaire which was analysed using descriptive and inferential statistics. The study revealed that many Junior High School learners perform poorly in solving linear equation word problems in one variable. This was established by the fact that fifty (50) learners of the control group who were engaged in the pre-test, thirty-seven (37) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 74% and out of fifty (50) learners of the experimental group who were also engaged in the pre-test, forty-six (46) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 92%. The study also revealed that Junior High School learners' difficulties in solving linear equation word problems in one variable were largely due to their inability to understand (comprehend) the problem, inability to devise a correct plan (write correct mathematical equation), inability to carry out their plans (solve the problem) and inability to check and state the correct solution (looking back). The study revealed that learners who are exposed to Problem-Based Learning developed more positive attitudes towards linear equation word problems than learners taught using the Traditional Method. The researcher resolved that PBL is a more effective teaching approach, which mathematics teachers need to incorporate into their teaching. The PBL approach is therefore recommended for use by mathematics teachers to enhance learners' achievement in solving mathematical problems. Finally, the study revealed that learners who are exposed to the Problem-Based Learning approach of teaching develop positive attitude towards solving linear equation word-problems in one variable and also performed better in the post-test than the Traditional group. This suggests that PBL has a positive effect on learners' achievement in solving linear equation word problems in one variable as a teaching strategy.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses the background of the study, the statement of the problem, the purpose of the study, the objectives of the study, the research questions, the significance of the study, delimitations, limitations, and the organisation of the study.

1.1 Background to the Study

Mathematics is described as the means of sharpening the mind, the reasoning ability, and developing the personality of the individual, for that matter its great contribution to general and basic education (Asiedu-Addo & Yidana, 2004). Mathematics is an important subject that aids learners' achievement in school, for modeling well-informed citizens, career success, and ultimately personal fulfillment. Mathematics is also considered an essential tool in many disciplines such as natural science, engineering, social sciences, and medicine. The scientific development of any nation and the overall personal and intellectual development of individuals in any society largely depends on the role of mathematics. Mathematics forms an integral part of our lives, without which man cannot function (Salman, Mamdouh, El-Nabie, Walaa, & El Talawy, 2022). Hence, countries that seek to grow scientifically place much emphasis on the study of mathematics.

Mathematics is one of the compulsory subjects at the basic and second-cycle levels of education in many countries including Ghana. The importance of mathematics in human life makes it form part of the core subjects that constitute the core curriculum for basic education in Ghana. The role that mathematics plays cannot be underestimated in the national curriculum. The subject is useful in all disciplines including language-based subjects such as English language and French. It is an undeniable fact that, for anyone to be successful in any form of training or work in general, his knowledge of mathematical concepts must come to bear for the effective interpretation of guidelines and calculation of time.

One's ability to cope with mathematics brightens his chances of academic, social, and political advancement (Jordan et al., 2013). The powerful nature of mathematics makes it a core subject, and a measuring tool that determines learners' progress to higher education and entry into certain professions (Chales-Ogan & Otikor, 2016). The importance of mathematics can be seen from its application in one's daily life and the role it plays in technology (Charles-Ogan & Otikor, 2016). Mathematics forms a stronger binding force among the various branches of science subjects than other subjects. Without mathematics, the knowledge of science and its findings often remains shallow. The key role that mathematics plays in education makes it a core subject in the Junior High Schools' (JHSs') curriculum. Most educational objectives such as promoting science and technology, and the provision of a trained skilled workforce in the applied sciences, technology, and Commerce can only be achieved with the knowledge of mathematics. Mathematics forms the basis for the acquisition of appropriate skills, abilities, and competencies both physical and mental, the tools for functional life and development of the society (Onoshakpokaiye, 2021). Mathematics enables learners to gain in-depth knowledge of scientific concepts by providing alternative ways to quantify and explain scientific relationships. Chales-Ogan and Otikor (2016), argued that with a good background in mathematics, one has the potential of doing well in science and its related subjects. This points out that without a proper understanding of the underlying principles in mathematics, the necessary skills and concepts in Science and Technology cannot be effectively acquired and applied by learners.

The development and sustainability of Ghana as a nation cannot be achieved if conscious and practical efforts are not put in place to improve and promote the teaching and learning of mathematics at the JHS level. The reason is that learners at the JHS level, make up the future leaders of the country. The requisite mathematical know-how of learners for the effective contribution of their quota towards national development depends largely on the educational structure that provides them with a good mathematical foundation at this level. This is the reason why every school-going child who enters the educational system in Ghana has to study mathematics at the pre-university level to the highest level of education.

At Junior High School in Ghana, mathematics education is designed to enable learners to make good use of mathematics in their daily lives and be able to identify situations that call for mathematical problem-solving strategies and apply the knowledge of mathematics to resolve them (Kuyini, 2013). It is the view of many mathematical literates that mathematics is tantamount to problem-solving (Sarfo, Eshun, Elen, & Adentwi, 2014). It is clearly stated in the Ghanaian mathematics curriculum that, teaching should be done through problem-solving which is emphasized in word problems across topics in Mathematics (MoE, 2010). The emphasis is established on the idea that learners will develop essential mathematical ideas, skills, and competencies through problem-solving instruction. Learners who actively involve themselves in problem-solving instruction develop, extend, and enrich their understanding (Hiebert & Wearne, 1993). For learners to become successful problem solvers, problem-solving should be considered an integral part of teaching and learning mathematics and not be treated separately after teaching the concepts and skills (Cai, 2010). Therefore, it is a basic goal of all mathematics instruction and an integral part of all mathematical activity.

Also, mathematics educators hold the view that word problems are the primary method to teach problem-solving (Gooding, 2009; Okpoti, 2004; Verschaffel, Erik, & Lasure, 1994) indeed, one of the essential goals of mathematics education in Ghana is to develop learners' ability to solve daily problems. Mathematics teaching should take into consideration teaching the content and its applications in real-life problem-solving. If mathematics is taught using problem-based learning it helps learners develop daily problem-solving skills which will eventually promote life-long learning. Mathematics teachers are therefore encouraged to help learners organize, interpret, and present mathematical information accurately in written text, graphical, and diagrammatic forms to analyze problems, select suitable strategies, and apply appropriate techniques to obtain their solutions (MoE, 2007). Problem-solving forms an integral part of the mathematics curriculum but not a topic on its own to be taught. It is therefore prudent that mathematics teachers integrate problem-solving activities in their daily lessons to help develop learner's competencies, skills, and reasoning.

Problem-solving is described as the method of accepting a challenge and making authentic strives to solve it (Okpoti, 2004). Problem-solving in mathematics is a complex process that seeks the attention of a problem solver who is engaged in a mathematical task to organize and deal with domain-specific and domain-general pieces of knowledge. Mayer and Moreno (2003) also posit that problem-solving is a multiple-step process that requires the problem solver to find relationships between past experiences and the problem at hand and then act upon a solution.

A word problem is defined as an aural description of a problem situation in which one or more questions are posed, whose answer is obtained by the application of mathematical operations to numerical data available in the problem statement (Dewolf, Van Dooren, Ev Cimen, & Verschaffel, 2014). Word problems are described as mathematical tasks that present authentic information on a problem as text, rather than being in the form of mathematical notation (Verschaffel, Greer, & De Corte, 2000). Word problems generally seek to relate mathematical concepts with real-world situations. With the help of word problems, learners can apply their knowledge of Mathematics to solve problems in their daily lives. According to Barwell (2011), word problems provide learners with the opportunity to connect reality to Mathematics. For the effective approach to word problems, learners are required to interpret and translate the statements in words into mathematical notations called expressions or equations before actual mathematical operations are executed to arrive at a solution. Montague (2003) posits that mathematical word problem-solving is a process that involves two stages: 'problem representation' and 'problem execution'. Montague (2003) added that problem-solving is not possible without first representing the problem appropriately. The implication therefore is that learners' reading and comprehension abilities greatly influence how likely they will be successful in solving a word problem.

In Ghana, most mathematics teachers are still regarded as the wardens of knowledge in the classrooms by their learners who hold the impression that their success in mathematics greatly depends on their ability to follow and master their teacher's instructions and approach to solving problems (Ampadu, 2012). Several studies have it that, the traditional teaching approach does not encourage active participation and creativity on the part of learners in the process of knowledge acquisition, but instead makes them passive recipients of information making the learners deficient in mathematical analysis and logical reasoning (C. R. Anderson, 2007). This traditional teaching approach confirms that mathematics teachers in Ghana also adopt the traditional method as their main mode of teaching mathematical concepts a contributory factor to the abysmal performance of learners in mathematics.

Mereku (2010) holds the view that the poor performance of learners in Mathematics is a result of the non-utilization of appropriate teaching methods in the Ghanaian mathematics classroom. This therefore calls for the need to use instructional approaches that will improve learners' understanding and performance in Mathematics. When a good teaching approach is used in teaching mathematics, it will facilitate learners' understanding and performance. Rivkin, Hanushek, and Kain (2005) posit that when learners are provided with high-quality teaching in Mathematics, they gain more experience and greater persistent achievement than their peers who are exposed to lower-quality teaching in Mathematics. For learners to overcome these difficulties, abysmal performance, and poor attitudes towards mathematics, particularly in word problems, there is an advocacy for mathematics teachers to move away from the teacher-centered approach to a more learner-centered approach. Problem-based learning is one of the several instructional strategies that provide the opportunity for learners to construct their knowledge.

Problem-based learning is a learner-centered teaching strategy that actively engages learners to construct knowledge in a learning process, facilitates their understanding of mathematical concepts, and promotes their creative and problem-solving skills. According to Boaler (2008), a learner-centered approach to instruction is an instructional strategy in which opportunities are provided for learners to demonstrate their ideas making them become actively engaged in their learning. Problem-Based Learning is described as a learner striving to achieve a goal by trying every means possible, where there is no readily available method to achieve it (Schoenfeld, 2013). This therefore suggests that the challenge or difficulty the learner encounters does not make a task a problem. Mereku and Cofie (2008) hold the view that a problem-based learning approach to teaching Mathematics goes beyond assisting learners to solve routine problems (tasks that can be solved by applying a standard procedure or formula) to non-routine problems (problems that cannot be solved by applying a routine procedure). Mereku and Cofie (2008) again, believe that learner's ability to read and comprehend the language of a Mathematical problem is close to finding a solution to the problem. Hiebert et al. (1996) maintain, that problem-solving is a practical skill, that can effectively be acquired through imitation and practice which will lead to the understanding of mathematical concepts as the ultimate goal rather than facts memorization.

Word problems in Mathematics most often are presented in the English language, algebraic letters and sometimes both. To be successful in problem-solving, learners need to understanding English language and mathematical language to be able to interpret the problem. Learner's ability in solving algebraic linear equation word problems in one variable provide them the opportunity to apply the knowledge to word problems in other areas of Mathematics.

As stated earlier, mathematics in Ghana is one of the important subjects that are to be learned by all learners from the Basic School to the higher level of education. Because of its importance, linear equation is one of the topics in the mathematics syllabus for

Junior High School learners to study. It involves linear equations in one or two variables and linear inequalities (Clements, 2007).

At the basic level of education as pointed by Tuffour (2014) the Ghanaian mathematics teacher is regarded as a demonstrator of process and transmitter of information and taught largely through lecturing and teacher-centered approaches. This denies the student from experiencing the learning of mathematics using manipulative materials. It is no surprise, therefore that learner's performance in mathematics in Ghana remains among the lowest in Africa and the world (Ampiah, 2011).

Learners' understanding of linear equations serves as the basis for learning other kinds of equations such as, linear equation word problems in one variable or two variables and simultaneous equations. Therefore, the teaching of linear equation must be handled with care. It is in this light that the researcher has decided to make a conscious effort to identify the level of achievement and attitudes of learners in solving word problem on linear equations in one variable and using problem-based learning approach to teach the learners to overcome their difficulty.

1.2 Statement of the Problem

Word-problem-solving is recognized as an important life skill involving a range of processes including analyzing, interpreting, reasoning, predicting, evaluating and reflecting. It is also viewed as verbal statement of a problem situation where problems are posed and appropriate responses can be obtained by translating it using mathematical symbols and carrying out operations to numerical values available in the problem statement (Depaepe et al., 2015). Word problems otherwise known as story problems by many, provide learners with the indication of how Mathematics is practical in the real world. Word problems fosters creativity in learners making them independent analytical thinkers and learners are capable of developing innovative methods to solve problems. Verschaffel, Schukajlow, Star, and Van Dooren (2020) state that solving word problems requires learners' knowledge on grammatical construction and how it relates to mathematics, in addition to the idea on basic numerical skills and strategies. This means that, for leaners to be able to solve a word problem will depend on their ability to translate the problem which is in the form of text into mathematical notations. Learners do not only learn mathematics in word-problem solving but also develop appropriate skills for learning new concepts.

Despite the position word-problem solving occupies in the mathematics curriculum, majority of Ghanaian learners still have challenges dealing with mathematical word problems. Reports from the chief examiner for Basic Education Certificate Examination (BECE) have it that learners have difficulty in translating word problems into mathematical sentences. The report highlights the point that learners who attempt answering questions on word problems usually perform abysmal by exhibiting lack of basic mathematical knowledge in their attempt to solve those questions. This abysmal performance by learners may be due to the teacher centred and the traditional method employed by mathematics teachers in the teaching and learning in the Ghanaian classroom (Mereku, 2010). The Traditional Teaching Approach (TTA) is an instructional approach employed by a teacher to impart mathematical knowledge to learners who sit quietly, listen to instruction by the teacher and subsequently practice what they were taught (Masingila, Muthwii, & Kimani, 2011).

Notwithstanding the strong desire and common concern about mathematics and the significant role linear equation word problems play in our daily lives, most learners in

Ghana continue to find it difficult to deal with word problems. Research findings by Emmanuel and Loconsole (2015) discovered that learners experience a lot of challenges in dealing with word problems in mathematics as well as linear equations in variable word problems. The challenges encountered by learners stem from numerous factors including lack of comprehension of the meaning of the algebraic symbols; difficulty in changing the data stated in grammatical language into mathematical equations; poor interpretations of the sentence structure of texts resulting in the misinterpretation of the relationships between quantities and finally, the difficulties to translate semantic facts from expressions to mathematical equations (Ng & Lee, 2009).

Reports from the Chief Examiner for Basic School Certificate Examination (BECE) consistently pointed out that learners find it difficult to translate word problems into mathematical sentences (WAEC, 2020). These reports indicate that learners who attempt to answer questions in word problems usually do not do well because they show a lack of understanding of these problem statements which challenge their problem-solving ability. The majority of learners who attempt word problems cannot translate them into relevant equations.

The difficulties learners experience in the process of solving word problems are very much attributed to the inappropriate teaching approaches employed by mathematics teachers in the delivery of their lessons to learners. The traditional approach to teaching is what most mathematics teachers use to deliver mathematical concepts to learners making them watch passively to demonstrations by the teacher, listen, and later practice what they were taught by their teachers (Boaler & Staples, 2008). The traditional approach to teaching does not promote learners' understanding, creativity, analytical thinking, and problem-solving skills. When appropriate teaching strategies and activities are used to teach mathematical concepts to learners, they develop an in-depth understanding of these concepts and can apply them in problem-solving. Problem-solving approach to teaching provide learners with the ability and confidence to relate similar problems, to construct their own mathematical knowledge, reason critically and think creatively (Collins et al., 2018). The concept of problem-solving is much more than the usual thinking and reasoning learners assume in their attempt to solving exercises given them by their teacher. It has to do with deep thinking about concepts, their related representations, procedures that will provide suitable solution, closely associated context and creating models of the problem (Collins et al., 2018). This study investigated the effect of problem-based learning on Junior High School learners' achievements and attitudes in solving linear equation word problems in one variable in the East Mamprusi Municipality.

1.3 Purpose of the Study

The purpose of this study was to determine the effect of problem-based learning on Junior High School learners' achievements and attitudes in solving linear equation word problems in one variable.

1.4 Objectives of the Study

The objectives of the study are to:

1. determine the level of achievements of Junior High School learners in solving linear equation word problems in one variable in the East Mamprusi Municipality;
2. identify the challenges Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality;

3. find out the effect of Problem-Based Learning approach on Junior High School learners' attitudes towards linear equation word problems in one variable in the East Mamprusi Municipality;
4. determine whether there is a significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality.

1.5 Research Questions

The study was guided by the following research questions:

1. what is the level of achievements of Junior High School learners in solving linear equation word problems in one variable in the East Mamprusi Municipality?
2. what challenges do Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality?
3. what is the effect of the Problem-Based Learning approach on Junior High School learners' attitude towards linear equation word problems in one variable in the East Mamprusi Municipality?
4. is there a significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality?

In order to answer Research Questions 3 and 4, the following null hypotheses were formulated.

H_{01}: There is no significant difference in the mean achievement scores of learners taught linear equation word problems in one variable using

Problem-Based Learning (PBL) approach and those taught using Traditional Method (TM).

H_{02}: There is no significant difference in mean attitude scores of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach and those taught using Traditional Method (TM).

1.6 Significance of the Study

The findings from the study will help learners develop the ability to construct and ask meaningful questions on word problems in linear equations. It will help build the confidence and enthusiasm of learners because Problem-Based Learning encourages discussion between and among the learners which promote interpersonal relationships among them (Verschaffel et al., 2020). The findings will also inform mathematics teachers of the appropriate teaching strategy to employ in the teaching of word problems in linear equation. The findings will also generate ideas that will inform policy makers, teachers and other stakeholders to help improve learners' problem-solving skill in Ghana, through the use of PBL. It will equally uncover information that will inform policy makers on how to implement the national policy on the integration of PBL into the teaching and learning of mathematics in Ghana.

The findings of the study will as well serve as a resource for teachers and curriculum developers to improve learners' learning outcomes in schools. The findings of the study will serve as an authentic document for other future researchers who will like to investigate into the effects of Problem-Based Learning on Junior High School learners' achievements in other concepts of mathematics.

1.7 Delimitation

This study was narrowed to the Junior High Schools within Gambaga circuit in the East Mamprusi Municipal in the North East Region of Ghana. Specifically, was delimited to only basic 8 learners of the schools in the circuit**.** The study focused on the use of Problem-Based Learning strategy of learning and equally determine the effect of the strategy on Junior High School learners' achievements, and their attitudes towards linear equation word problems in one variable solving, though there are other strategies of learning. The study further delimit itself to only linear equation word problems in one variable.

1.8 Limitation of the Study

Limitations in the research report are the shortcomings or influences that the researcher finds difficult to control which place restrictions on the methodology and conclusions. Learners' absenteeism was a problem, some of the learners were not regular to school during the treatment period that lasted for three weeks but were present to take part in the post-test. Using problem-based learning as a teaching strategy that was alien to learners was difficult. However, the researcher tried every means possible to take the learners through it for a successful interaction. The study period lasted for only three weeks and this places a limitation on the results. A longer time spent during the treatment might have brought about a greater difference between the pre-test and post-test scores of learners and also between the control and experimental groups. In this study only two Junior High Schools out of seven Junior High Schools in the Gambaga circuit of the East Mamprusi Municipal of North East Region of Ghana were used. The study's optimal sample size was selected to ensure that any descriptive or inferential conclusions accurately reflect the population. Therefore, conclusion drawn from this study will be limited by these factors and as a result, the findings of this study cannot be generalized to cover all Junior High Schools in Ghana.

1.9 Operational Definition of Terms

Problem-Based Learning is a learner-centered learning in which learners work collaboratively in groups lead by a tutor or "expert" to develop conceptual knowledge and procedural skills necessary to find solutions to mathematical problems.

Traditional teaching method is a teacher-centered learning in which learners are passive listeners without working in groups and no interaction among groups. For the purposes of this study by the term traditional teaching, refers to where a teacher demonstrated new material to learners and they practiced by doing it just as the teacher had demonstrated it. The teacher played a very active role in explanations and discussions, acting like the dispenser of knowledge while the learners copied notes and practiced problems on their own in class or at home. The learners are considered as empty vessels in which knowledge is poured.

1.10 Organisation of the Study

This study was organised into five major chapters. Chapter One contains background to the study, statement of the problem, purpose of the study, research objectives, research questions, hypotheses, significant of the study, delimitation and limitation of the study. Chapter Two tackled the review of the related literature on the study. Chapter Three focused on the methodology which discussed the research design, the population, sample and sampling methods, instruments for data collection, data collection procedure and data analysis procedure. Chapter Four presented and discussed the results of the study. Chapter Five consisted of the summary of findings, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The study explored the effect of problem-based learning approach on Junior High School learners' achievement and attitudes in solving linear equations word problems. The literature review is discussed under the following areas;

- Theoretical framework
- Concept of Problem-Solving
- The concept of Linear Equation Word Problems
- General Procedures for Solving Linear Equations
- Procedures for Solving Linear Equation Word Problems
- Learners' Challenges in Solving Linear Equation Word Problems
- Learners' Attitude towards Linear Equation Word Problems
- Concept of Problem-Based Learning (PBL)
- Implementation of Problem-Based Learning in Mathematics Education
- Benefits of PBL to the Learners
- Challenges in Problem-Based Learning
- Effectiveness of PBL and Learners' Achievement and Attitudes in Mathematics

2.1 Theoretical Framework

The theoretical framework for this study was centered on George Polya's Problem-solving Techniques. Believing that mathematics is not all about the result, George also argued that the essence of mathematics education has to do with thinking and creativity employed in problem-solving. Polya (1957) Problem-solving Model comprises of four main phases:

- Understanding the problem,
- Devising a plan,
- Carrying out the plan,
- Looking back.

According to Polya (1957) the problem solver must understand the problem first, then proceed to devise a workable plan, advance to carrying out the plan and finally looking back, which suggests checking the solution and solution process used in the solution process.

The first phase in the Polya (1957) model is to understand the problem. This is often the most overlooked step in the problem-solving process. This may seem like a clear step that does not need mentioning, but for a problem-solver to correctly solve a problem, he or she must first understand the problem, and get to know what is required, he or she must understand how various items are connected, how the unknown is linked to the data, in order to obtain an idea of the solution. He or she must also understand the verbal statement of the problem as well as point out the principal parts of the problem. Polya (1957) suggested that teachers or facilitators should ask learner questions similar to those suggested as follows:

- do you understand all the words used in stating the problem?
- what are you required to find or show?
- can you restate the problem in your own words or differently?
- can you think of a picture or a diagram that might help you understand the problem?
- is there enough information to enable you to find a solution?

The second phase in Polya's model requires that learners devise a plan for solving the problem at hand. Learners should find the link between the data and the unknown. By the end of this phase, they should have a clear plan for the solution. Polya also suggested that the learner should consider questions such as the following when devising the plan:

- have you seen the same type of problem in a slightly different form or manner?
- try to think of a familiar problem having the same or a similar unknown.
- could the problem be restated differently and still make the same sense?
- did you use all the data?

There are problems where learners may find it suitable necessary to explore with the information before they are able to think of a strategy that might produce the desired solution. This exploratory stage will also help the learner to comprehend the problem better and become aware of some information they neglected after the first reading.

Polya again suggested problem-solving strategies in no particular order that one may need to combine:

- construct a table
- look for a pattern
- make a diagram
- write an equation
- work backwards
- make a model
- use indirect reasoning
- solve a simple or similar problem

The third phase is all about carrying out the plan. Polya suggested that learners have to decide on a specific plan and as well should follow certain criteria which includes;

- use your plan to solve the problem.
- double check each step you have taken.
- if the plan is not proving the desired results after a few attempts, try a different plan.
- allow for mistakes as they are part to a solution of the problem (remember the plan may need some revision).
- verify your answer.

Polya finally suggested the fourth phase, which is the final phase of his proposed theorem on problem-solving which he identified as looking back. At this phase, Polya suggested that, after learners have completed their problem and came out with a solution they are satisfied with, they should reflect on the problem-solving process. Much can be gained by taking the time to reflect and look back at what have been done, what worked and what didn't. Doing this will enable the learner to predict what strategy to use to solve similar or same future problems. Polya outlined the following questions as checks at the looking back phase:

- can you check the result?
- can you check the argument?
- does your answer make sense?
- did you answer all parts of the question?
- what methods worked? What methods failed? What did you learn from completing this problem?
- could I have solved this problem another way?

- was there an easier way to solve this problem?
- if I encounter a similar problem in the future, how could I better solve it?

Polya's problem-solving approach is similar to that proposed by Johnston and Wu (1994) and Suydam (1980). Suydam (1980) identified these steps: understand the problem, plan how to solve it, solve it, and finally review the adequacy of the solution as carried out by effective problem solvers in solving problems. Johnston and Wu (1994), however, identified six steps as stated below:

- represent the unknown by a variable.
- break the word problem into small parts.
- represent the pieces by an algebraic expression.
- arrange the algebraic expression in an equation.
- solve the equation.
- check the solution.

What appears to be fundamental in both Polya's (1957) and Suydam's (1980) models is understanding the given problem before solving it. The Learner cannot represent the unknown by a variable if he or she cannot understand the problem. After understanding the problem, the learner needs to select or order the processes available to him or her. If the processes are not available to the learner, then it would be hard to move forward in solving the given problems. Even though there exist similarities between Polya (1957) and Suydam (1980), but Suydam model is the revised model of Polya's model. Polya is the first to develop and introduce the concept of problem-solving model, hence Polya's model was used as the theoretical framework for this study. Polya (1957) model is illustrated in the following example: Twice the difference of a number and 1 is 4 more than the number. Find the number.

Phase 1: Understand the problem:

The learner reads the question carefully several times. Once the problem is seeking an unknown quantity or number, the learner will let x = the number.

Phase 2: Devise a plan

The learner translates twice the difference of a number and 1 is 4 more than the number

as, $2(x - 1) = x + 4$.

Phase 3: Carry out the plan (solve)

The learner proceeds to solve it as:

$2(x - 1) = x + 4$

$2x - 2 = x + 4$

$2x - 2 - x = x + 4 - x$

$x - 2 = 4$

$x - 2 + 2 = 4 + 2$

$x = 6$

Phase 4: Look back (check and interpret)

The learner checks and interprets his or her solution as: If you take twice the difference of 6 and 1, which is the same as 4 more than 6. Where the left-hand side of the equation is equal to the right-hand side when answer 6 is substitute in the place of the unknown.

Final Answer: The number is 6

If learners are to apply Polya's four phase approach to solving word problems, teachers or facilitator need to scaffold and develop learners' analytical and critical thinking skills. This shows that mastery of word problems is not solely dependent on learners' performance. Teachers or facilitators also play a very crucial role in shaping the learning environment and guiding learners to mastery (Keiler, 2018).

2.2 Concept of Problem-Solving

According to Bigelow (2004), a problem-based learning is a situation for which a person must come up with a solution that is not immediately evident. One of the main goals of learning mathematics is to develop problem-solving skills, because difficulties are a part of everyday life. The goal of teaching mathematics is to improve learners' ability to solve mathematical problems. Okpoti (2004) asserted that "a problem is a challenging question or statement presented in a such a way that learners accept a change" (p. 31). (Suárez-Pellicioni, Núñez-Peña, and Colomé (2016)) defines a problem as a representation which arouses uneasiness in the individual and therefore leads him to seek for a solution using his prior knowledge. However, in the context of the mathematics curriculum, a problem is one requiring mathematical skills, concepts or process used to arrive at a goal.

According to Yavuz and Erbay (2015), problem-solving includes "the combinations and coordination of various skills, beliefs, attitudes, intuitions, knowledge and previous acquisitions" (p. 2687). Problem-solving in mathematics is a complex process which calls for the problem solver to engage in mathematical task to organize and deal with domain specific and domain-general pieces of knowledge. However, Hasibuan, Saragih, and Amry (2019) describes problem-solving as the ability to read, process and solve mathematical situations while Barkley and Major (2020) assert that problem-solving involves the learner's readiness to accept a challenge. Whether the task at hand is difficult or not does not matter. It is the learner accepting the challenge that matters.

Accepting a challenge here means that the learner is willing to find appropriate methods to solve a problem. In this regard, problem-solving refers to the effort needed in achieving a goal or finding a solution when no automatic solution is available (Schunk, 2000; Surif, Ibrahim, & Mokhtar, 2012). Problem-solving is known as a vital life skill involving a range of process including analyzing, interpreting, and reasoning, predicting, evaluating and reflecting (Karatas & Baki, 2013). Collins et al. (2018) described problem-solving as a principal instructional strategy used to fully engage learners in important mathematics learning situation. It also goes beyond the domain of mathematics to include everyday life activities in general.

Satriawan, Budiarto, and Siswono (2018) also describes mathematical problem-solving as finding a way around a difficulty, around an obstacle, and finding a solution to a problem that is unknown. This suggests that reasoning and higher order thinking must occur during mathematical problem-solving (Rubin & Rajakaruna, 2015), "for there is no mathematics without thinking, and no thinking without problems" (Aljaberi, 2015). Therefore, problem-solving is considered as central to school mathematics and an approach to thinking. Problem-solving is highlighted in reform documents by National Council of Teachers of Mathematics as a key factor of change in mathematics education. Savery, (2015) states that learners should be given the chance to apply and adapt a variety of appropriate strategies to solve problems and monitor and reflect on their mathematical processes during problem-solving. This is because Problem-solving provides an important context for learners to learn numbers and other mathematical terms. The learners' problem-solving ability is enhanced when they have opportunities to solve problems themselves and to see problems being solved (Lazakidou & Retalis, 2010). It is therefore stressed that problem-solving is an important way of doing, learning and teaching mathematics (Masingila, Olanoff, & Kimani, 2018).

According to Ukobizaba, et al. (2021) problem-solving refers to mathematical tasks that have the potential to provide intellectual challenges for enhancing learners' mathematical understanding and development. This means that problem-solving will serve as a key through which learners can achieve the functional, logical and aesthetic values of mathematics.

Teaching problem-solving or learning to solve problems is a situation where the teacher motivates his learners to accept challenging questions and guides them to find solutions to these challenging questions. Teaching problem-solving in the classroom enhance learners' understanding, foster their ability to reason and communicate mathematically and capture their interests and ability (Marcus & Fey, 2003; Pimta, Tayraukham, & Nuangchalerm, 2009). Therefore, employing problem-solving as a teaching strategy helps learners to develop firm conceptual understanding, promote cooperative learning among learners, and develop their confidence in solving mathematical problems.

The need for problem-solving to be viewed as a vehicle by which learners make sense of mathematics and learn context, skills and strategies and that when learners learn mathematics through problem-solving, they understand better in both content and pedagogy and make meaning of the reasons behind the solution

(Anthony & Walshaw, 2009). Hence, problem-solving would support learners to do mathematics and to comprehend mathematics meaningfully (Strohmaier et al., 2022). Furthermore, Kahan and Wyberg (2003) identified the benefits of teaching mathematics through problem-solving to include the following;

a. Teaching through problem-solving helped learners to understand that mathematics develops through sense-making process
b. Deepen their understanding of underlying mathematical ideas and methods, and engaged their interest.

Jonassen, (2010) further indicated that problem-solving skills do not develop within few weeks or months. Development of the problem-solving skill is slow and progressive. Problem-solving is to be expressed every day in every lesson and should continue from the start of the preschool until high school, because the learning of mathematics in problem-solving is related to each other. Teachers need to be informed about what good problem-solving skill covers while involving learners with problem-solving activities (Jonassen, 2010).

Lewis and Mayer (1987) explained problem-solving processes using different forms of knowledge leading to the goal of solving the problem. According to Lewis and Mayer (1987), the types of knowledge applied in problem-solving consisted of:

- linguistics and factual knowledge – about how to encode statements,
- schema knowledge – about relations among problem types,
- algorithmic knowledge – about how to present distinct procedures, and
- strategic knowledge – about how to approach problems

Similarly, Siniguian (2017) argue that learners must possess the relevant knowledge and be able to coordinate their use of appropriate skills to solve problems. Knowledge factors such as algorithmic knowledge, linguistic knowledge, conceptual knowledge, schematic knowledge and strategic knowledge are vital traits of problem-solving ability.

A problem-solving approach to teaching mathematics, according to Mereku and Cofie (2008), goes beyond simply assisting learners in resolving routine problems (i.e., problems that use a standard algorithm, formula, or procedure). It also encourages learners to pose problems, work on puzzle problems, complete projects, and keep journals, all of which are non-routine problems. Also (Mereku & Cofie, 2008), point out the importance of learners' language skills, namely; their capacity to read and understand the problem's language.

In order for learners to be effective in solving mathematical problems including linear equation word problems in one variable they need to develop problem-solving processes that can help in dealing with mathematical tasks that have the potential to provide intellectual stimulations for enhancing their mathematical development and understanding (Ersoy, 2016). As such, learners develop an in-depth understanding of mathematics when they are engaged in solving mathematical problems because it helps them to conceptualize the mathematics being study (Kelly, 2006). Reading, comprehension, and mathematical skills are elements in solving mathematical problems. For a learner to solve a mathematical problem, he or she must acquire these elements, especially reading comprehension and text analysis.

Teachers at all levels of pre-tertiary education should provide practical problem-solving opportunities for learners as well as adequate practical examples to enable them to consolidate the mathematical concepts being taught and to develop interest in solving mathematical problems. In conclusion, studying mathematics through problem-solving improves one's ability to think, to reason, and to solve problems in the real world. Hence, if problem-solving is successfully used and well taught in the classroom the learners will be successful in applying them in real life situations.

2.3 The Concept of Linear Equation Word Problems in One Variable

Blitzer (2009) defines an equation "as an equality connecting some unknowns" (p.108). The unknowns are represented by letters and are called "the variables". If the equation has only one unknown, it is called an equation in one variable. Blitzer (2009) also stress that, the word **'linear'** means degree one, hence, if only a single variable with degree one occurs in an equation, it is called a linear equation in one variable. Therefore, a linear equation in one variable y is an equation that can be written in the form $ay + b = c$ where a, b and c are real numbers and $a \neq 0$. Example, $15x - 7 = 23$.

According to Baratto, Bergman, and Hutchison (2013), an equation is a mathematical assertion that two algebraic expressions have the same value. The expression on the left side of the equality symbol "=" and the expression on the right side of the equal symbol have the same value. The collection of all values in the variable's domain that fulfill the specified equation is known as the solution set of the equation. Stephens et al. (2022) described an equation as a number sentence that says that the expressions on either side of the equals sign '=' represent the same number. Examples; 7 + 4 =

11, $9 - 4 = 4 + 1$, $x + 9 = 15$. This means that equations have expressions on each side of the equal sign. The equation "$9 - 4 = 4 + 1$" asserts that the expressions $9 - 4$ and $4 + 1$ mean the same number. Some equations are true, some are false and some are neither true nor false. For example; $7 + 3 = 10$ is a true equation, $7 + 9 = 17$ is a false equation, $x + 5 = 11$ is neither true nor false equation because the value of x is not known.

Equations are therefore, thought as a balance scale because its two sides are equal. To maintain this balance, whatever you do to one side must be done to the other side. For that matter, solving an equation is defined as the process of finding the number that makes the equation a true statement. This unknown number that makes the equation true is called the truth set or the solution set or the root of the equation. Equations form significant part of mathematics, mainly algebra, because of the several uses they have. Equations may express one variable in terms of the others, or provide information about when a particular quantity is minimized or maximized, a property used in determining extreme points for functions.

Solving linear equation means finding the value of the variable that makes the equation true (Boyce, DiPrima, & Meade, 2021). This indicates that solving linear equations is a process of finding a numerical value for the unknown (usually represented by a variable or a letter) or making the unknown the subject in the given or formulated equation. The success of the process of solving linear equations depends on the solver's conceptual, procedural and conditional knowledge and hence his or her understanding of linear equations.

To solve an equation correctly, one must know the application of procedures of simplifying an algebraic expression. Learning of linear equations comprises of formulating equations from context problems, solving the equations and finally giving solutions to the original problems (Boyce et al., 2021). Formulating equations from context problem and solving them and solving them helps in advancing in other areas of mathematics such as geometry and algebra. Successful understanding of how to solve linear equations helps learners to develop skills in solving advance equations (Lehtonen, 2022).

2.3.1 General Procedures for Solving Linear Equations

To solve an equation means to find its solutions. Various steps or procedures have been outlined when solving an equation. Bittinger, Beecher, and Johnson (2015) outline the following steps or procedure that one has to follow when solving linear equations;

i. multiply on both sides to do away with the equation of fractions or decimals.
ii. if parentheses occur, multiply to remove them using the distribution laws.
iii. collect like terms on each side of the equation, if necessary.
iv. get all terms with variables on one side and all numbers (constant terms) on the other side, using the addition principle.
v. collect like terms again, if necessary.
vi. multiply or divide to solve for the variable, using the multiplication principle.
vii. check all possible solutions in the original equation.

Blitzer (2009) also outline the following step-by-step procedure for solving linear equation:

i. simplify the algebraic expression on each side.
ii. collect all the variable terms on one side and constant terms on the other side.

iii. isolate the variable and solve.

iv. check the proposed solution in the original equation. (p. 125).

One cannot solve an equation successful without following a series of steps. Teachers must take their time to let their learners understand the steps or procedures involved when solving an equation. By so doing, learners will develop both procedural and conceptual understanding of solving equations.

2.3.2 Procedures in solving linear equation word problems

Word problems are defined as the set of problems which in education contexts are solved through the application of series of basic arithmetic operations successively combined with one another until a result is obtained (arithmetic procedure) or through the formulation of equations which are later solved to produce a result (algebraic procedure) (Resnick, 2020). Verschaffel et al. (2020) defined word problems as verbal descriptions of problem situations where a single or several questions are raised, the answer to which can be obtained by application of mathematical operations to numerical data available in the problem statement. Hence, effectively solving a mathematical word problem is assumed to depend not only on learners' ability to perform the required mathematical operations, but also on the extent to which they are able to accurately understand the text of the problem (Jitendra & Star, 2012). Successful word problem solvers are those who make a pictorial or diagrammatic representation and as well use verbal translation and visual representation to solve a problem (Boonen, van der Schoot, van Wesel, de Vries, & Jolles, 2013).

Kikas, Mädamürk, and Palu (2020) described mathematical word problem-solving as a process involving two main stages: problem "representation" and "problem execution". Both of them are necessary for a successful problem-solving. Mathematical word problem-solving according to Mayer and Hegarty (2012), is categorize into four stages: translating, integrating, planning and execution. Learners normally encounter challenges in solving word problems firstly from translating the word representations into mathematical representation, which is the basis for solution process. Boonen, de Koning, Jolles, and Van der Schoot (2016) contend that "successfully solving mathematical word problems requires both mental representation and reading skills" (p. 1). Also, Kurshumlia and Vula (2019) have categorize mathematical word problems into four distinct types, each type defined by the problem-solving strategy required. These are: compare, change, combine, and equalize.

There are series of steps or procedures one has to follow in other to solve word problems successfully. Bittinger et al. (2015) suggest the following five steps to consider when solving word problems:

1. Familiarize oneself with the problem situation.
2. Translate the problem in to an equation.
3. Solve the equation.
4. Check the result or answer in the original problem.
5. State clearly the answer to the problem.

Powell et al. (2022) propose the following seven steps in solving word problems:

1. read the problem carefully to comprehend what the problem is asking. One may need to read the problem several times to fully understand it.
2. clearly identify the unknown quantities. Represent each unknown quantity with a letter (or Variable). Use a letter (in lower case) for an unknown quantity that make sense to the problem solver.

For example, one might use d for distance or t for time.

3. if possible, represent all the unknowns in terms of just one variable.
4. make a sketch (if possible) to makes the problem clearer.
5. make a careful analysis of the problem. Try to write one equation that shows how all the known and the unknown quantities are related. If it is not possible to write one equation, write several of them.
6. solve the equation and indicate the appropriate units.
7. check your answer in the original problem

It is therefore important to note that, in order for learners to be successful in solving word problems they must first understand all the essential key words in the problem by thoroughly reading the problem several times before proceeding to represent the unknown by a variable which will help them to come out with a suitable equation. After forming the suitable equation, they then proceed to solving the problem. After solving the equation successfully, learners should not hurriedly state the final answer but rather try to check their answer before writing the final answer for the given word problem.

2.4 Learners' Challenges in Solving Linear Equation Word Problems

Word problems are essential part of the mathematics curriculum. According to Andam, Okpoti, Obeng-Denteh, and Atteh (2015) many researchers have observed that word problems involving linear equations generate among learners a feeling of fear, anxiety, unease and insecurity. However, learners face difficulties in solving mathematical word problems as they often do not understand the wording of the problem (Siniguian, 2017). Various studies have pointed out that many learners globally faced difficulties in solving word problems (Abdullah, Abidin, & Ali, 2015; Ellion, 2016; Jupri & Drijvers, 2016). Also, studies in Ghana shows that Ghanaian learners have difficulties in solving word problems, including linear equations word problems (Adusei & Atteh, 2022; Bajuri, Othman, & Alam, 2021). According to Siniguian (2017), learners' difficulty in problem-solving may occur at one of the following phases namely, comprehension, strategy know-how, transformation, process skill and solution. Fuchs, Gilbert, Fuchs, Seethaler, and N. Martin (2018) singled out comprehension as the main difficulty learners' encounter when solving mathematical word problems and this result to their inability to formulate the suitable equation to be solved. Adusei and Atteh (2022) and Bajuri et al. (2021) in their studies found that the main cause of learners' difficulties in solving word problems involving linear equation in one variable account for incorrect interpretation, wrong translation and misrepresentation and wrong coding. In addition, Adu-Gyamfi, Bossé, and Chandler (2015) also found that learners' difficulties in solving linear equation word problems is largely as a result their inability to understand and interpret the sentences so as to continue to the process and encoding skills. Adu-Gyamfi et al. (2015) also observed that Ghanaian learners have poor or little knowledge in tackling linear equations word problems. Similarly, Seifi, Haghverdi, and Azizmohamadi (2012) also pointed out learners' inability to represent and understand word problems as other major difficulties they faced when solving mathematical word problems. Ellion (2016) and Salemeh and Etchells (2016) in their studies also discovered language barrier as a major factor which brings about learner's difficulties in attempting word problem. Among the specific difficulties are text difficulties, unfamiliar contexts, using of inappropriate strategies and lack of problem-solving skills.

Jupri and Drijvers (2016) in their study to investigate learners' difficulties in solving linear equation word problems in one variable, found that formulating a mathematical model– evidenced by errors in formulating equations, schemas or diagrams were the main difficulty faced by learners. Learners had problems in understanding words, phrases or sentences, formulating equations, solving the equations and in checking the solution processes. Giesen, Cavenaugh, and McDonnall (2012) also argue that learners with learning difficulties show lower academic achievement than their non-disabled peers because of the higher order cognitive demands presented in mathematical problem-solving.

Andam et al. (2015) also observed a generally low performance of the learners in terms of modeling algebraic linear equations out of word problems. The indication was that, learners were not able to read and comprehend the word problem. They find it difficult to analyze and interpret the key words (for example: sum, difference, product of, less than, quotient, etc.) used as well as translating them into mathematical statements, equations and solving the equations correctly. This finding corroborates with the study conducted by Abdullah et al. (2015) which posit that learners' who had difficulties interpreting mathematical problems, failed to develop a strategy and device a strategic plan, which ultimately led to mistakes in choosing the operations and incorrect answers. This difficulty may be due to the teaching methods which lacked sufficient emphasis in understanding the language of mathematics. This calls for the need for teachers to ensure that learners grasp the basic skills and mathematical terminologies and language as foundation for solving word problem. Clearly, the absence of essential word problem-solving knowledge and skills (reading and computational skills) is a major source of learners' problem-solving difficulty.

Duru and Koklu (2011) conducted a study to investigate the middle school learner's abilities to translate mathematical texts into algebraic representations (equations) and vice versa. Duru and Koklu (2011) found that learners had difficulties in translating the mathematical sentences into algebraic equations because of their inability to read and understand and lack of knowledge about the meaning of symbols, signs, and words used in mathematical texts and algebraic representations. Duru and Koklu (2011) equally established that learners' difficulties in translating between mathematical texts and algebraic representations emanate from lack of their ability to use and organize prior knowledge.

The linguistic factors affecting the formulation or solving of word problems have been considered as relevant factors in the study of word problems (Verschaffel et al., 2020). Lack of mathematical skills such as number fact, visual-spatial and information skills also contribute to learners' difficulties in solving mathematics problems (Karimah, Kusmayadi, & Pramudya, 2018).

In Ghana, the Chief Examiner's report for Basic Education Certificate Examination (2017 to 2020) consistently points out that learners have difficulty in translating word problems into mathematical sentences. The Chief Examiner's report points out that learners who respond to word problems typically do abysmally because they lack fundamental mathematical knowledge, which limits their capacity for problem-solving. Most learners could not write relevant equations from giving word problems. Boadi, Acquandoh, Adams, Kpai, and Atteh (2020) also found that most Ghanaian learner's poor comprehension of word problem items involving algebraic thinking, limit their ability to transform the problems into mathematical equations. Similarly, Phonapichat, Wongwanich, and Sujiva (2014) also point out that learners difficulties in solving problems is largely due to their inability to understanding the keywords appearing in problems, thus they cannot interpret them in mathematical sentences and are also unable to figure out what is giving and what information from the problem is necessary to solving it. Verschaffel et al. (2020) also expressed those difficulties with problem-solving could also be brought on by a problem solver's ability for spatial visualization and attention to structural aspects of problems, dispositions like beliefs and attitudes, and experiential background like previous instruction and problem-solving experience. It is therefore evident that learners all across the globe, especially Ghanaian learners, have a tough time completing word problems involving linear equations.

2.5 Learners' Attitude towards Linear Equation Word Problems

Learners' success in solving mathematical word problems, including linear equations word problems depends upon their attitude towards mathematics. Learners' attitude towards mathematics has a factor that is known to have influence learner's achievement in mathematics including linear equations and word problems (Kiray, Gok, & Bozkir, 2015).

Davis, Ntow, and Beccles (2022) and Maamin, Maat, and Iksan (2021) in their studies have explored factors that influence learners' performance in mathematics. Among these factors, learner's attitude towards mathematics has been consistently studied. Often the studies on the relationship between learner's attitude and academic performance show a positive relationship (Longobardi, Settanni, Lin, & Fabris, 2021; Mensah, Okyere, & Kuranchie, 2013). In order to study mathematics and solve mathematical problems, such as word problems involving linear equations, learners' attitudes toward mathematics are vital. Awofala (2014) argued that "learning of mathematics word problems is largely influenced by learners' attitude toward mathematics word problems" (p. 284).

Srivastava and Rojhe (2021) described attitude as a state of readiness or the propensity of a person to respond in a certain way when confronted with a certain stimulus. Attitudes could either be described as positive or negative. Attitudes may represent beliefs regarding a matter, emotional responses or behaviors related to a matter. A positive attitude could simply mean a positive emotional character toward the matter; a negative attitude is a negative emotional character toward the matter (Anderson & Bourke, 2013; Motsoane, 2017).

It is therefore important to note that positive attitude facilitates learners learning of mathematics and problem-solving while negative attitude hinders learners learning of mathematics and problem-solving. By so doing a positive attitude towards mathematics word problem-solving should be fostered so that learners will enjoy learning mathematics as well as develop interest in solving word problems.

Asante (2012) studied 181 Senior High Learners attitudes towards mathematics in Accra, Ghana and recommended that "the teacher should develop positive relationships with learners and stress classroom activities which involve teaching-learning process and learners' participation in the class" (p. 129) to improve their attitude towards mathematics. Ajzen, Fishbein, Lohmann, and Albarracín (2018) assert that attitudes are moderately strong emotions that make individuals respond continuously when challenged with a particular object. It is therefore representing a mental state that guides the way individuals respond to a particular stimulus. Attitude toward mathematics comprises three components: an emotional response to mathematics, positive or negative, a conception about mathematics, and a behavioral tendency with regard to mathematics (Ignacio, Nieto, & Barona, 2006). Attitude is essential to human identity. This is because everyday people love, hate, like, dislike, favor, oppose, agree, disagree, argue, persuade etc. with objects around them. Hence attitudes can be defined as "a summary evaluation of an object of thought" (Oruwari, Ajeka, & Urenyere, 2021). Other researchers view attitude as inclinations and predispositions that guide an individual's conduct to an action that can be appraised as either positive or negative (Abbas, Ekowati, Suhariadi, & Hamid, 2022; Brenner & Metcalf, 2020).

According to A. Erdogan and Yemenli (2019), learners' attitudes towards mathematics are very much connected to their attitude towards problem-solving in general. In addition, negative attitudes need to be address so that later in life learners will not suffer from poor problem-solving skills. It is important to master problem-solving skills as these skills are essential for dealing competently with our everyday life. Mohd, Mahmood, and Ismail (2011) argued that learners must have a positive attitude towards problem-solving if they are to succeed because solving problems requires patience, perseverance, persistence and willingness to accept risks. This concurs with Capuno et al. (2019) claim that learners with a positive attitude toward mathematics will generally excel at it. Capuno et al. (2019) in their study also expressed that learner with a positive attitude toward mathematics lead to give outstanding performance in education as a whole.

Chan (2011) carried out a study on primary 6 learners' Attitudes towards mathematical problem-solving in a Problem-Based Learning setting. In this study, 80 primary 6 learners were surveyed to determine their attitudes toward solving mathematical modeling problems in a Problem-Based Learning setting after they had solved five modeling tasks. Results from the Attitudes Questionnaire show positive responses in the attributes of interest, perseverance, and confidence suggesting that

Problem-Based Learning promote a positive attitude in mathematics learning. Similarly, Demirel and Dağyar (2016) also established that Problem-Based Learning is effective in helping learners to gain a positive attitude towards courses including mathematics. Ahamad, Li, Shahrill, and Prahmana (2017) posit that Problem-Based Learning permit learners to develop a positive attitude towards lessons. Hence, the teaching environments or lessons which are prepared about Problem-Based Learning enhances learners' performance and attitude towards lessons. Siagan, Saragih, and Sinaga (2019) suggested that Problem-Based Learning impact learners' performance and attitude toward mathematics including linear equations word problems. In their study to investigate. It is clear that attitude towards mathematics plays a crucial role in the teaching and learning processes of mathematics. It also affects learners' achievement in mathematics. Again, teachers' attitude to mathematics and the amount of confidence and support they give to learners' influence their attitude towards problem-solving and mathematics in general (Marchis, 2011) and this leads to their success in solving mathematical problem as well as developing interest in it.

2.6 Concept of Problem-Based Learning (PBL)

Problem-Based Learning is a learner-centered approach in which learners work collaboratively in groups to develop conceptual knowledge and procedural skills needed to find solutions to mathematical problems (Savery, 2015; Zumbach & Prescher, 2022). The learners' groups are guided by teachers who play the role of facilitators. In addition, the teachers encourage group members to explain their thinking and guides them to discuss ideas (Hofmann & Mercer, 2016; Webb, 2009). Teachers provide less support as learners assume more responsibility for their collaborative learning (Erdogan & Senemoglu, 2017). Moreover, if view in terms of the learners' role, the main focus is the involvement of learners in the learning process which shift them from being passive to actively involved in solving a given problem.

Learning in Problem-Based Learning begins with a problem posed in such a way that learners need to connect their prior knowledge to new strategies before they can solve the problem and thereby learning both thinking strategies and domain knowledge (Hmelo-Silver, 2004). Problems here are used as stimulus for learners to start the learning process. The learners' reason through the problem and find out what they already knew and what they should know in order to solve the problem. It is through this active and reflective thinking process that they become responsible for their own learning. Through the application of their knowledge to the problem, the learners test and integrate what they are learning. Problem-Based Learning was pioneered in the medical school of the McMaster University in Canada in the 1960s (Schmidt, 2012; Sherbino, Norman, Whyte, & Servant-Miklos, 2022). Since then, Problem-Based Learning has spread worldwide to other disciplines in higher education such as engineering, economics, architecture, mathematics and law (Boud & Feletti, 2013). PBL stems on constructivist principles (Kemp, 2011; Srikan, Pimdee, Leekitchwatana, & Narabin, 2021). The constructivist principles suggest that learning is achieved by the active construction of knowledge supported by various perspectives within meaningful contexts. Knowledge and skills are not automatically given by the teacher but it is necessary for learners actively construct learning (Du Plessis, 2020). It also serves as a means of "providing space for cognitive diversity and allow the possibility of solving problems in different ways" (Nabie, Raheem, Agbemaka, & Sabtiwu, 2016).

Putri, Artini, and Nitiasih (2017) argue that PBL is consistent with the constructivist theory where learners take the responsibility of their own learning. The strength of constructivism lies in its emphasis on learning as a process of personal understanding and the development of meaning in ways which are active and interpretative (Kiger & Varpio, 2020). Constructive learning is theoretically supported by cognitive psychology. In cognitive psychology each individual person's thinking, memory and other inner processes are highlighted. An individual is not an empty box. Each learner has his or her background in which he or she mirrors new things. This is one important fact that is also utilized in problem-based learning.

The goals of problem-based learning are to develop flexible, effective problem-solving skills, self-directed learning, fostering active learning, critical thinking, effective collaborative skills, intrinsic motivation and desire to learn for a lifetime as well as permanent storage of knowledge (Alrahlah, 2016; Fukuzawa, Boyd, & Cahn, 2017; Hung & Amida, 2020). Problem-Based Learning allows learners to construct an extensive and flexible knowledge base, which goes beyond factual knowledge, allowing them to fluently retrieve and apply their knowledge in varied situations (Yadav, Subedi, Lundeberg, & Bunting, 2011). Hence Problem-Based Learning allows learners to move beyond the mental understanding of information and learn to apply concepts to real-life format. Learners also learn to work both independently and collaboratively. According to Simons, Klein, and Brush (2004), PBL is attached by a complex, ill-structured problem (i.e., one for which there are many different paths to solutions), learners go through a variety of activities to frame their understanding of the problem, access resources, increase understanding, and recommend solutions.

Problem-based learning (PBL) is considered to be one of the most appropriate solutions to increase learners' learning motivation (Mokhtar, Tarmizi, Ayub, & Nawawi, 2013) and to develop practical skills. It is a learner-centered instructional strategy (Azer, 2009) and learners can solve problems collaboratively and reflect on their experiences. Muñoz Campos (2017) defined PBL as an educational approach in which complex problems serve as the context and the stimulus for learning. Similarly, according to Laxman (2010), PBL is an instructional method which aims to help learners develop information-seeking and problem-solving skills. The common denominator to the varieties of PBL definitions is that learners actively construct their own knowledge of mathematics. Hence, PBL typically involves significant amount of self-directed learning on the part of learners. Problem-based learning, considered part of the tradition of experiential learning, makes use of an authentic problem as a meaningful task to situate learning. The problem-based learning is process organized around the investigation, explanation and resolution, is shaped and directed by learners as they work collaboratively in small groups to solve the problem (Veneranda, 2014). In problem-based learning the teacher acts as a metacognitive coach and his goal is to foster outcomes, conceptual knowledge and problem-solving, collaboration, self-directed and lifelong learning as well as intrinsic motivation in learners (Muniz, 2020).

PBL stresses on learner-centered approach in the process of learning (Chimbi & Jita, 2021; Karimi, 2011). Learners work in small groups (Davidson & Major, 2014; Takeda, Takahashi, Masukawa, & Shimamori, 2017) and they learn collaboratively, communicatively, and cooperatively. Problem-based learning as a learner-centered approach provides a high level of interaction among peers and facilitator and also teaches learners how to work as a team (Dmitrenko, 2016). This enhances content knowledge while at the same time fosters the development of communication, problem-solving, critical thinking, and self-directed learning skills. PBL also provides learners with opportunities to learn conceptual knowledge and develop the appropriate skills and attitudes relevant in their chosen careers as well as society at large without the need to extend or overburden the curricula (Servant-Miklos, Norman, & Schmidt, 2019). PBL focus on experiential learning organized around the investigation and resolution of messy, real-world problems. Learners are engaged as problem solvers seeking to identify the root problem and the conditions needed for a good solution and in the process becoming self-directed learners (Savery, 2015).

Furthermore, Alrahlah (2016) also view PBL as a learning technique which involves learner centered learning in small groups lead by a tutor or "expert", rather than teaching using traditional lecture teaching. The role of the tutor is to guide the learners toward discovering answers on their own rather than to simply provide the correct answer. Through the guiding process the tutor will stimulate the learners' cognitive learning process and problem-solving skills with self-directed learning, also known as auto didacticism. Auto didacticism, which is commonplace in higher learning, is the idea that the teacher does not need to schedule learners' private time, learners learn on their own and at their own pace in discovering knowledge which promote problem-solving and also aim at developing higher-order thinking skills (Kiwelu & Ogbonna, 2020).

Tan (2021) mentioned 10 key thoughts of problem-based learning (PBL) as follows:

1) problem is the start of learning process;
2) existing real-life problems are complicated and can be developed into the real problem;

3) there are various perspectives to view each problem, and we need to use various fields of knowledge to solve it;
4) challenging problem focuses on determining learning objectives;
5) learners' self-responsibility can be developed by leading themselves to learn by acquiring various kinds of information;
6) there are various forms and places of learning resources which are related to learning process;
7) PBL is collaborative learning which includes communication, cooperation, and work in a small group of learners. Learners' ability can be developed by having high interaction between friends and presenting their ideas to the group;
8) the development of problem examining and solving ability is the center of knowledge apart from knowing knowledge enough to solve problems. Therefore, instructors should solely play the role as a facilitator and advisor by raising questions to promote better understanding;
9) learning should be concluded by synthesizing knowledge based on problem, then thoroughly integrated that knowledge to reflect ideas and review it further; and
10) learning should be also concluded based on problem by conducting evaluation and reviewing learners' experiences and learning processes.

Regarding Tan (2021) thoughts on problem-based learning, it could be concluded that problem was the start of learning processes when it existed in the real-life and complicated in related fields of study. Similarly, Barrow, Lyte, and Butterworth (2002) also point out the following characteristics of PBL: (a) learning is learner-centered; (b) authentic problems form the organizing focus for learning; (c) new information is acquired through self-directed learning; (d) learning takes place in small learner groups; and (e) teachers are facilitators and guide.

In summary, Problem-Based Learning is a model which centered on learners, develops active and motivated learning, problem-solving skills and broad field knowledge. PBL as a philosophy aims to design and deliver a total learning environment that is holistic to learner-centered and learner empowerment. Generally, PBL aims to motivate learners to participate in the learning process and to help foster problem-solving skills.

2.6.1 Implementation of Problem-Based Learning in Mathematics Education

Research suggests that effective use of problem-based learning methods can prepare learners to be flexible thinkers who can work productively with others to solve problems (Mansor et al., 2015; Zabit, 2010). This means that learners can do well in mathematics if problem-based learning instruction is well implemented. Ali (2019) posits that a successfully implementing problem-based learning (learner-centered learning) requires skills and resources that are very different from those required by more traditional, teacher-centered classroom activities. Peterson (2004) identified three major factors for successfully implementation of Problem-Based Learning as; orienting the learners, picking the problem, and forming the team. Further, Bate, Hommes, Duvivier, and Taylor (2013) argue that in order to successfully implement problem-based learning, strong support from staff and faculty, and learners and teachers' readiness are very paramount.

Implementation of Problem-Based Learning successfully brings about high achievement of learners in mathematics and problem-solving abilities. Sagala and Simanjuntak (2017) found that learners' success and progress in problem-solving abilities increased through Problem-Based Learning than conventional learning. Hence there is the need for Ghanaian mathematics teachers or instructors to adopt and implement Problem-Based Learning in their mathematics classroom, since it helps fosters greater healthy rivalry of mathematics instructions, boost the performance of learners in skills acquisition, increase problem-solving abilities and develop the right attitude toward mathematics (Ajai & Imoko, 2015). In addition, Okolie et al. (2020) established that the implementation of Problem-Based Learning (PBL) helped to motivate learners to collaboratively work as a group and learn from their peers.

2.6.2 Benefits of PBL to the Learners

Problem-Based Learning enhances the problem-solving skills of learners as opposed to providing only theoretical knowledge. Learning, therefore, goes beyond bookish knowledge and helps learners to face and see-through practical problems. PBL allows learners to use prior knowledge to solve new problems and ensures deeper comprehension and make learners learning to be effective (Ahamad et al., 2017). PBL method also provides learners with thinking skills and lifelong learning (Hursen, 2021). PBL demands a collaborative approach to solve one problem through group interactions. This makes the group members' responsible for each other and not just for one's own self. Also, through the use of problems in problem-based learning, learners are motivated to learn new concepts and idea (Moust, Bouhuijs, & Schmidt, 2021).

According to Hmelo-Silver (2004), problem-based learning approach help learners: (i) to make sense of information, (ii) to improve effective problem-solving skill, (iii) to acquire lifelong learning and individual learning skills (iv) to improve fruitful collaboration, (v) to improve intrinsic motivation in learning and to be productive individuals. Similarly, Yulia, Farida, and Yuni (2018) also pointed out that Problem-based Learning provides channels for learners to experience authentic problems. By having authentic problems to be solved learners are more involved in the learning process.

2.6.3 Challenges in Problem-Based Learning

According to Lee and Ward (2002), to effectively implement PBL, teachers must adopt new roles that are frequently very different from those of their past. In lecture-based instruction, the teacher is in control and is the "expert" dispensing knowledge. In PBL, the teacher selects the problem, presents it to the learners, and then provides direction for learner research and inquiry. The teacher functions as a facilitator, and the learner controls the problem-solving process. For many teachers such a change is untenable. Challenges in implementing problem-based learning in the classroom is centered at three levels: (1) teacher (beliefs, previous experiences, pedagogical and content knowledge, and commitment to the innovation), (2) classroom (resources, support, class size, and class schedule) (3) school/community (curricular and testing policies, community support and involvement) (Liu, Wivagg, Geurtz, Lee, & Chang, 2012; Romanowski & Karkouti, 2021).

Another factor inhibiting implementation of PBL was noted by Albion and Gibson (2000) in teacher education programs. Most of these teacher education programs still rely heavily on rote learning and traditional lecture formats. It is difficult to expect teachers to adopt learning methodologies that they have not experienced personally or through their teacher education programs. With many administrators, curriculum developers, and teachers lacking experience in interdisciplinary education, barriers to broad scale change can become insurmountable. Problem-based learning implementation could also be affected by the lack of prepared materials for classroom instruction. Few training materials are available. Present curriculum guides and textbooks do not contain the variety of sample problems or assessment tools needed to support this methodology on a broad scale. The philosophies supporting PBL are well established, but ready materials are in limited supply (Lim, 2012). Few teachers have the time or the motivation to prepare all new materials for classes. Likewise, not only are ill-structured problems unavailable for much of the public-school curricula, but most accountability assessment that is presently in use is product driven and knowledge based. Teachers' and learners' performances are examined in the light of standardized testing that does not address critical thinking process skills. Lee and Ward (2002) report that with many time constraints and administrative pressures to improve test scores, many teachers will not believe they can justify the time necessary for PBL. Hence, the preparations and practice of PBL may seem to be time consuming (Kavlu, 2017; Miles, Kellett, & Leinster, 2017).

2.6.4 Effectiveness of PBL and learners' achievement in mathematics

Many studies that employed Problem-based Learning (PBL) in their studies reported its effectiveness on learners' achievements in mathematics (Firmansyah, Tandililing, & Mursyid, 2022; Kazemi & Ghoraishi, 2012) carried out a study on comparison of the Learning Effectiveness of Problem Based Learning and Conventional Method of Teaching algebra. The study was undertaken to find out the effect of PBL approach on Senior Secondary School Learners' achievement in algebra. Firmansyah et al. (2022) and Kazemi and Ghoraishi (2012) employed quasi-experimental pre-test post-test control group as their design. Intact classes from three schools were randomly assigned to experimental and control groups. The study found that learners taught algebra using PBL outperformed their counterparts taught using conventional methods. Also, the post-test mean scores of the PBL learners were found to be significantly different from those of their colleagues in the conventional group. The findings revealed the efficacy of Problem Based Learning in enhancing learners' achievement in algebra. This finding corroborates Perveen (2010) who also confirmed that a group of learners who experience Problem-Based Learning performed better than conventional group learners. (Iji, Emiakwu, and Utubaku (2015)) carried out a study to explore the effect of Problem-Based Learning on Senior Secondary School Learners' achievement in trigonometry. The study employs a quasi-experimental design of non-equivalent group. Specifically, the study used a non-randomized pre-test post-test control group design. Intact four schools were randomly assigned to experimental and control group. The experimental group was taught using the Problem-Based Learning approach whiles the control group was taught using the Traditional Method. The study revealed that there existed a significant difference between the experimental and control groups in favor of the experiment.

Isik and Kar (2012) also carried out a study to investigate whether there is a different between the achievement levels of learners who received Problem-Based Learning and Traditional Instruction methods in learning linear combination, sub-vector spaces, linear dependence-independence, and the spaced spanned by a set and basis dimension concepts in linear algebra course. The sample of the study was composed of 34 learners in experimental group and 38 learners in control group. Linear Achievement Test was used. The results of the study revealed the instruction of related concepts with Problem-Based Learning method was more effective in increasing learner achievement compared to that with Traditional Instruction. The findings also revealed that learners had positive opinions towards the Problem-Based Learning method.

Perveen (2010) carried a study to determine the effect of a problem-solving approach on academic achievement of mathematics learners at the secondary level. Secondary school learners studying mathematics were used as the population of the study. The learners of a grade 10 class of the Government Pakistan Girls High School Rawalpindi were selected as a sample for the study. Using a sample size of 48 learners, Perveen (2010) equally divided them into an experimental group and a control group on the bases of an assessment conducted. The experimental group then received a treatment over a period of six weeks based on a planned problem-solving approach using Habet and Terrioux (2021) and G. Polya (1945) heuristic steps of problem-solving. The control group continued with the instructional approach that they had prior to being identified as the control group. After the treatment or intervention, an assessment was used to see the effect of the intervention. A two-tailed t-Test was used to analyze the data, which revealed that both the experimental and control groups were equal in mathematics knowledge at the beginning of the experiment. However, the experimental group outscored the control group significantly on the assessment following the intervention.

Another study by Kadir, Abdullah, Anthony, Salleh, and Kamarulzaman (2016) to determine the effect of problem-based learning approach on learners' problem-solving skills using a quasi-experimental non-equivalent group pretest-posttest design, found that learners who were exposed to the PBL approach have better problem-solving skills compared to those who were not.

It is therefore evident that Problem-Based Learning approach of teaching have great impact on learner's achievement in mathematics. However, the review did not identify any study in Ghanaian context on the effects of Problem-Based Learning on Junior High School learners' achievements in mathematics especially on linear equations word problem-solving. It is in quest to fill this gap that the current study was designed to establish the effects of Problem-Based Learning (PBL) on Junior High School learners' achievements in solving linear equation word problems.

2.7 Summary

Admittedly studies have shown that problem-based learning technique is an effective teaching and learning technique that significantly impact on learners' mathematical achievement. After reviewing articles and documents related to problem-based learning in children classroom learning situations and the benefits of problem based-learning in terms of its contribution to the field of academic and child development, it is clearly shown that there is strong potential in curriculum based on problem based-learning. With proper support for teachers and students in the Junior High School the outcome of the use of PBL would enormous. However, many studies failed to point out the effects of problem-based learning on Junior High School learners' particularly on word problems involving linear equations in one variable, in the Ghanaian context. The current study was designed to determine the benefits of Problem-Based Learning (PBL) on Junior High School learners' achievement in solving linear equation word problems in one variable in an effort to close this knowledge gap.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter discusses the research paradigm, research design, population, sample and sampling procedures, research instruments, design of intervention, piloting, data collection procedure and data analysis procedure.

3.1 Research Paradigm

The word "Paradigm" was first used by Thomas Kuhn in 1962 to mean a philosophical way of thinking. The word has its aetiology in Greek where it means pattern. According to Mackenzie & Knipe (2006) the term paradigm in educational research is used to describe a researcher's 'worldview'. This worldview is the perspective way of thinking, school of thought, or collection of beliefs guiding how research data is understood or interpreted. Research paradigm naturally reflects the researcher's worldview and how they desire to live in it. It consists of the underlying ideas and principles that guide a researcher's worldview, as well as how they understand it and act in it.

The study employed post-positivist paradigm to guide the research. This Paradigm arose among philosophers who argued that it was not possible to access the 'truth' about the real world solely by virtue of a single scientific method as advocated by the Positivist paradigm, nor was it possible to determine social reality as constructed under the Interpretivist paradigm. The reason behind the adoption of post-positivist paradigm is that post-positivist opens the door to multiple methods, different worldviews, and different assumptions, as well as different forms of data collection and analysis. Also, individual researchers have a freedom of choice. In this way, researchers are free to choose the methods, techniques, and procedures of research that best meet their needs and purposes.

3.2 Research Design

A research design is described as detailed structure of how a study would be conducted. It takes the form of, data collection procedure, instruments for data collection and how data would be collected and analysed. It provides a clear direction of how to conduct a research study using a particular research methodology. Abutabenjeh and Jaradat (2018) defined a research design as the path that a researcher will follow in order to find answers to the research question or to test the research hypothesis. Creswell (2009) describes research design as plans, strategies and procedures for research involving consensus from the underlying worldviews of how data is collected and analysed. A researcher's decision to use a specific research design is greatly influenced by the worldview assumptions of the researcher, experiences encounter by the researcher, audiences of the study, nature of the research problem, strategy of the research, and the intended methods of data collection, analysis and interpretation (Creswell, 2009).

This study used a Quasi-experimental research design of non-equivalent pre-test and post-test control group with the support of a Design-Based research. Hoadley and Campos (2022), posits that, Design-Based Research (DBR) has to do with designing a research instrument or an intervention that will bring about an in-depth understanding of learning. Intervention as used in Design-Based Research studies represent the object, an activity, or the designed process which serves as a possible solution to address the problem at hand. The basic design for this study is a Problem-Based Learning lesson plan. Davies and McKerrow (2022) described a Quasi-experiment as an empirical study employed to measure the causal impact of an intervention on a target population of a study. Most researchers (Carrieri, D'Amato, & Zotti, 2015; Hmelo-Silver, Jordan, Eberbach, & Sinha, 2017; Manshur & Husni, 2020) use the quasi-experimental study to evaluate teaching interventions. The reason is that, it is very difficult to justify how to practically assign learners to experimental and control groups by random (Creswell, 2009). In quasi-experimental research, the researcher has the opportunity to compare among groups because the groups possess the similar characteristics (Krishnan, 2022).

The quasi-experimental non-equivalent pre-test and post-test control group research design was employed for this study. In this design, the researcher has two groups between which to make comparison, the control group to be compare with an experimental group. Singh (2021) described a non-equivalent control group design as that part of a quasi-experimental research design that do not permit the random assignment of subjects to the control and experimental groups. Namaziandost and Çakmak (2020) also hold the view that, in research on the effectiveness of teaching approaches to improve learners' performances, random assignment of subjects to groups is not common. The quasi-experimental non-equivalent pre-test and post-test control group research design is suitable when the researcher wants to compare scores obtained from a group before treatment and after treatment and same set of scores recorded from a group that does not receive the treatment (Pamungkas & Chamroonsawasdi, 2020). The quasi-experimental research method is chosen by the researcher because "it provides the best approach to investigating cause-and-effect relationships" (Rahman & Islam, 2022).

This study sought to compare learners' scores in Linear Equation Word Problems' (LEWPs) achievement tests before treatment and after treatment in the experimental group and the control group. The researcher is motivated to carry out this study because there is paucity of study conducted in this study area on Junior High School learners.

The variables of this study were classified into independent and dependent variables. The independent variable was the treatment in the experimental group and the control group, whereas the dependent variable was the post-test scores of learners. The researcher taught the experimental group using problem-based learning approach whilst the control group was taught by regular mathematics teacher of the learners using the traditional teaching method. The post-test scores obtained from the performance of learners of both groups was used to ascertain the effect of each of the teaching strategies on learners' academic achievement.

Because using both quantitative and qualitative research methods yields greater information than using just one of them, the researcher chose to employ a mixed methodology. According to Polit and Beck (2010) researchers can simultaneously draw generalizations about a population from the findings of a sample and develop a deeper grasp of the issue under investigation when they use both qualitative and quantitative data and data analysis.

3.3 Population

Population is described as the total number of subjects of a research study that have a common clearly defined set of characteristics (Awanta & Asiedu-Addo, 2008). The total population of learners in the two schools were three hundred and thirty-four (334), comprising of one hundred and fifty-six (156) for School A (ninety-four (94) females and sixty-two (62) males) and one hundred and seventy-eight (178) for School B (one hundred and two (102) females and seventy-six (76) males).

3.4 Sample and Sampling Procedure

Hill and Williams (2012) described a sample as a subset of a population selected by a researcher from whom data is gathered for a study. A sample can be seen, as a part of a population carefully considered to participate in a study. Alreck and Settle, (2004) pointed out that a sampling ratio of 30% is adequate for a population of less than 1000, a sampling ratio of 20% is adequate for a population between 1000 and 10000 and a sampling ratio of 10% is adequate for a population which is above 10000. For this study, the researcher used 30% of the population of the JHS learners as the sample since they are less than 1000 learners. Therefore, the sample size was one-hundred (100) learners of School A and School B, which comprised forty-six (46) males and fifty-four (54) females for the study. The number of female sample in the study is more than the number of males because of the high number of female enrolment than male enrolment in the two schools. School A and School B were selected as sample for the study where School A was considered as the experimental group and School B the control group. These schools were selected because they the recorded the lowest performance in mathematics for several years in the municipality.

For the purpose of this study, the sampling procedures employed were purposive sampling and simple random sampling. Ghayab, Li, Abdulla, Diykh, and Wan (2016) described simple random sampling as a sampling technique that provides equal opportunity for all participants in a population for selection to take part in a study. It is also known as probability sampling or chance sampling. It describes the procedure of selection of random samples of human population by drawing lot numbered slips of paper from a container without looking inside and also tables of random numbers. Purposive sampling is a non-probability sampling technique in which a researcher relies on his or her own judgment when choosing members of population to participate in the study (Mishra & Alok, 2022). The study employed both purposive and simple random sampling techniques at various levels base on their suitability. The purposive sampling technique was used to select the region and the schools as well as the class due to the persistence poor performance of learners in solving questions involving word problems over the years. The simple random sampling technique was employed to select the subjects to provide them with equal opportunity to participate in the study because they have the same characteristics. Also, the simple random sampling technique was used to assign the schools as control and experimental groups.

3.5 Research Instruments

Research Instruments are tools design by researchers to collect data for their studies. Oben (2021) described research instruments as data collection tools such as a questionnaire, test, or interview guide used to gather data on a topic of interest from research subjects. The instruments that were used for data collection in this study were tests, questionnaire and interview guide.

3.5.1 Pre-test

A pre-test was administered to all the participating learners before carrying out the experiment. The pre-test was used to measure and compare the performance levels of learners in both the control and experimental groups prior to the start of the treatment. The pre-test questions consisted of seven (7) items involving algebraic linear equation word problems in one variable (see Appendix A). The test was conducted for learners during the normal teaching period using mathematics lesson. The learners were required to solve all the questions within one hour. In administering the pre-test, each learner in the classroom was given a printed question paper with space provided under each question for them to provide their answers. The scripts were collected after the one-hour duration and marked by the researcher with the guide of a prepared marking scheme (see Appendix B). Each question correctly answered was scored a maximum of 4 marks, given a total of twenty-eight (28) marks on the whole test. The results of the pre-test provided the researcher with the opportunity to identify the challenges learners faced in the process of solving linear equation word problems in one variable and also establish the level of similarity before the commencement of the treatment between the control and the experimental groups. The results of pre-test were used as a measure to answer both Research Question One and Question Two.

3.5.2 Post-test

After the treatment learners in both control and experimental groups were post-tested. The post-test was designed to measure the effect of each teaching method (Traditional and Problem Based Learning approaches) on the performance of learners. The post-test also comprised of seven (7) test items which were similar to the pre-test questions with the level of difficulty. With the exception of the test items, every condition during the post-testing was the same as it was during the pre-testing (see Appendix C). In order to ensure accurate measure and fairness in scoring the post-test items, the scripts of both control and experimental groups were marked by the researcher using an already prepared marking scheme (see Appendix D). The post-test was also marked out of twenty-eight (28). The post-test was used to answer Research Question Three.

Both tests challenge learners' content knowledge and understanding of Linear Equations Word Problems in One Variable (LEWPs). The tests required pen and paper writing where learners were expected to work and produce their own solutions to all the test items.

3.5.3 Questionnaire

Closed ended questionnaires was used to answer Research Question Two and Research Question Four. The questionnaire for research question two consisted of two parts. The first part of the questionnaire investigated JHS leaner's background information. The second part of the questionnaire assessed JHS learner's challenges that influenced their achievements in linear equations word Problems in one variable. The learners were requested to show their response on a five-point Likert-scale which were scored from: 1 Strongly Disagree, 2 Disagree, 3 Undecided, 4 Agree and 5 Strongly Agree. The questionnaire for Research Question Four required learners to show their response on a three-point Likert-scale which were scored from: Agree, Undecided and Disagree.

3.5.4 Interview Guide

According to Qu and Dumay (2011), an interview is a conversation between the interviewer and the interviewee to learn specific information from the interviewee's responses. There are three types of interviews: structured, semi-structured and unstructured interviews (Stuckey, 2013). A structured interview is one in which the interviewer has questions prepared in advance to enable him ask the same questions of the respondents in the same way. These questions are intended to elicit a certain reaction from the respondent. An unstructured interview is that kind of interview in which there is no already specific set of questions prepared in advanced before the interview, however, the interviewer usually has some topics in mind to guide him conduct the interview when engaging the interviewee. Semi-structured interviews are similar to structured interviews in that the questions to be asked are planned in advance, but semi-structured interviews use open-ended questions as opposed to closed questions (Stuckey, 2013).

The researcher carried out an unstructured interview with ten (10) learners in the experimental group to find out their views on how the problem-based learning approach of teaching influenced their attitudes towards linear equation word problems as an intervention. The researcher considered the performance of learners in the post-test in his selection of participants for the interview. The interviewees consisted of four (4) learners who performed above average in the post-test, three (3) learners who performed averagely in the post-test, and three (3) learners who performed below average in the post-test. All the ten learners were asked the same interview question and their responses were written down verbatim in the form of short notes for analysis.

3.6 Piloting of Instruments

Piloting, is to determine whether respondents'/subjects' understanding of the requirements and the clarity of the questions and instructions. Piloting is carried out to see if a specific research tool can be used in a significant study. It offers a chance to test out the instrument's completion instructions, particularly if it is being used for the first time. Piloting comprises a trial administration of a recently created instrument to find any flaws and gauge the amount of time needed. Creswell (2012) described piloting as a procedure in which a researcher makes relevant changes in an instrument base on the feedback obtained from individuals on whom the instrument is administered. To make sure the data were reliable and valid, the instruments used for data collection underwent piloting. Piloting is done so that the researcher can correct potential mistakes that might have occurred during administration and analysis. Validity and reliability have distinct meanings in research though they are commonly used interchangeably.

To ensure the appropriateness of the data collection instruments, a piloting was administered to a sample of basic 8 learners at Awalia E/A JHS in Gambaga of the same municipality. Mugenda and Mugenda (2003) specify that the permissible sample size for the piloting of a research instrument falls between 1 and 10 percent. Nine (9) learners representing 9 percent of the sample size were employed for the piloting.

3.7 Validity and Reliability of Instruments

The validity of a research instrument in a study best described how well it measures the concept(s) it is intended to measure (Heale & Twycross, 2015). To validate the research instrument, the curriculum for the Common Core Programme for the JHS was consulted and some prescribed mathematics text books for JHS learners. The reason was to gain insight into what learners are expected to learn under linear equations word problems in one variable. Reliability on the other hand measures the degree to which an experiment, test, or any measuring procedure produce the same results on repeated trials (Cypress, 2017). This means that if the results of a study can be reproduced under a similar or same methodology, the research instrument is therefore reliable. The split- half was used to divide the items into two parallel halves (odd and even) and Spearman-Brown's formula was used to correlate the items to check the reliability of both the pre-test and post-test of the scores of the learners. After piloting the research instruments, the reliability of the questionnaire was calculated by the researcher using a Cronbach's Alpha coefficient. This was determined with the aid of SPSS software (version 26). The reliability coefficient of the questionnaire used was found to be 0.80. Mugenda and Mugenda (2003) emphasised that any alpha coefficient value of 0.70 or higher is considered acceptable, especially in research related to social sciences. In view of this, the researcher can conclude that the questionnaire demonstrated reliability, given the procedures employed. The research instruments were also given to the supervisor for further scrutiny and correction.

3.8 Threats to Validity

Threats to validity refer to factors in a research study that may undermine the accuracy, reliability, and generalizability of the findings. These threats can impact either the internal or external validity of the research.

3.8.1 Testing

Testing invalidity occurs when the process of taking a pre-test influences the results of a post-test. Many studies use pre-tests to establish participants' baseline status regarding the variables being studied. However, taking a pre-test can increase the likelihood of improved performance on a post-test, particularly if the tests are similar. This can lead to an inaccurate measure of the treatment effect, potentially exaggerating or minimizing its impact. To reduce the risk of testing threats, the researcher used different but equivalent versions of the test for pre-testing and post-testing. Additionally, the researcher recognized that differences observed between pre-test and post-test results could stem from changes in testing procedures, such as content variations, administration methods, and data collection (Harris & Newton, 2019). Therefore, efforts were made to maintain consistency in the pre-test and post-test, as well as in the personnel and procedures used during administration.

3.8.2 History

In the context of research, "history" refers to external events that occur concurrently with the study's experimental manipulation. A common example of history bias, known as the "teacher effect," occurs when results from Teacher A using Method A are compared to results from Teacher B using Method B. In such cases, it can be difficult to separate the effects of the teacher from those of the instructional method (Kim & Ross, 2020). To avoid compromising internal validity due to historical factors, the researcher compared the experimental group's results with those of a control group that experienced the same external events during the study. Furthermore, it was ensured that both the experimental and control groups shared similar histories in all respects, except for the experiences directly related to the independent variable being tested. The researcher made sure that materials, conditions, and procedures were identical for both groups, except for the specific instructional method.

3.8.3 Selection

When studies compare the effects of different treatments on different groups, bias can occur if the groups are not equivalent at the outset. For instance, if one group consists of individuals who are inherently more capable, older, or more receptive than another group, any observed differences might be due to these initial disparities rather than the treatment itself. To minimize selection bias, the researcher carefully matched the groups based on characteristics such as age, grade level, and exposure to the same curriculum, ensuring that any observed effects could be more confidently attributed to the treatment (Davies & Weller, 2021).

3.8.4 Statistical Regression

Statistical regression issues arise when participants are selected based on extreme scores on a particular variable. Extreme scores are often influenced by chance factors, which are unlikely to persist in subsequent tests or with different measurements. To avoid the tendency for extreme pre-test scores to regress toward the population mean, participants were not selected solely based on their extreme scores. Instead, the study included participants with average scores to manage this issue effectively (Garcia & Lee, 2018).

3.8.5 Experimental Mortality (Attrition)

In research, it's crucial to collect post-test data from all participants initially enrolled in the study. Failure to do so can introduce bias if the characteristics of those who drop out differ from those who remain, potentially leading to differences in the dependent variable and introducing post-test bias. This type of bias arises when a study involves multiple conditions and participants drop out disproportionately from different groups. To address this issue, the researcher used sufficiently large groups and took measures to ensure that the remaining participants were representative of the original sample (Taylor & Green, 2020).

3.8.6 Maturation

Maturation refers to natural changes within participants that occur over time during an experiment. In long-term studies, these changes can confound the results, making it difficult to determine whether observed effects are due to the experimental treatment or natural development. To minimize the impact of maturation, the researcher included a control group that was similar in terms of age and developmental stage. Additionally, the time between the pre-test and post-test was kept short to reduce the likelihood that maturation would influence the results (Roberts & Anderson, 2019).

3.8.7 Instrumentation Bias

Instrumentation refers to the methods and tools used for measurement or observation in a study, including testing devices, mechanical instruments, and scorer judgment. While mechanical instruments usually remain consistent, human scorers may change their data collection approach over time. A threat to validity arises if scorers become aware of the study's purpose and unintentionally bias the results. To address this issue, the researcher ensured consistency by maintaining the same measurement tools and data collectors throughout the study. Additionally, participants were given equal time for both the pre-test and post-test to ensure fairness and consistency (Evans & Cole, 2018).

3.9 Design of the Intervention

The researcher designed two types of teaching plans to be used for lesson delivery, one for the Control group and the other for the Experimental group. The control group were taught using traditional method or the teacher-centered approach whiles the experimental group were taught using the Problem-Based Learning approach.

3.9.1 Treatment Procedure

The researcher planned the treatment and spread it over three weeks with each week comprising six periods (35 minutes per period). The design of the treatment was in the form of lesson delivery in the classroom by the researcher. The researcher planned the lessons for the treatment using the Polya's (1945) heuristic steps of problem-solving and complement it with Problem Based Learning Approach. According to Polya (1945), good problem solvers usually go through four stages of problem-solving. They are:

- Understand the problem

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

Understand the problem, at this stage, learners are expected to read the problem statement out to themselves to ensure that they comprehend it, they next utilize reading comprehension techniques to convert the language and numerical data in the problem into mathematical notations. *Devise a plan*, at this stage, learners are encouraged to generate an appropriate solution plan for solving the problem by breaking it down into a series of steps and also creating mathematical notations/formula from the text. *Carry out the plan*, mathematical computations are performed at this stage. This involves solving the problem step-by-step to obtain the answer, if the solution is not found, the strategy is revised. *Look back*, at the final stage, the learner/problem solver checks to ensure that the answer arrived at from the mathematical computations is correct and make sense by substituting it into the original equation formed. Details of the treatment activities are shown in Appendix F.

3.10 Scoring the Test Items

In scoring the learners emphasis was on the logic of learners' working process to determine their ability of solving linear equation word problems in one variable. The processes and the answers were scored as correct if learners were able to apply right approach and wrong if learners were unable to apply the right approach of solutions. The test items required learners to think and make decisions using appropriate strategies. One (1) mark was awarded to each correct thinking/process and answers and zero (0) for each wrong approach and answer. The processes involved in a successful solution of the word problems were categorized into the four steps according Polya's model for word problem-solving namely: 1) defining the variable (understanding the problem); 2) writing the correct mathematical expressions or translation (devising a plan); 3) solving the equation (carrying out the plan); and 4) Verifying and writing the correct answer (Looking back).

3.11 Data Collection Procedure

The researcher officially wrote to the head teachers of the sampled Junior High Schools seeking for permission to conduct the research study. The researcher used seven pre-test questions on linear equation word problems in one variable to assess both groups (control and experimental groups). The researcher spends three weeks to plan and deliver lessons to the Experimental group using the problem-based learning approach whilst the control group was taught by the regular mathematics teacher who used the Traditional teaching approach. After successful delivery of lessons, a Post-test of seven questions involving linear equation word problems in one variable each of similar difficulty was given to both groups to solve to help the researcher to answer Research Question 3. All the scripts for both groups were marked by the researcher to ensure fairness and to have a clearer understanding of how the two groups presented their solutions. The researcher administered a questionnaire to learners to ascertain their attitude towards Linear Equations Word Problems.

3.12 Data Analysis Procedure

According to Wiech et al. (2022), a data analysis procedure is an organized series of steps that transform raw data into actionable insights. It consists of several steps: defining objectives and questions, collecting data, cleaning data, analyzing it, interpreting and visualizing the results, and ultimately, telling the data's story. The study employed the mixed data approach. The researcher employs descriptive data analysis to, interpret and describe the experiences of the participants. An inferential statistic with the Independent-samples t-test at 95% confidence level was used to compare learners' conceptual understanding in Linear Equations Word Problems in one variable. The Statistical Package for Social Sciences (SPSS, V 26) was used for the analysis of the data.

The primary method of analysis for the qualitative data in this study was thematic content analysis. Thematic content analysis is a method of identifying, analysing, and reporting themes or patterns within data set (Braun & Clarke, 2006). The interviews were transcribed qualitatively using the thematic content analysis based on the objectives of the study. Codes were assigned to respondents to conceal their identities. The selection of a letter code "Learner" was assigned to all the interviewees who were selected in the treatment group to keep their identities hidden in the study. Therefore Learner 1, Learner 2, and so forth were used to refer to the various participants that were interviewed.

3.13 Chapter Summary

This chapter focused on the approach employed in the study as well as the research method, and justification of why a quasi-experimental research design was chosen. The chapter also discussed the research instruments, piloting the instruments, validity and reliability of instruments, design of the intervention, data collection and analysis. Both quantitative and qualitative methods of analysis were used to collect and analyse data. Questionnaires and interview guide were used in gathering data for the study using the simple random sampling and purposive sampling approaches. Quantitative data were analysed using the SPSS software (version 26), and descriptive statistics such as mean, standard deviations, and percentages were used to summarize and describe data in the form of tables. Qualitative data were analysed using thematic themes.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

The main purpose of this study is to use the problem-based learning (PBL) to improve learners understanding and ability to solve linear equation word problems in one variable. This study used a Quasi-experimental research design of non-equivalent groups with the support of a Design-Based research. The quasi-experimental non-equivalent pre-test and post-test control group research design was employed for this study. This is because it offered practical options to work with intact classes in both control and experimental schools. Also, a quasi-experimental non-equivalent pre-test and post-test control group research design would ensure that participating learners continued learning other subjects according to their school's time-tables and also take part in any other school related activity in their schools. The dependent variable was the learners' scores in the post-test and the independent variables were the teaching approaches (Traditional Teaching and Problem Based Learning). Data for this study were gathered using both quantitative and qualitative methods. The quantitative data obtained from the pre-test and post-test scores were analyzed using descriptive and inferential statistics. The pre-test and post-test scores of learners were keyed into the Statistical Package for Social Sciences (SPSS) software for the analysis. The qualitative method of data analysis was used to analyse the data obtained from the questionnaire and the interview. The results of this study are presented, analysed and discussed based on the research questions and hypothesis. The present study was guided by the following questions:

1. What is the level of achievements of Junior High School learners in solving linear equation word problems in one variable in the East Mamprusi Municipality?
2. What challenges do Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality?
3. What is the effect of the Problem-Based Learning approach on Junior High School learners' attitude towards linear equation word problems in one variable in the East Mamprusi Municipality?
4. Is there a significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality?

Sex distribution of respondents

The sex distribution of learners who were involved in the study is shown in figure 4.1.

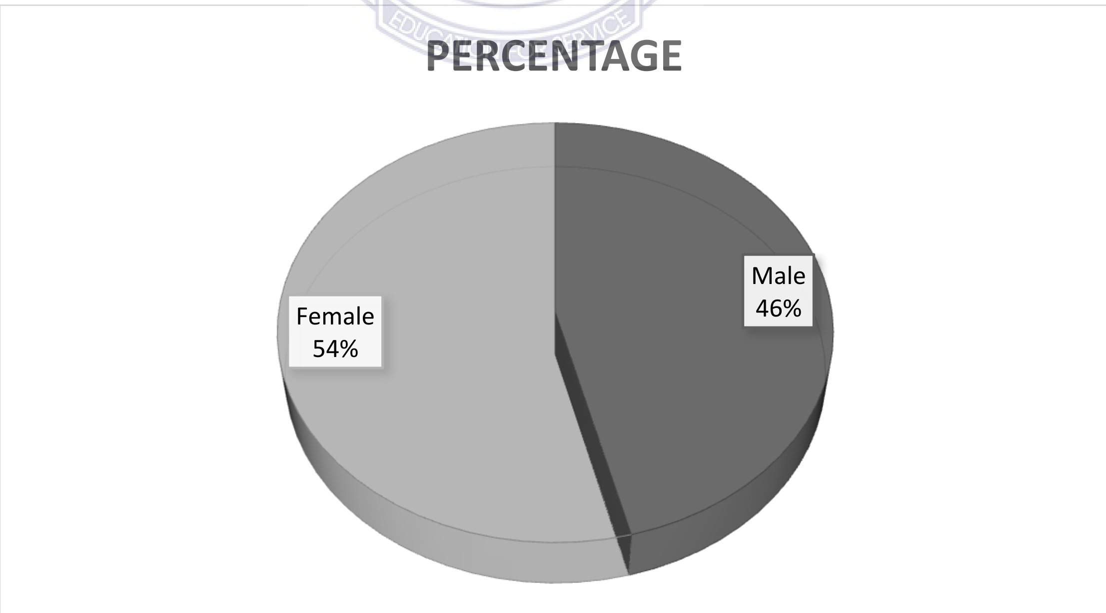

Figure 4.1: Pie chart showing the sex distribution of respondents.

Source: Field Survey, 2023

The sex distribution of the respondents in the Figure 4.1 shows that 54% of the learners in the Junior High School in East Mamprusi Municipality Ghana are females while the males make up the remaining 46%. Since females form the larger portion, the learning of mathematics and performance of learners on word problems involving linear equation in one variable is something that needs serious attention.

Age distribution of respondents

The age distribution of learners is shown in figure 4.2.

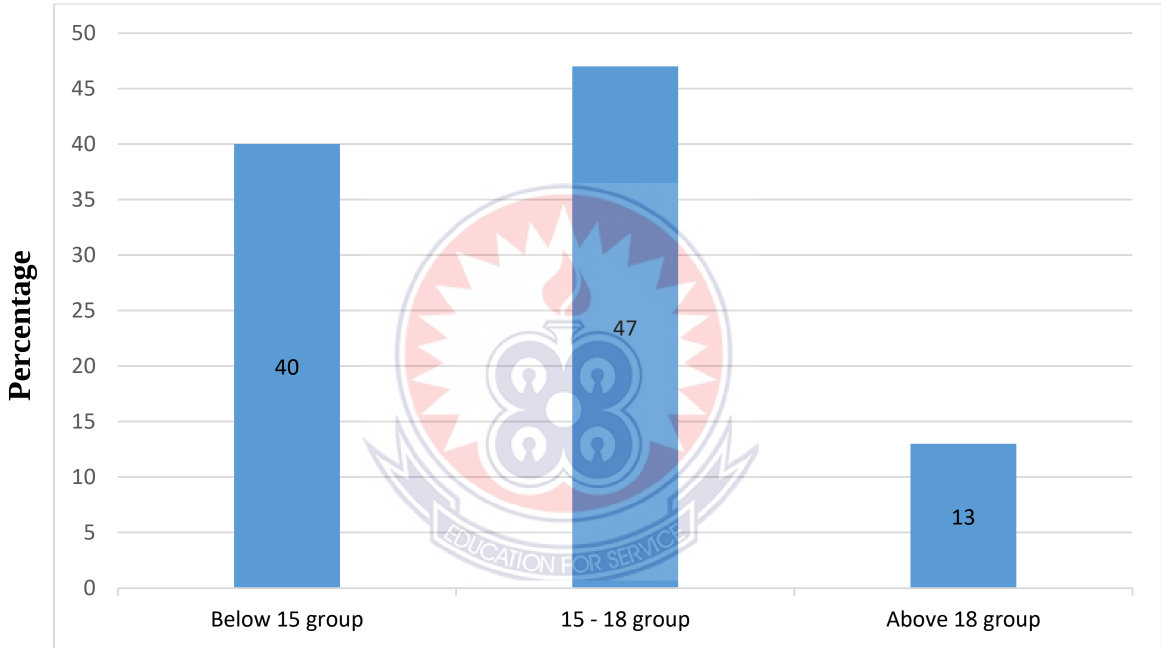

Figure 4.2: Bar graph showing age groups of learners.

Source: Field Survey, 2023

The figure indicates that 40% of the learners in JHS are below 15years of age while 47% of the learners are between the ages of 15 to 18 years. Also, only 13% of the respondents are adults. According to Thoren, Heinig, and Brunner (2016) and Yaaba (2020) age has an impact on the performance of learners in mathematics in the Junior High Schools. This means that, we are expected to see from the descriptive analysis that performance of the learners in word problems is low due to the fact that over 50% of the respondents are below 18 years.

4.1 Research Question 1: What is the level of achievements of Junior High School learners in solving linear equation word problems in one variable in the East Mamprusi Municipality?

A pre-test was given to learners in the control and experimental groups to help answer Research Question 1. There were seven (7) questions on the test that involved linear equation word problems in one variable. The maximum possible score for the entire test was 28 marks with pass mark of 13 marks. A maximum of 4 marks awarded for each successfully answered question. The researcher conducted the pre-test to find out the level of achievement in learners in solving linear equation word problems in one variable. Table 4.1 shows the distribution of scores in the pretest.

Table 4.1: Distribution of Pre-Test Scores

Score	**Frequency**		**Percentage**	
	Control	*Experiment*	*Control*	*Experiment*
0 – 4	19	26	38.00	52.00
5 – 8	11	15	22.00	30.00
9 – 12	7	5	14.00	10.00
13 – 16	9	2	18.00	4.00
17 – 20	4	2	8.00	4.00
21 – 24	0	0	0.00	0.00
25 – 28	0	0	0.00	0.00
Total	50	50	100.00	100.00

Source: Field Survey, 2023

The frequency distribution Table 4.1 shows the distribution of performance of Junior High School learners of the control and experimental groups in the pre-test scores. Majority of the learners a total of nineteen (19) representing 38% and twenty-six (26) representing 52% of the control and experimental groups respectively scored between 0 and 4, indicating a low level of achievement in solving linear equation word problems in one variable. In addition, a total of eleven (11) representing 22% and fifteen (15) representing 30% of the learners of the control and experimental groups respectively scored between 5 to 8. Seven (7) representing 14% and five (5) representing 10% of the learners of the control and experimental groups respectively scored between 9 to 12. Nine (9) representing 18% and two (2) representing 4% of the learners of the control and experimental groups respectively scored between 13 to 16 while four (4) representing 8% and two (2) representing 4% of the learners of the control and experimental groups respectively scored between 17 to 20. None of the learners scored a mark greater than or equal to 21 to 24 or 25 to 28 representing 0%.

Also, out of fifty (50) learners of the control group who were engaged in the pre-test, thirty-seven (37) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 74% and out of fifty (50) learners of the experimental group who were also engaged in the pre-test, forty-six (46) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 92%. The remaining thirteen (13) learners of the control group and four (4) learners of the experimental group scored the pass mark and more of the pre-test and this represents 26% and 8% respectively. This was an indication that majority of the learners exhibited poor performance in solving linear equation word problems in one variable. It is therefore concluded that there are low achievements of Junior High School learners in solving linear equation word problems in one variable in the East Mamprusi Municipal.

4.2 Research Question 2: What challenges do Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality?

The objective of Research Question 2 was to determine the challenges learners in junior high school encounter when solving word problems involving linear equations in one variable. In order to pass the pre-test, the learners had to solve word problems involving linear equations in one variable using the following four skills outlined.

i. Defining the variable (Understanding the problem).

ii. Writing the correct mathematical expression (Devising a plan).

iii. Solving the equation (Carrying out the plan).

iv. Verifying and writing the correct answer (Looking back).

Table 4.2 shows the overall distribution of learners' mean correct, and the mean incorrect of the pre-test under the four main categories of Polya's problems solving.

Table 4.2: Distribution of Learners Difficulties in Solving Linear Equation Word Problems

		Mean (Achieved)		**Mean (Failed)**	
Category	**No.**	**N**	**(%)**	**N**	**(%)**
Understanding the Problem	100	41	(41.00)	59	(59.00)
Devising a Plan	100	35	(35.00)	65	(65.00)
Carry out the Plan	100	6	(6.00)	94	(94.00)
Look back	100	0	(100.00)	100	(0.00)

Source: Field Survey, 2023

From Table 4.2, the number of learners who attempted to understand the problem is one hundred (100). Of these, 59% could not understand the problem, they find it extremely difficult to define the suitable variable for the word problem. Some of the learners skipped the first step for lack of understanding of the problem. Only 41% understood some of the word problems and were able to define the correct variables that suit the problems. Additionally, it was noted that not all the learners who made an effort to devise a plan (i.e., write the correct mathematical equation) to answer the problem were successful in doing so. Of the 100 learners who gave it a trial, 65% had difficulties in devising a suitable plan or writing the correct mathematical equation to satisfy the word problem. A small number of 35% were able to devise a correct plan for the word problems. Also, majority of the learners made an effort to carry out their plans to solve the problems for the right answer, but they encountered difficulties in solving the problems. 94% of the 100 learners who made the attempt to carry out their formulated plans to solve the problems could not be successful. Only 6% of the 100 learners were able to carry out their plans in solving the word problems. These learners were able to define the correct variables, devise a suitable plan by formulating the correct mathematical equation to the word problems and were able to solve the problems. The table again shows that all the learners had challenges checking their responses after executing their plans, even though few of them sought to do so. None of the 100 learners could check and write the right response (Looking back).

The conclusion drawn from the above results have it that, majority of the learners in this study had challenges in solving word problems that involved linear equations in one variable, despite their efforts to do so. These challenges include their failure to comprehend the problems, devise a correct plan (write the correct mathematical expression), carry out their plan (solve the formulated equations), and confirm and record the precise solution (look back). Find sampled of marked scripts of learners in Appendix H.

Factor Analysis

The KMO and Batlett's Test of Sphericity analysis is carried out and the results shown in Table 4.3 to determine the suitability of the data for factor analysis. Table 4.3 shows the suitability of the data for factor analysis on some of the challenges learners face when solving linear equation word problems in one variable.

Table 4.3: Kaiser-Meyer-Olkin and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.581
Bartlett's Test of Sphericity	Approx. Chi-Square	601.398
	Df	435
	Sig.	.000

From Table 4.3, the KMO value (0.581) describes the data as suitable for factor analysis. The Bartlett's Test of Sphericity has produced a small significance value (0.000) which indicates that, the 30 indicators in the analysis can be grouped into factors. The analysis therefore can be continued since these two statistics are appealing. Figure 4.3 shows the thirteen (13) factors extracted by the scree plot at the elbow level from the factor analysis.

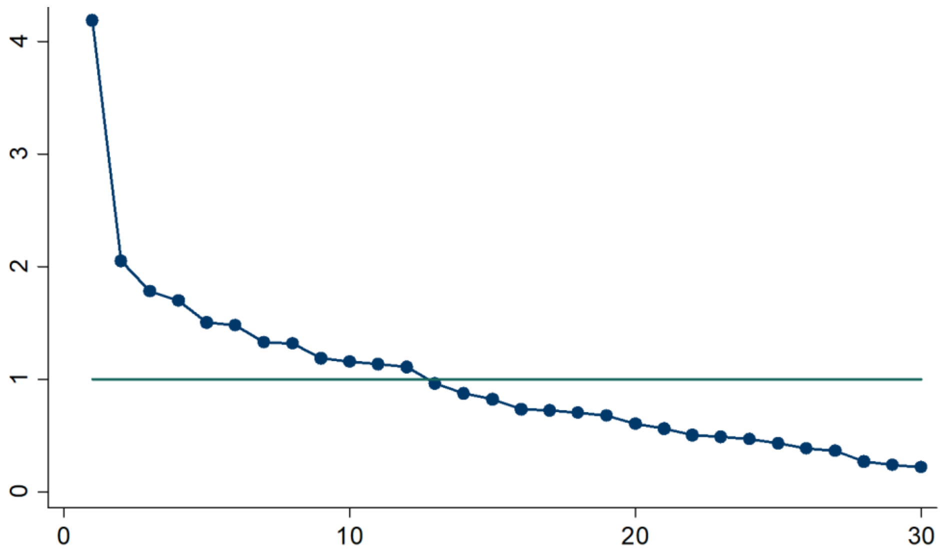

Figure 4.3 The Scree Plot.

The scree plot gives the number of factors that are explained. Figure 4.3 indicates that there are three (3) factors described by the plot. The elbow occurred at the 13th factor. This means that, thirteen factors can be extracted from the 30 indicators. From the Eigen values greater than 0.5 are selected. All components below 0.5 are not extracted.

Total Variance explained

Table 4.4 shows the number of factors that best explains the proportion of explained factors extracted from the data.

Table 4.4: Total Variance Explained

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.900	9.668	9.668	2.900	9.668	9.668	2.607	8.690	8.690
2	2.491	8.303	17.972	2.491	8.303	17.972	2.396	7.986	16.675
3	2.303	7.678	25.649	2.303	7.678	25.649	2.344	7.812	24.487
4	2.141	7.136	32.786	2.141	7.136	32.786	2.251	7.505	31.992
5	1.958	6.527	39.313	1.958	6.527	39.313	2.196	7.321	39.313
6	1.801	6.003	45.316						
7	1.686	5.618	50.934						
8	1.527	5.089	56.023						
9	1.429	4.762	60.786						
10	1.281	4.269	65.054						
11	1.196	3.988	69.042						
12	1.128	3.761	72.803						
13	1.056	3.520	76.323						
14	.933	3.109	79.432						
15	.857	2.858	82.290						
16	.749	2.497	84.787						
17	.663	2.210	86.997						
18	.576	1.919	88.916						
19	.533	1.777	90.694						
20	.462	1.538	92.232						
21	.398	1.328	93.560						
22	.370	1.234	94.794						
23	.324	1.080	95.874						
24	.270	.898	96.773						
25	.255	.852	97.624						
26	.189	.630	98.254						
27	.178	.593	98.847						
28	.138	.461	99.308						
29	.122	.408	99.716						
30	.085	.284	100.000						

Extraction Method: Principal Component Analysis.

Table 4.4 presents the Total Variance Explained. It is indicated that, thirteen components account for 76.323% of the total variation of the data.

Table 4.5 presents the Eigen Values Component Matrix of the extracted factors

Table 4.5: Component Matrix

Rotated Component Matrix	Component				
	1	**2**	**3**	**4**	**5**
I feel motivated when solving linear equation word problems because I get right answers.	.641			.227	
Because I practice mathematics at home I like linear equation word problems.	.569		.308	-.114	-.160
I like mathematics because of that I enjoy solving linear equation word problems.	.536	.307	.296		
I do not like linear equation word problems because I work a lot at home.	.534	.170	.292	.154	
I like solving linear equation word problems because I understand simple text.	.527	.158		.151	.148
The mathematics teacher does not use learning aids/resource and that makes me not understand his lessons.	.403				
I am very confident when solving mathematics problems because of that I like linear equations word problems.		.635			.203
No mathematics textbooks for us to learn.	.203	.572		.155	.161
Our mathematics teacher does not understand word problems and that makes it difficult for him to teach for me to understand.	-.104	.517		.196	
My parents are not educated so they are not able to help me learn mathematics.		.491		.326	-.412

Our mathematics teacher reads directly from textbook and that makes it difficult to understand.	.198	-.425	.186	.155	
I like solving linear equation word problems because I understand the terms used in the text.	-.390	.400	.107	.238	
Because I don't have mathematics text book, solving linear equation is difficult.	.194	.388	.250	.279	-.188
I like solving mathematics problems but not linear equation word problems.			.680	-.228	.311
I dislike linear equation word problems because I cannot read simple text.	.292		.663		
Our mathematics teacher handles other subjects so he does not teach it well.		-.203	.595	-.235	.102
I do not attend most mathematics lessons hence my inability to understand word problems.	.168	.193	.438	-.228	-.109
I have no one to guide me in the house to learn mathematics because of that I don't like linear equation word problems.	.138	.151	.410	.214	.182
I do not like linear equation word problems because when I read the statements I don't understand.	-.144	.144	-.258	-.125	-.121
I do not like linear equation word problems because solving them make me feel uncomfortable and restless.	.118			.760	
I would enjoy mathematics more if there were no linear equation word problems lessons.	.216			.672	
Reading linear equation word problems is confusing because of that I do not like it.	-.304	.199		.522	-.140
I dislike linear equation word problems lessons because it makes me feel bored.	.118			-.107	.687
I want to be a mathematics teacher because of that I like linear equation word problems.		-.109		.348	.502

I like linear equation word problems because I can solve equations.	-.114				-.486
I do not like mathematics because of that I dislike linear equation word problems.	.239	.208			.435
My Mathematics teacher does not involve us when teaching his lessons.	-.120	-.317		.281	.428
My teacher does not teach using practical approaches hence my difficulty to understand word problems.	-.264	-.325	.370	.107	.377
My mathematics teacher makes me hate linear equation word problems because he makes his lessons less interesting.	-.303		.285		.304
I really enjoy linear equation word problems lessons because my teacher makes them simple to understand.		.241	-.128	-.232	.298

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Factor Naming

From Table 4.5 it is explained that five factors are extracted from the data. This aspect names the factors extracted.

Factor 1 Self-Motivation

The following indicators loaded high on factor 1. The following table gives the indicators and factor loadings, which describes the factor accounting for the challenges faced by learners in the pre-test process.

I feel motivated when solving linear equation word problems because I get right answers.	.641
Because I practice mathematics at home, I like linear equation word problems	.569
I like mathematics because of that I enjoy solving linear equation word problems.	.536
I do not like linear equation word problems because I work a lot at home.	.534
I like solving linear equation word problems because I understand simple text.	.527

The first factor is named self-motivation. It is realized that most learners who do well in mathematics especially solving word problems in the Junior High School are mostly those that motivates themselves in different ways and this enables them to maintain that interest.

Factor 2 Teaching and Learning Resource

The second factor is named Teaching and Learning Resources. It can be realized that teachers and learners' ability to deploy resources facilitates their ability to learn.

I am very confident when solving mathematics problems because of that I like linear equations	.635
No mathematics textbooks for us to learn.	.572
Our mathematics teacher doesn't understand word problems and that makes it difficult for him to teach for me to understand.	.517

The second factor from the indicators shows teacher's inability to influence learners positively. Learners in Junior High School perform poorly in solving word problems involving equations in one variable because teachers fail to influence learning in the classroom environment using the appropriate teaching and learning aids. They lack the basic concepts that are required to influence the learners learning ability positively.

Inadequate Mathematics Learning Resources in the Junior High School is one factor accounting for the differences in performance of the two categories of learners from the factor 2 extracted above.

Factor 3 Comprehension of text

The third factor is named comprehension of text. Learner's inadequate literacy skills to be able to read and understand word problems involving linear equations in one variable pose a challenge.

I like solving mathematics problems but not linear equation word problems.	.680
I dislike linear equation word problems because I cannot read simple text.	.663
Our mathematics teacher handles other subjects so he does not teach it well.	.595

The third factor from the indicators is learners' inability to comprehend word problems accounting for the differences in performance of the two categories of learners. Thus, the learners lack basic literacy competency to be able to have understanding of word problems involving linear equations in one variable.

Factor 4 Mathematics Anxiety

The fourth factor is named mathematics anxiety. Learner's negative feeling for mathematics greatly affect their performance in word problems involving linear equation in one variable.

I do not like linear equation word problems because solving them make me feel uncomfortable and restless.	.760
I would enjoy mathematics more if there were no linear equation word problems lessons.	.672
Reading linear equation word problems is confusing because of that I do not like it.	.522

The fourth factor from the indicators is learners' fear for mathematics which influence their ability to solve word problems involving linear equation in one variable. This account for the differences in performance of the two categories of learners.

Factor 5: Perseverance/Persistence

The fifth factor is named perseverance/persistence. It can be realised that learners' dislike word problem involving linear equation.

I dislike linear equation word problems lessons because it makes me feel bored.	.687
I want to be a mathematics teacher because of that I like linear equation word problems.	.502

The fifth factor from the indicators is learners' dislike for word problem involving linear equation. Learner's difficulty in understanding word problem involving linear equation makes it boring to most learners.

In addition to the challenges identified above, the five factors also highlighted the challenges (such as lack of motivation, inadequate teaching learning resource, learner's inadequate literacy skills to be able to read and understand, learners' anxiety and lack of interest in Mathematics) Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality. This challenges agreed to the finding of Thoren et al. (2016) and Yaaba (2020).

4.3 Research Question 3: What is the effect of the Problem-Based Learning approach on Junior High School learners' attitude towards linear equation word problems in one variable in the East Mamprusi Municipality?

The third research question sought to determine the effect of Problem-Based Learning (PBL) on Junior High School learners' attitude towards linear equation word problems in one variable in the East Mamprusi Municipal by comparing their attitude scores before treatment (pre-attitude) and their attitude scores after the treatment (post-attitude scores). The questionnaire developed and used for the pre-attitude was the same questionnaire used at the end of the treatment to collect data on learners' post-attitude by using independent sample t-test. The results of the analysis are summarised in the following tables.

Table 4.6: Pre-Attitude Mean Scores for the Control and Experiment Groups

Groups	Test	N	Mean	Standard deviation	t-value	p-value
Control	Pre-test	50	6.49	5.657	1.391	0.167
Experiment		50	5.12	4.538		

Source: Field Survey, 2023

Table 4.6 shows the pre-attitude mean scores of the control group and the experimental group. The results indicate that the mean score for experimental group was 5.12 with a standard deviation of 4.53 and that of the control group was 6.49 with a standard deviation of 5.65. The results also indicate that the difference between the attitude mean scores for experimental and control groups was not significant because $p = 0.167 > 0.05$. It therefore suggests that the experimental and control groups had at the same level of attitude towards solving linear equation word problem in one variable at the commencement of the study.

The pre-attitude means and standard deviation scores for the control group and experimental group is shown in Table 4.7.

Table 4.7: Post-Attitude Mean Scores for the Control and Experiment Groups

Groups	Test	N	Mean	Standard deviation	t-value	p-value
Control	Post-test	50	8.96	4.785	-10.299	0.001
Experiment		50	18.86	4.828		

Source: Field Survey, 2023

Table 4.7 shows the post-attitude mean scores of the control and the experimental groups. The results indicate that the mean score for control group was 8.96 with a standard deviation of 4.78 and that of the experimental group was 18.86 with a standard deviation of 4.82. The results also indicate that the difference between the attitude mean scores for experimental and control groups was significant with $p = 0.001 < 0.05$. This therefore suggests that the Hypothesis 2 (H_{02}) that states there is no significant difference in mean attitude scores of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach and those taught using Traditional Method (TM) is rejected. This is because the Problem-Based learning group learners achieved higher in the post-attitude scores than the traditional group learners. This also shows that there was a positive change in attitude of the experimental group towards linear equation word problems in one variable as a result of the intervention.

The paired samples t-test for experimental group and control group in the pre-test and post-test is shown in Table 4.8.

Table 4.8: Paired Sample t-test for Control and Experiment Groups

Groups	Tests	N	Mean	Standard deviation	Paired Mean difference	t-value	P-value
Control	Pre-Test	50	6.49	5.657	2.47	-2.671	0.000
	Post-Test	50	8.96	4.785			
Experiment	Pre-Test	50	5.12	4.538	13.74	-11.237	0.000
	Post-Test	50	18.86	4.828			

Source: Field Survey, 2023

Table 4.8 shows a paired sample t-test conducted between the means of both the control group and the experimental group using the pre-attitude and the post-attitude which shows a statistically significant difference in both cases at p = 0.000 < 0.05. However, the paired mean difference for the control group and the experimental group was found to be 13.74 and 2.47 respectively. This difference suggests that the Problem-Based Learning teaching method is more effective than the Traditional method of teaching. Therefore, learners who were taken through the Problem-Based Learning lessons develop more positive attitude than their counterparts taken through the Traditional method lessons. This means that Problem-Based Learning teaching strategy has a great effect on learners' attitude.

The researcher carried out an unstructured interview with ten (10) learners from the experimental group that were taken through the problem-based learning approach. The interviewees consisted of four (4) learners who performed above average in the post-test, three (3) learners who performed averagely in the post-test, and three (3) learners who performed below average in the post-test. The interview was meant to complement the findings in Table 4.13 that compares learners' performance in the pre-test and the post-test that shows an improvement in performance and hence change of attitude due to the use of problem-based learning approach as an intervention tool. The interview question and the response of learners during the interview are shown as follows:

Interview Question:

How has the Problem-Based Learning approach changed your feelings and attitude towards solving linear equation word problems in one variable?

Learners Responses:

Learner 1:

> *'The Problem-Based Learning approach has made mathematics more interesting and enjoyable for me. I used to find linear equation word problems in one variable boring, but now I feel more motivated to solve them because I can see how they relate to real-life situations'.*

Learner 2.

> *'Before using the Problem-Based Learning approach, I used to feel worried and confused when faced with linear equation word problems. But now, I feel more confident because the approach encourages me to think critically and try different problem-solving strategies'.*

Learner 3.

> *'The Problem-Based Learning approach has made solving linear equation word problems in one variable less frightening for me. It allows me to work in groups and discuss the problems with my classmates, which helps me understand the concepts better and feel supported in my learning'.*

Learner 4:

> *'I used to find linear equation word problems difficult and time confusing, but the Problem-Based Learning approach has changed my feelings about word problems. Because I can now solve them with less difficulty'.*

Learner 5:

'The Problem-Based Learning approach has increased my confidence in solving linear equation word problems. It allows me to actively engage in the learning process and apply my knowledge to solve real-life problems, which gives me a sense of achievement'.

Learner 6:

'I used to think linear equation word problems were not important and didn't see their purpose. However, the Problem-Based Learning approach has shown me their practical applications, making me more interested in solving them'.

Learner 7:

'Initially I thought problem-based learning was time wasting but I realized it is interesting and the best way to learn mathematics. It made me understand linear equation word problems in one variable'.

Learner 8:

'I find the Problem-Based Learning approach more engaging because it allows me to work on real-life problems that involve linear equation word problems. The approach makes mathematics looks interesting to me'.

Learner 9:

'The Problem-Based Learning approach is good but it is time consuming when using it. I could not finish solving all the problems but I enjoy using it. I wish that our mathematics teacher continues to use it to teach us'.

Learner 10:

'Before using the Problem-Based Learning approach, I used not to like linear equation word problems in one variable. But now I enjoy working the problems and other topics in mathematics because the approach helped to develop my confidence and interest in solving problems'.

The findings from the interview of learners reveal a consistent positive impact of the Problem-Based Learning (PBL) approach on their attitudes towards linear equation word problems in mathematics. Learners expressed a shift from finding these problems boring, worrying, or difficult to feel motivated, confident, and engaged in solving linear equation word problems in one variable. PBL facilitated this transformation by relating mathematics concepts to real-life situations, encouraging critical thinking and problem-solving strategies, fostering collaboration and support among peers, and demonstrating the practical applications of linear equation word problems in one variable. Despite some learners noting the time-consuming nature of PBL, they still appreciated its effectiveness and expressed a desire for its continued use in mathematics teaching. Learners attributed their newfound enjoyment, confidence, and interest in mathematics and solving linear equation word problems in one variable to the transformative impact of the PBL approach.

The results from the interview of the learners regarding how the intervention changed their attitudes towards linear equation word problems in one variable support the findings of Chan (2011) who carried out a study on primary 6 learners' attitudes towards mathematical problem-solving in a Problem-Based Learning setting. In his study, 80 primary six (6) learners were surveyed to determine their attitudes towards solving mathematical modeling problems in a Problem-Based Learning setting after they had solved five modeling tasks. Results from the Attitudes Questionnaire showed positive responses in the attributes of interest, perseverance, and confidence suggesting that Problem-Based Learning promote positive attitude in mathematics learning. Also, Siagan et al. (2019) suggested that Problem-Based Learning impact learners' performance and attitude towards mathematics including linear equations word problems. This again corroborates the findings of Demirel and Dağyar (2016) who established in their study that Problem-Based Learning is effective in helping learners to gain positive attitude towards courses including mathematics.

4.4 Research Question 4: Is there a significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality?

The fourth research question sought to determine if there is a significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality. The descriptive statistics is comparing the scores of both groups in the pre and post tests using independent sample t-test. The results of the analysis are summarised in table 4.9.

Table 4.9 shows the mean, standard deviation, minimum and maximum scores for the pre-test and post-test of the control group.

Table 4.9: Mean, Standard Deviation, Minimum and Maximum Scores for the Control Group in the Pre-test and Post-test

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Pre-Test	50	6.5	4.49603	0	20
Post-Test	50	9.72	4.44026	3	22

Source: Field survey, 2023

Table 4.9 compares the pre-test and post-test results of learners within the control group. The minimum score in the pre-test was 0 and the maximum score was 20. In the post-test, the minimum score was 3, while the maximum score was 22. Learners mean score in the pre-test was 6.5 while that of the post-test was 9.72, an increase of

3.22. This marginal increase might be due to the traditional method alone used and other factors including the teacher factor. This also support factor 2 of KMO factor analysis which talks about teachers not using teaching and learning materials in the delivery of their lesson.

The mean, standard deviation, minimum and maximum scores for the experimental group in the pre-test and post-test is shown in Table 4.10.

Table 4.10: Mean, Standard Deviation, Minimum and Maximum Scores for the Experiment Group in the Pre-test and Post-test

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Pre-Test	50	7.6	5.20596	0	20
Post-Test	50	18.66	4.05377	8	24

Source: Field Survey, 2023

Table 4.10 compares the pre-test and post-test results of the learners within the Experimental Group. The minimum score obtained by learners in the pre-test was 0, while the maximum score obtained was 20. In the post-test, the minimum score was 8, while the maximum score was 24. The mean score of learners in the pre-test was 7.6, while that of the post-test was 18.66, an increase of 11.06. This is an indication that in the post-test every learner's performance had increase in the Experiment Group. These improvements might be due to the effect of the PBL and other factors including the teacher factor. This is because during the intervention the researcher designed a detailed teaching plans with varied teaching strategies in the delivery of the lesson.

Independent samples *t*-test inferential analysis was used to determine the effect of the use of the Problem-Based Learning (PBL) teaching approach on learners' achievement in solving linear equation word problems in one variable. The results of the independent samples *t*-test on the participants' scores in the pre-test and post-test are presented in Tables 4.11 and 4.12.

Table 4.11: Independent Sample t-test for Control and Experiment Groups in Pre -Test

Group	N	Mean	Standard Deviation	t-value	p-value
Control	50	6.5	4.49603	-1.1308	0.2609
Experiment	50	7.6	5.20596		

Source: Field Survey, 2023

Table 4.11 shows the pre-test scores of the experimental and control groups. The results indicate that the mean score for experimental group was 7.6 with a standard deviation of 5.21 and that of the control group was 6.5 with a standard deviation of 4.50. The results indicate that the difference between the achievement mean scores for experimental and control groups was not significant (p = 0.261 > 0.05). This, therefore, means that the experimental and the control groups were at same level of achievement at the start of study. The researcher went further to investigate the effect of the intervention on the achievement of learners in a post-test. Table 4.12 shows the results.

Table 4.12: Independent Sample t-test for Control and Experiment Groups in Post -Test

Group	N	Mean	Standard Deviation	t-value	p-value
Control	50	9.72	4.44026	-10.514	0.0000
Experiment	50	18.66	4.053771		

Source: Field Survey, 2023

Table 4.12 shows the post-test achievement mean scores of the experimental and the control groups. The results indicate that the mean score for the experimental group was 18.66 with a standard deviation of 4.05 and that of control group with a mean score of 9.72 with a standard deviation of 4.44. The results indicate that the difference between the achievement mean scores for experimental group and the control group was significant since (p = 0.000 < 0.05) this shows that the academic performance of learners in the experimental group has significantly improved. The result also affirms that there is significant difference between the mean achievement scores of learners taught using Problem-Based Learning and those taught using the Traditional Method. Thus, the Hypothesis 1 (H_{o1}) that states that, there is no significant difference in the mean achievement scores of learners taught linear equation word problems using Problem Based Learning (PBL) approach and those taught using Traditional Method (TM) was rejected. That is Problem-Based Learning group achieved higher in the post-test scores than the Traditional group learners. This imply that the Problem-Based Learning group achieved higher scores in the post-test than the Traditional group as a result of the intervention.

The paired samples t-test for control group and experimental group in the pre-test and post-test is shown in Table 4.13.

Table 4.13: Paired Sample t-test for Control Group and Experiment Group in Pre-Test and Post-Test

Groups	Tests	N	Mean	Standard Deviation	Paired Mean diff.	t-value	p-value
Control	Pre-Test	50	6.5	4.49603	3.22	-3.4481	0.0012
	Post-Test	50	9.72	4.44026			
Experiment	Pre-Test	50	7.6	5.20596	11.06	-11.916	0.0000
	Post-Test	50	18.66	4.05377			

Source: Field Survey, 2023

Table 4.13 shows a paired sample t-test conducted between the means of both experimental group and the control group using the pre-test and the post-test. The difference was found to be statistically significant in both cases at $p = 0.000 < 0.05$. However, the paired mean difference for the experimental and the control groups was found to be 11.06 and 3.22 respectively. The test results show that the paired mean difference of the experimental group exceeds that of the control group by 7.84. This difference suggests that the Problem-Based Learning teaching method as an intervention strategy is more effective than the Traditional method of teaching.

4.5 Discussion of Major Findings

The teaching approach used by a teacher has a great impact on how well learners perform in mathematics. A good teaching strategy can improve learners' mathematical comprehension and performance. Learners who receive excellent mathematics instruction experience higher and longer-lasting gains in their academic performance than learners who receive poor mathematics instruction (Kariuki, Njoka, & Mbugua, 2019).

This study was an attempt to contribute to the present search for the effective teaching and learning approaches that will enhance learners' understanding, and develop their skills in problem-solving in mathematics. Hence, the current study finds out the effect of problem-based learning on Junior High School learners' achievements in solving linear equation word problems in one variable. The knowledge of the achievements of learners in linear equation word problems in one variable and the challenges they faced in the process of solving linear equation word problems in one variable help mathematics teachers plan their lessons better. In order to determine the achievement of learners, a pre-test was conducted to both the control and the experimental groups.

The findings in Research Question 1 revealed that out of fifty (50) learners of the control group who were engaged in the pre-test, thirty-seven (37) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 74% and out of fifty (50) learners of the experimental group who were also engaged in the pre-test, forty-six (46) of them scored less than the pass mark of the total score of twenty-eight (28) and this represents 92%. This was an indication that majority of the learners exhibited poor performance in solving linear equation word problems in one variable. The finding corroborate that of Adu-Gyamfi et al. (2015) and Andam et al. (2015). The finding is also consistent with statements in the Chief Examiner's report for Basic Education Certificate Examination (2017 to 2020) that point out that learners who respond to word problems typically do abysmally because they lack fundamental mathematical knowledge, which limits their capacity for problem-solving.

Research Question 2 sought to identify the challenges Junior High School learners face in solving linear equation word problems in one variable in the East Mamprusi Municipality.

The results have it that, majority of the learners in this study had difficulties in solving word problems that involved linear equations in one variable. These difficulties include their failure to comprehend the problems, devise a correct plan (write the correct mathematical expression), carry out their plan (solve the formulated equations), and confirm and record the precise solution (look back).

The results imply that the learners were unable to comprehend the problems. 59% of the learners could not understand the problem, they find it extremely difficult to define the suitable variable for the word problem. Some of the learners skipped the first step for lack of understanding of the problem. The results obtained is consistent with research works by Adu-Gyamfi et al. (2015), Siniguian (2017), who posit that learners' difficulties in solving linear equation word problems is largely as a result of their inability to understand and interpret the sentences so as to continue to the process and encoding skills. This corroborate the findings of Fuchs et al. (2018) who point out comprehension as the main difficulty learners' encounter when solving mathematical word problems and this result to their inability to formulate the suitable equation to be solved. The findings of this study also support the research of Adusei and Atteh (2022) and Bajuri et al. (2021) in their studies found that the main cause of learners' difficulties in solving word problems involving linear equation in one variable account for incorrect interpretation, wrong translation and misrepresentation and wrong coding. Also, Andam et al. (2015) observed a generally low performance of the learners in terms of modeling algebraic linear equations out of word problems. The indication was that, learners were not able to read and comprehend the word problem. They find it difficult to analyse and interpret the key words (for example: sum, difference, product of, less than, quotient, etc.) used as well as translating them into mathematical statements, equations and solving the equations correctly. This findings agree with the works of Abdullah et al. (2015) who hold the view that learners' who had difficulties interpreting mathematical problems, failed to develop a strategy and device a strategic plan, which ultimately led to mistakes in choosing the operations and incorrect answers. Duru and Koklu (2011) also found that learners had difficulties in translating the mathematical sentences into algebraic equations because of their inability to read and understand and lack of knowledge about the meaning of symbols, signs, and words used in mathematical texts and algebraic representations.

Research Question 3 which sought to find out the effect of the Problem-Based Learning approach on Junior High School learners' attitude towards linear equation word problems in one variable in the East Mamprusi Municipality by conducting a paired sample t-test between the means of both the control group and the experimental group using the pre-attitude and the post-attitude. The results of the findings show that there is a statistically significant difference in both cases. This difference suggests that the Problem-Based Learning teaching method in solving linear equation word problems in one variable is more effective than the Traditional method of teaching. Therefore, learners who were taken through the Problem-Based Learning lessons develop more positive attitude than their counterparts taken through the Traditional method lessons. This means that Problem-Based Learning teaching strategy has a great effect on learners' attitude. This is because when learners work in groups, they feel that they can depend on others for support during problem-solving and therefore increase their confidence in solving mathematical word problems including linear equation word problems in one variable. These findings are consistent with Servant-Miklos et al. (2019) who also found that PBL also provides learners with opportunities to learn conceptual knowledge and develop the appropriate skills and attitudes relevant in their chosen careers as well as society at large without the need to extend or overburden the curricula. This finding corroborates with the study of Ajai and Imoko (2015) who also support that Problem-Based Learning helps fosters greater healthy rivalry of mathematics instructions, boost the performance of learners in skills acquisition, increase problem-solving abilities and develop the right attitude toward mathematics.

Research Question 4 which sought to find out the significance difference in the mean achievement score of learners taught linear equation word problems in one variable using Problem-Based Learning (PBL) approach compared to those taught using the Traditional Method (TM) in the East Mamprusi Municipality. This was done by comparing the scores of both the experimental and the control groups in the pre-test and post-test using independent sample *t*-test.

The results of the findings show that there was a significant difference between the achievement mean scores for experimental and control groups. Thus, learners taught linear equation word problems in one variable using problem-based learning outperformed their counterparts taught using the traditional method. The post-test achievement mean scores of learners in the experimental group were found to be significantly different from those of their colleagues in the control group. The findings reveal the effectiveness of the use of PBL in enhancing learners' achievement in solving linear equation word problems in one variable.

The analysis of the data reveals that there was a significant difference between the experimental group and the control groups in their achievement mean scores. This means that, learners who learned linear equation word problems using problem-based learning performed better than those who learned using the traditional method. Learners in the experimental group's post-test achievement mean scores were found to be significantly different from their peers in the control group. The findings reveal how effective use of problem-based learning can enhance learners' achievement in linear equation word problems in one variable. The findings of the study support that of Sagala and Simanjuntak (2017) that learners' success and progress in problem-solving abilities increased through Problem-Based Learning than conventional learning. Also, Ahamad et al. (2017) found that problem-based learning allows learners to use prior knowledge to solve new problems and ensures deeper comprehension and make learners learning to be effective. The findings of this study was also consistent with Hmelo-Silver (2004) who hold the view that problem-based learning approach help learners: (i) to make sense of information, (ii) to improve effective problem-solving skill, (iii) to acquire lifelong learning and individual learning skills (iv) to improve fruitful collaboration, (v) to improve intrinsic motivation in learning and to be productive individuals. This finding corroborate that of Hursen (2021) found that problem-based learning method also provides learners with thinking skills and lifelong learning. (Moust et al. (2021)), also found that through the use of problems in problem-based learning, learners are motivated to learn new concepts and idea.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the findings, conclusions, recommendations and suggestions for further studies.

5.1 Summary of the Study

Both learners' performance and understanding of mathematical concepts are significantly influenced by the teaching strategies adopted by their classroom teacher. This study therefore explores the effects of problem-based learning on junior high school learners' achievements in solving linear equation word problems in one variable. The study also aimed at exploring Junior High School learners' achievements in linear equation word problems in one variable and the challenges they face when solving problems involving linear equation word problems in one variable. The target population for this study was Junior High School learners in the East Mamprusi Municipality in the North East Region of Ghana. The study employed purposive and simple random sampling techniques; two schools were selected. One school was randomly assigned as the experimental while the other as control school with basic 8 learners as the target group. The study involved 100 learners as participants comprising (50 in the experimental group taught by the researcher using the Problem-Based Learning (PBL) approach and 50 in the control group taught by the regular Mathematics teacher using Traditional Method (TM).

A quasi-experimental research design of non-equivalent pre-test and post-test control group with the support of a Design-Based research. As a measure to identify the challenges learners encounter when solving linear equation word problems in one variable, a pre-test constructed items of seven (7) involving linear equation word problems in one variable was administered to learners to gather information on their performance. The pre-test graded scripts' analysis suggested that learners had difficulties in solving word problems involving linear equations in one variable. It stands out clear that, learners do not understand the sentences used in linear equation word problems as they found the problems confusing. As a result, translating the word problems into meaningful equations became difficult.

Both control and experimental groups were taught the same concept/topic for three weeks. To compare the relative impacts of the two teaching strategies, pre-tests was conducted for both groups before the start of the treatment, and a post-test was also administered at the end of the treatment. The experimental groups showed a high degree of improvement in terms of understanding when it came to solving word problems involving linear equations in one variable, according to the analysis of the pre-test and post-test results. The researcher employed pre-test and post-test as achievement test and questionnaire for collecting data on the two groups of learners. The tests were directed on learners' achievements and the progress they make in their working process, while the questionnaire focused on the challenges faced by learners and their attitude towards solving linear equation word problems in one variable.

Inferential statistics (such as dependent and independent sample t-test) and descriptive statistics (such as frequency distribution table, percentages, mean, mode, and charts) were used to analyse the scores of learners in the pre-test and the post-test and show the data. Both the control and experimental groups started with the same degree of understanding when it came to solving word problems involving linear equation word problems in one variable, according to an analysis of the pre-test results. The experimental group did better in the post-test than the pre-test, according to a study of the post-test results. The experimental group, however, outperformed the control group in terms of success. The main conclusions of this investigation are:

1. Learners' difficulties in solving word problems involving linear in one variable were found to be their failure to comprehend the problems, devise a correct plan, carry out their plan and confirm and record the precise solution.
2. Learners in the experimental group who were taught using the problem-based learning performed better in the post-test than the pre-test as compared to their colleagues in the control group taught using the traditional method.
3. Problem-based learning is very effective in making learners develop positive attitudes towards the learning of linear equation word problems in one variable and mathematics in general.
4. The learners also felt that problem-based learning is the best approach to teaching mathematics. It helped them understand mathematics better by providing them with the opportunity to discuss problems with one another.

The results from the factor analysis in Research Question 2 revealed the challenges Junior High School learners faced in solving linear equation word problems in one variable in the East Mamprusi Municipality. These challenges were: lack of motivation, inadequate mathematics teaching learning resources, learner's inadequate literacy skills to be able to read and understand simple text, learner's anxiety and lack of interest in Mathematics and lack of perseverance on the part of learners to study mathematics to a higher level of education.

5.2 Conclusions

Problem-based learning approach of teaching is a learner-centered teaching strategy that engages learners actively in the learning process, by enhancing their understanding of mathematical concepts and develops their problem-solving skills. Teaching mathematics through a problem-based learning approach provides a suitable learning environment for learners to discover knowledge on their own, to explore problems and to find new ways to solve the problems. The study was to explore the effects of problem-based learning on junior high school learners' achievements and attitudes in solving linear equation word problems in one variable in the East Mamprusi Municipality. The study revealed that many of the JHS learners who took the pre-test initially performed abysmal in solving linear equation word problems in one variable as 85% of them scored less than half of the total mark (28).

The study also uncovered that the challenges faced by Junior High School learners in solving linear equations word problems in one variable, the researcher identified that learners challenges in solving linear equation word problems in one variable are as a result of their inability to: understand (comprehend) the problem, devising a correct plan, carrying out their plans and to verify and state the correct answer (Looking back). Understanding a problem is the first step to a successful solution of a linear equation word problem in one variable. With understanding the other three steps can be achieved with little effort. This confirmed the results found in research question two of the study that states that, Junior High School learners in the East Mamprusi Municipality inability to solve linear equation word problems is largely on lack of motivation, inadequate mathematics teaching learning resources, Learner's inadequate literacy skills to be able to read and understand simple text, learners anxiety and lack of interest in Mathematics and lack of perseverance on the part of learners to study mathematics to a higher level of education.

This study again brought to light that learners in the experimental who were taught using Problem-Based Learning approach of teaching performed better in the post-test than their colleagues in the control group who were taught using the Tradition Method since the use of PBL technique as an intervention teaching strategy was more effective in solving linear equations word problems in one variable than the Traditional Method.

Finally, the Junior High School learners who are exposed to Problem-Based Learning approach (learner-centered) developed positive attitude towards linear equation word problems in one variable than their counterparts in the control group who experienced the Traditional Method (teacher-centered). This made learners to understand that they can always seek support from their peers to assist them solve a mathematical problem when the need arises and that, discussion together with colleague learners to solve a linear equation word problem in one variable promote better understanding and helps them to obtain the right answers to word problems. The study therefore concludes that the problem-based learning approach if well implemented has the potential of increasing learners' performance in mathematics.

5.3 Recommendations

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

1. Mathematics teachers should construct suitable assessment items on linear equation word problems in one variable and administer them to learners to know their entry behaviour before choosing an appropriate teaching strategy to deliver their mathematics lessons.

2. Stakeholders in education such as Ghana Education Service and Parent Teachers Association should ensure that in-service training is organized for mathematics teachers to help them understand how to use problem-based learning in their mathematics lesson delivery to help learners improve upon their challenges and attitudes towards linear equation word problems in one variable and mathematics in general in the East Mamprusi Municipality Ghana.

5.4 Suggestions for Further Studies

The findings of this study call for further research on how effective mathematics can be taught to Junior High School leaners to make it more attractive and understandable in the East Mamprusi Municipality and the nation at large. The researcher suggested the following areas for future research.

Since the study was delimited to only two Junior High Schools in the East Mamprusi Municipality in the North East Region of Ghana because of limited time and proximity of convenient to complete the study and finance, future researchers should modify the research design to cover more Junior High Schools to provide a wider view on the effect of Problem-Based Learning on Junior High School learners' achievement in solving linear equation word problems in one variable. It is suggested that the study could be replicated in many more schools to obtain the general picture of how Problem-Based Learning improves students' learning and conceptual understanding of linear equation word problems in Ghana. To obtain a general picture of how Problem-Based Learning approach enhances learners' learning and conceptual understanding of linear equation word problems in one variable in Ghana, it is suggested that the study be conducted in many other Junior High School schools. It is also suggested that future researches should focus on the long-term effects of problem-based learning approach of teaching on learners' understanding and performances in mathematics. This can be accomplished by extending the treatment and performance monitoring periods for both the control and experimental groups by at least two years instead of three weeks.

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APPENDICES

APPENDIX A: Pre-Test

Code: ……………………

This test is part of a research on your achievement in solving linear equations word problems. Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided below. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

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2. The sum of four consecutive odd numbers is 16. Find the numbers.

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3. Majeed is now five times as old as Baba. In ten years' time, Majeed will be three times as old as Baba. How old are they?

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4. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

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5. Five times a number is 4 more than the number. Find the number.

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6. A book and a bag cost GHC 240. How much did each cost, if the book cost five times as much as the bag.

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7. Yaw is 7 years older than his wife Ama. The sum of their ages is 63. Find Yaw's age.

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APPENDIX B

Marking Scheme for Pre-Test

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

   $let\ the\ number\ be\ x\ and\ (x+5)=19$ **B1……………Defining variables**

   $x+(x+5)=19$ **M1…………Writing correct mathematical equation.**

   $2x=19-5$

   $2x=14$ **M1…………Solving the equation**

   $x=7.$

   $7+(7+5)=19$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

   Therefore, the number is 7.

   [4 marks]

2. The sum of four consecutive odd numbers is 16. Find the numbers.

   Let y be the first odd number, then the other numbers are;

   $y,(y+2),(y+4),(y+6)$ **B1……………Defining variables**

   $y+(y+2)+(y+4)+(y+6)=16$ **M1…………Writing correct mathematical equation**

   $y+y+2+y+4+y+6=16$

   $4y+12=16$

   $4y=4$ **M1…………Solving the equation**

   $y=1.$

   $1+(1+2)+(1+4)+(1+6)=16.$ **A1………Substituting the value of y into the equation to obtain correct answer.**

   The numbers are $1,3,5\ and\ 7$.

   [4 marks]

3. Majeed is now five times as old as Baba. In ten years' time, Majeed will be three times as old as Baba. How old are they?

   Let Baba's present age be x and Majeed's present age = $5x$

In 10 years time,

the age of Baba will be $(10 + x)$ and that of Majeed will be $(10 + 5x)$

B1……Defining variables

$(10 + 5x) = 3(10 + x)$ **M1…………Writing correct mathematical equation**

$10 + 5x = 30 + 3x$

$5x - 3x = 30 - 10$

$2x = 20$ **M1…………Solving the equation**

$x = 10$

$\big(10 + 5(10)\big) = 3(10 + 10).$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

Hence the age of Baba is 10 and the age of Majeed is $5 \times 10 = 50$

[4 marks]

4. When seven times a certain number is subtracted from 15, the result is -4. Find the number.

$let\ x = the\ number\ 7x = seven\ times\ the\ number.$ **B1……Defining variables**

$15 - 7x = -4$ **M1…………Writing correct mathematical equation**

$-7x = -4 - 15$

$-7x = -19$ **M1…………Solving the equation**

$x = \frac{19}{7}\ or\ 2.71$

$15 - 7\left(\frac{19}{7}\right) = -4$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

Therefore, the number is 14

[4 marks]

5. Five times a number is 4 more than the number. Find the number.

$let\ m = the\ number$ and $5m = five\ times\ the\ number$ **B1……Defining variables**

$5m = m + 4$ **M1…………Writing correct mathematical equation**

$5m - m = 4$

$4m = 4$ **M1…………Solving the equation**

$m = 1$

$5(1) = 1 + 4$ **A1…………Substituting the value of m into the equation to obtain correct answer.**

$5 = 5$

Therefore, the number is 1

[4 marks]

6. A bag and a book cost GHC 240. How much did each cost, if the bag cost five times as much as the book.

$let\ y = cost\ of\ book,\ then\ 5y = cost\ of$ bag **B1……Defining variables**

$5y + y = 240$ **M1…………Writing correct mathematical equation**

$6y = 240$ **M1…………Writing correct mathematical equation**

$y = 40$

$5(40) + 40 = 240$ **A1…………Substituting the value of y into the equation to obtain correct answer.**

Therefore, the cost of book is GHC 40 and

The cost of bag is 5(40) = GHC 200

[4 marks]

7. Yaw is 7 years older than his wife Ama. The sum of their ages is 63. Find Yaw's age.

$let\ y = \text{Ama}'s\ age, then\ y + 7 = \text{Yaw}'s\ age$ **B1……Defining variables**

$y + y + 7 = 63$ **M1…………Writing correct mathematical equation**

$2y + 7 = 63$

$2y = 63 - 7$

$2y = 56$ **M1…………Writing correct mathematical equation**

$y = 28$

$28 + 28 + 7 = 63$ **A1…………Substituting the value of y into the equation to obtain correct answer.**

Therefore Ama's age is 28years

And Yaw's age is (28+7) = 35years

[4 marks]

APPENDIX C

Post-Test Question

Code: ……………………

This test is part of a research on your achievement in solving linear equations word problems. Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

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2. The sum of four consecutive odd numbers is 16. Find the numbers.

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3. Yaw is now five times as old as Kwame. In ten years' time, Yaw will be three times as old as Kwame. How old are they?

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4. A rectangular playing field is 10metres longer than its width. If the perimeter of the field is 300metres, find its length and width.

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5. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

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6. The sum of four consecutive even numbers is 28. Find the numbers.

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7. $\frac{5}{6}$ Of a certain number is 4 greater than $\frac{3}{4}$ that number. Find the number.

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APPENDIX D

Marking Scheme for Post-Test

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

   $let\ the\ number\ be\ x\ and\ (x+5) = 19$ **B1……………Defining variables**

   $x + (x + 5) = 19$ **M1…………Writing correct mathematical equation.**

   $2x = 19 - 5$

   $2x = 14$ **M1…………Solving the equation**

   $x = 7.$

   $7 + (7 + 5) = 19$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

   Therefore, the number is 7.

   [4 marks]

2. The sum of four consecutive odd numbers is 16. Find the numbers.

   Let y be the first odd number, then the other numbers are;

   $y\ (y+2), (y+4), (y+6)$ **B1……………Defining variables**

   $y + (y+2) + (y+4) + (y+6) = 16$ **M1…………Writing correct mathematical equation**

   $y + y + 2 + y + 4 + y + 6 = 16$

   $4y + 12 = 16$

   $4y = 4$ **M1…………Solving the equation**

   $y = 1.$

   $1 + (1+2) + (1+4) + (1+6) = 16.$ **A1…………Substituting the value of y into the equation to obtain correct answer.**

   The numbers are $1, 3, 5\ and\ 7.$

   [4 marks]

3. Yaw is now five times as old as Kwame. In ten years' time, Yaw will be three times as old as Kwame. How old are they?

   Let Kwame's present age be x and Yaw's present age = $5x$

   In 10 years time,

the age of Kwame will be $(10 + x)$ and

that of Yaw will be $(10 + 5x)$ **B1……Defining variables**

$(10 + 5x) = 3(10 + x)$ **M1…………Writing correct mathematical equation**

$10 + 5x = 30 + 3x$

$5x - 3x = 30 - 10$

$2x = 20$ **M1…………Solving the equation**

$x = 10$

$\big(10 + 5(10)\big) = 3(10 + 10)$. **A1…………Substituting the value of x into the equation to obtain correct answer.**

Hence the age of Kwame is 10 and the age of Yaw is $5 \times 10 = 50$

[4 marks]

4. A rectangular playing field is $10 metres$ longer than its width. If the perimeter of the field is $300 metres$, find its length and width.

Let the length of the field $= x\ metres$ and

the width $= (x - 10) metres$ **B1……Defining variables**

Perimeter of the playing field $2(x + x - 10) = 4x - 20$ **M1…………Writing correct mathematical equation**

$4x - 20 = 300$

$4x = 300 + 20$

$4x = 320$ **M1…………Solving the equation**

$x = 80$.

$4(80) - 20 = 300$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

Hence the length $= 80 metres$ and the width $= 70 metres$.

[4 marks]

5. When seven times a certain number is subtracted from 15, the result is -4. Find the number.

$let\ x = the\ number$ and

$7x = seven\ times\ the\ number$. **B1……Defining variables**

$15 - 7x = -4$ **M1…………Writing correct mathematical equation**

$-7x = -4 - 15$

$-7x = -19$ **M1…………Solving the equation**

$x = \frac{19}{7}\ or\ 2.71$

$15 - 7\left(\frac{19}{7}\right) = -4$ **A1…………Substituting the value of x into the equation to obtain correct answer.**

Therefore, the number is 14

[4 marks]

6. The sum of four consecutive even numbers is 28. Find the numbers.

$let\ y = the\ 1st\ number$ **B1……Defining variables**

$y + 2 = the\ 2nd\ number$

$y + 4 = the\ 3rd\ number$

$y + 6 = the\ 4th\ number$

$y + y + 2 + y + 4 + y + 6 = 28$ **M1…………Writing correct mathematical equation**

$4y + 12 = 28$

$4y = 16$ **M1…………Solving the equation**

$y = 4.$

$4 + (4 + 2) + (4 + 4) + (4 + 6) = 28.$ **A1…….Substituting the value of y into the equation to obtain correct answer.**

Therefore, the numbers are $4, 6, 8, and\ 10$.

[4 marks]

7. $\frac{5}{6}$ Of a certain number is 4 greater than $\frac{3}{4}$ of that number. Find the number.

$let\ m = the\ number$ **B1…………...Defining variables**

$\frac{5}{6}m = \frac{3}{4}m + 4$ **M1…………Writing correct mathematical equation**

$12 \times \frac{5}{6}m = 12 \times \frac{3}{4}\ m + 4 \times 12$

$10m = 9m + 48$

$10m - 9m = 48$ **M1…………Solving the equation**

$m = 48$

Substitute the answer in to the equation to confirm the answer.

$\frac{5}{6}(48) = \frac{3}{4}(48) + 4$ **A1…………Substituting the value of m into the equation to obtain correct answer.**

$40 = 40$

Therefore, the number is 48

[4 marks]

APPENDIX E

Questionnaire for Learners

CODE…………

Dear learner,

This questionnaire seeks your views on the challenges that influence your ability to solve Linear Equations Word Problems in one variable. Your responses will enable the researcher introduce appropriate methods to help you improve upon learning of Linear Equations Word Problems in one variable at your level. The filling of this questionnaire will take you approximately about thirty (30) minutes to complete.

Your maximum cooperation is needed as all your responses will be treated with all the confidence it requires.

Instruction: You are kindly requested to tick (√) in spaces provided in the various questions in the questionnaire.

A Learners' Background Information

1. Gender

(a) Male [ ] (b) Female [ ]

2. Age

(a) Below 15 years [ ] (b) 15-18years [ ] (c) Above 18years [ ]

B. Challenges that influence learners' ability to solve Linear Equations Word Problems in one variable

3. On a scale of 1 - 5 (1 = Strongly Disagree, 2 = Disagree, 3 =Undecided, 4 = Agree, 5 = Strongly Agree), how would you rate your agreement to the following statements about how you learn linear equations word problems? (Please rate EVERY option according to the scale).

	Statements about the linear equation word problems you learn in school	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1.	I do not like linear equation word problems because solving them make me feel uncomfortable and restless.					
2.	I like solving mathematics problems but not linear equation word problems.					
3.	I dislike linear equation word problems lessons because it makes me feel bored.					
4.	I feel motivated when solving linear equation word problems because I get right answers.					
5.	I do not like linear equation word problems because when I read the statements I do not understand.					
6.	I like solving linear equation word problems because I understand simple text.					
7.	I would enjoy mathematics more if there were no linear equation word problems lessons.					
8.	I do not attend most mathematics lessons hence my inability to understand word problem.					
9.	I like linear equation word problems because I can solve equations.					
10.	I dislike linear equation word problems because I cannot read simple text.					
11.	I like mathematics because of that I enjoy					

	solving linear equation word problems.					
12.	I do not like mathematics because of that I dislike linear equation word problems.					
13.	I want to be a mathematics teacher because of that I like linear equation word problems.					
14.	I am very confident when solving mathematics problems because of that I like linear equation word problems.					
15.	Our mathematics teacher does not understand word problems and that makes it difficult for him to teach for me understand.					
16.	My mathematics teacher makes me hate linear equation word problems because he makes his lessons less interesting.					
17.	I really enjoy linear equation word problems lesson; my teacher makes them simple to understand.					
18.	My Mathematics teacher does not involve us when teaching his lessons.					
19.	My teacher does not teach using practical approaches hence my difficulty to understand word problems.					
20.	Our mathematics teacher reads directly from textbook and that makes it difficult to understand.					
21.	Our mathematics teacher handles other subjects so he does not teach it well.					
22.	Because I practice mathematics at home, I					

	like linear equation word problems.					
23.	I have no one to guide me in the house to learn mathematics because of that I do not like linear equation word problems.					
24.	I do not like linear equation word problems because I work a lot at home.					
25.	Because I do not have mathematics text book, solving linear equation is difficult.					
26.	No mathematics textbooks for us to learn.					
27.	The mathematics teacher does not use learning aids/resource and that makes me not understand his lessons.					
28.	Reading linear equation word problems is confusing because of that I do not like it.					
29.	My parents are not educated so they are not able to help me learn mathematics.					
30.	I like solving linear equation word problems because I understand the terms used in the text.					

APPENDIX F

Questionnaire for Learners' Attitude

Dear learner,

This questionnaire seeks your view on the use of **Problem-Based Learning** approach of teaching mathematics. Your sincere response will enable the researcher to use appropriate teaching method in teaching mathematics. Your maximum cooperation is needed as your response would be treated confidentially.

You are required to tick **[√]** in the space provided in each of the questions in the questionnaire

1. The Problem-Based Learning approach has increased my interest in solving linear equation word problems in one variable. **Agree [ ] Undecided [ ] Disagree [ ]**
2. The Problem-Based Learning approach has improved my problem-solving skills in relation to linear equation word problems in one variable. **Agree [ ] Undecided [ ] Disagree [ ]**
3. The use of Problem-Based Learning has helped me understand the real-life applications of linear equation word problems in one variable. **Agree [ ] Undecided [ ] Disagree [ ]**
4. Given learners the opportunity to participate actively in mathematics lessons improve their understanding. **Agree [ ] Undecided [ ] Disagree [ ]**
5. The Problem-Based Learning approach has made me more confident in solving linear equation word problems in one variable. **Agree [ ] Undecided [ ] Disagree [ ]**
6. The Problem-Based Learning approach has positively influenced my overall attitude towards linear equation word problems in one variable. **Agree [ ] Undecided [ ] Disagree**

APPENDIX G

Treatment Plan

Week 1

Weekending: 06/02/2023 – 10/02/2023

Class: JHS Two (2)

Subject: Mathematics

References: Peter, A. (2017). Mathematics for Junior High Schools (form 1, 2, and 3). Accra: Aki-Ola Publication

Obeng, A. K. B. (2012). Mathematics for Junior High Schools (book 2). Accra: Approaches' Ghana Limited.

Translating algebraic word problems into mathematical symbols.

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems in one variable.

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

Activity One

The researcher asked learners to solve the question stated below:

Majeed is four years older than Abu. The sum of their ages is 42 years. Find their ages.

Some of the learners presented the following equations as their interpretation of the problem.

Learner 1 (L1) presented

Let x represents Abu's age and Majeed's age = $x + 4$

Hence, the equation $x + x + 4 = 42$

Learner 2 (L2) presented $4x = 42$

Learner 3 (L3) presented $x + 4 = 42$

Other learners also presented their equations as follows:

Let y represents Abu's age

Learner 4 (L4) presented $y + 4 = 42$

Learner 5 (L5) presented $y = 42 + 4$

One of the learners who the researcher described as learner 6 (L6) presents the equation as

Let m represents Abu's age and n, Majeed's age

$$m + 4n = 42$$

The researcher asked the learners to present their equations on the chalk board one after the other for whole class discussion.

After the discussion the learners agreed with the research that the suitable equation to the problem is the one presented by Learner 1 (L1). That is;

$x + x + 4 = 42$

$2x + 4 = 42$

$2x = 42 - 4$

$2x = 38$

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

$x = 19$

Therefore, $Abu\ is\ 19\ years\ old,\ and\ Majeed's\ age = 19 + 4 = 42\ years$

The learner then developed the following guidelines for solving word problems in one variable with the help of the researcher.

1. Read the word problem thoroughly for understanding (reading the word problem severally may enhanced your understanding). Identify the important information(s) present in the word problem. Assign a letter, for example x, y, p, q or any letters of the alphabet of your choice to represent the unknown quantity or quantities in the word problem but do not use i or o because one can mistaken i for 1 and o for 0. Sketch a diagram where necessary.

2. Write down an equation.

3. Solve the equation formed.

4. To make sure the solution is valid and makes sense, check it by substituting the answer arrived at into the original problem formed.

Learners were assisted in recognizing the words and phrases that allude to the four basic operations (**Addition, Subtraction Multiplication, and Division**). Words/phrases such as 'add', 'sum', 'more than', 'increased by', 'combined', 'plus', etc. suggest **ADDITION**. Phrases or words such as 'less than', 'reduced by', 'decreased by', 'difference between', 'difference of', etc. suggest **SUBTRACTION**. Phrases or words such as 'of', 'product', 'times', 'multiplied by', 'double', 'twice', etc. suggest **MULTIPLICATION**. Words/phrases such as 'divide', 'out of', 'ratio of', share 'quotient', 'percent' etc. suggest **DIVISION**.

Activity Two

Learners were guided by the researcher to translate algebraic word problems into algebraic expressions. The researcher emphasized to learners on reading and understanding the word problem before attempting to translate it into algebraic expression or equation.

The following are some of the examples the researcher went through with the learners to enhance their understanding. The learners are required to write an algebraic expression for each of the phrases.

1. Seven more than a certain number

Let x represents the unknown number

The phrase 'more than' implies addition

Learners' answer: $x + 7$ or $7 + x$

2. A number more 25

Let y represents the unknown number

Learners' answer: $y + 25$ or $25 + y$

3. Twelve less than a number.

Let n represents the unknown number.

The researcher asked the learners to write an expression for '12 less than n'.

Learners' answer: $n - 12$

4. A number less than 19

Let m represents the unknown number

Students' response: 19 – m

5. The product of thirteen and a number

Let q represents the unknown number

Learners' answer: $13q$

After going taken the learners through Activity Two, the researcher observed that the learners were excited and very much interested in the activity and as well showed a positive interest in translating word problems into algebraic expressions. This was due to their active involvement in the lesson.

Week 2

Weekending: 13/02/2023 – 17/02/2023

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems in one variable

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

Activity Three

1. Twice a number

Let x represents the unknown number

Students' response: $2x$

2. One-fifth of a number

Let y represents the unknown number

Students' response $\frac{1}{5}y$

3. The sum of a number and six times the same number.

Let r be the unknown number

The researcher asked the learners to write an expression for '6 times r'

Learners' answer: $6r$.

The researcher asked the learners to write an expression for the sum of r and $6r$

Learners' answer: $r + 6r = 7r$

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

Let q represents the unknown number

The researcher tasked the learners to write an expression for the product of q and 5.

Learners' answer: $5q$

The researcher tasked leaners to write an expression for 9 less than $5q$

They response: $5q - 9$

6. Seventy-four less than 12 percent of a number.

Let x be the unknown number

Learners were tasked to write 12 percent of x

Learners answer: $\frac{12}{100}x$

Learners were again tasked to write an expression for 74 less than $\frac{12}{100}x$

Learners' answer: $\frac{12}{100}x - 74$

8. The ratio of 11, and 12 increased by a number.

Let m represents the unknown number

Learners were tasked to write12 increased by m

Learners were again tasked to write the ratio of 11, and $12 + m$

Learners' answer: $\frac{11}{12+m}$

9. The difference of one-half a number and 11

Let y represents the unknown number

The researcher asked the learners to write an expression for one-half of y

Learners' answer: $\frac{1}{2}y$.

The researcher again asked the learners to write an expression for the difference of: $\frac{1}{2}y$ and 11

Learners' answer: $\frac{1}{2}y - 11$.

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

i) Twice a number less than 35

Let t be the unknown number.

Learners' answer: $35 - 2t$

ii) 3 times the sum of x and 6

The researcher asked the learners to write an expression for the phrase "the sum of x and 6

Learners' answer: $x + 6$

The researcher again asked the learners to write an expression for the phrase '3 times the sum of x and 6'.

Learners' answer: $3(x + 6)$.

iii) When a certain number is subtracted from 11 and the result is multiplied by two.

Let y represents the unknown number

The researcher asked learners to write an expression for 'a number is subtracted from 11'

Learners' answer: $11 - y$

The researcher again tasked the learners to write an expression for the phrase '2 multiplied by $11 - y$'

Learners' answer: $2(11 - y)$.

iv) Four less than thrice a number

Let k represents the unknown number

The researcher asked the learners to write for thrice k

Learners' answer: $3k$

The researcher again tasked the learners to write an algebraic expression for 4 less than $3k$

Learners' answer: $3k - 4$

Continuation of Week 2 activities

Topic: Algebraic Word Problems

Sub-Topic: Algebraic Linear Equation Word Problems in one variable

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

Activity Four

In this activity, researcher made the learners to work in groups of five to discuss and solve problems together in order to maximize time and be able to complete their learning activities with less difficulty. The researcher guided the learners to solve problems on linear equation word problems in one variable assigned them. The researcher made learners to understand that, when solving an equation, all terms containing 'letters or variables' 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. This is done by,

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

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

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

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

5. Checking the solution to make sure the answer is correct and also satisfy the equation

After taken learners through the above steps in solving linear equation word problems in one variable, the researcher spent some time guiding them to solve the questions stated below.

1. The sum of two numbers is 147. The larger number exceeds the smaller by 55.

Find the numbers.

The researcher asked the learners to read the problem carefully and write down an equation that is suitable for the given information and then solve for the values of the unknown numbers.

The learners provided their responses as follows;

Let x represents the smaller number

Then, the larger number is $x + 55$.

The equation below was formed together with learners as suitable to the word problem.

$x + (x + 55) = 147$

$x + x + 55 = 147$

$2x + 55 = 147$

Subtract 55 from both sides of the equation

$2x + 55 - 55 = 147 - 55$

$2x = 92$

Divide both sides of the equation by 2

$\frac{2x}{2} = \frac{92}{2}$

$x = 46$.

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$x + (x + 55) = 34$, but $x = 46$

$46 + (46 + 55) = 147$

$147 = 147$

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

Let q be the unknown number.

The researcher asked the learners to write an expression for q subtracted from 14'

Learners' answer: $14 - q$

The researcher tasked the learners to multiply $(14 - q)$ by 5

Learners' answer: $5(14 - q)$

Learners were asked write an equation for the problem and solve it

Learners' answer: $5(14 - q) = 20$

$70 - 5q = 20$

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

$-5q = -50$

Divide both sides of the equation by -5

$\frac{-5q}{5} = \frac{-50}{5}$

$q = 10.$

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$5(14 - 10) = 20$

$20 = 20.$

3. The sum of three consecutive odd numbers is 75. Find the numbers.

The researcher asked the learners to read the problem carefully and come out with a pattern or formula to solve the problem.

Let y represents the first odd even number

Then, the three odd numbers are: y, $(y + 2)$, $(y + 4)$

$y + (y + 2) + (y + 4) = 75$

$y + y + 2 + y + 4 = 75$

$3y + 6 = 75$

Subtract 6 from both sides of the equation

$3y + 6 - 6 = 75 - 6$

$3y = 69$

Divide both sides of the equation by 3

$$\frac{3y}{3} = \frac{69}{3}$$

$y = 23.$

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$23 + (23 + 2) + (23 + 4) = 75$

$23 + (25) + (27) = 75$

$75 = 75$

The three odd numbers are: 23, 25, and 27

4. The sum of two-third of a number and four is 12. Find the number

The researcher asked the learners to translate the problem into an equation and solve the equation.

Let m represents the unknown number

Two-third of m: $\frac{2}{3}m$

Then, $\frac{2}{3}m + 4 = 12$

Multiply through by LCM, 3

$3 \times \frac{2}{3}m + 3 \times 4 = 12 \times 3$

$2m + 12 = 36$

Subtract 12 from both sides of the equation

$2m + 12 - 12 = 36 - 12$

$2m = 24$

Divide both sides by 2

$$\frac{2m}{2} = \frac{24}{2}$$

$m = 12.$

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$\frac{2}{3}(12) + 4 = 12$

$12 = 12.$

5. If $\frac{2}{3}$ of a certain number is added to one-half of the same number, the result is 21.

Find the number.

The researcher asked the learners to translate the problem into an equation and solve the equation.

Learners' answer: Let x represents the unknown number,

Then, $\frac{2}{3}$ of $x = \frac{2}{3}x$ and

One-half of $x = \frac{1}{2}x$

Hence, the equation: $\frac{2}{3}x + \frac{1}{2}x = 21$

Multiply through by L.C.M, 6

$6 \times \frac{2}{3}x + \frac{1}{2}x \times 6 = 21 \times 6$

$4x + 3x = 126$

$7x = 126$

Divide both sides of the equation by 7

$\frac{7}{7}x = \frac{126}{7}$

$x = 18.$

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$\frac{2}{3}(18) + \frac{1}{2}(18) = 21$

$12 + 8 = 21$

$21 = 21.$

6. Jerry is four times as old as Ivy. In 8 years time, Jerry will be twice as old as Ivy.

Find their ages.

Learners' answer: Let y represents Ivy's age

Jerry's age: $4y$

$2(y + 8) = 4y + 8$

$2y + 16 = 4y + 8$

$2y - 4y = 8 - 16$

$-2y = -8$

$\frac{-2y}{-2} = \frac{-8}{-2}$

$y = 4$

The researcher tasked the learners to check the solution by substituting the answer into the equation formed.

$2(4 + 8) = 4(4) + 8$

$24 = 24$

Ivy is 4 years old, and Jerry's age: $4 \times 4 = 16$ years

The schedule activity of Week 3

Weekending: 20/02/2023 – 23/02/2023

The researcher used the third week for revision with learners to have them well prepared for a post-test on linear equation word problems in one variable. It was characterised by solving questions on algebraic linear equation word problems in one variable this lasted for four days from Monday to Thursday. The researcher conducted the post-test on Friday a day after the revision exercise.

APPENDIX H

Sample of Marked Scripts

00/28

PRE-TEST

Code: ....

This test is part of a research on your achievement in solving linear equations word problems.

Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

R = y = 5
= x - 7 = 5
= x = 5 + 7
= x = 12

R = 7 = 5
= 12 + 7 = 19

B0 M0 A0

2. The sum of four consecutive odd numbers is 16. Find the numbers.

{1, 3, 5, 7}

B0 M0 A0

3. Yaw is now five times as old as Kwame. In ten years' time, Yaw will be three times as old as Kwame. How old are they?

5 x 10
= 50

= 50 x 3 = 150

B0 M0 A0

4. A rectangular playing field is 10metres longer than its width. If the perimeter of the field is 300metres, find its length and width.

1

5. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

x

6. The sum of four consecutive even numbers is 28. Find the numbers.

~~4~~ 2, 8, 10

7. $\frac{5}{6}$ Of a certain number is 4 greater than $\frac{3}{4}$ that number. Find the number.

06
28

PRE-TEST

Code: ....

This test is part of a research on your achievement in solving linear equations word problems.

Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

   12 − 7 = 5

   12 + 7 = 19

   The numbers are 12 and 7

   B0 M0 A0

2. The sum of four consecutive odd numbers is 16. Find the numbers.

   1 + 3 + 5 + 7 = 16

   The numbers are 1, 3, 5, and 7.

   B0 M0 A0

3. Yaw is now five times as old as Kwame. In ten years' time, Yaw will be three times as old as Kwame. How old are they?

   Let Yaw = A

   Kwame = B ⇒ A = 5×B ⇒ A = 5B

   ⇒ (5B + 10) Yaw = 3×(B+10) ⇒ 5B+10 = 3B+30

   ⇒ 5B − 3B = 30 − 10 = $\frac{2B}{2} = \frac{20}{}$ = B = 20

   B1 M1 A0

4. A rectangular playing field is 10metres longer than its width. If the perimeter of the field is 300metres, find its length and width.

   L + W + L + W

   P = 2L + 2W ⇒ 300 = 2×(W+10m) + 2×W)

   ⇒ 300 = 2W + 20 + 2W = 300 − 20 = 2W + 2W

   ⇒ $\frac{280}{4} = \frac{4W}{4}$ ⇒ $\frac{280}{4}$ = W ⇒ 70m

   L = 70 + 10m

   ⇒ L = 80m

   B0 M0 A0

1

5. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

$7 \times x = 7x$

$15 - 7x = -4 \Rightarrow$ B1

$\Rightarrow 15 + 4 = 7x$ M1 $\Rightarrow \frac{19}{7} = \frac{7x}{7}$ M1 $= \frac{19}{7} = x = -4$

B0 M0 A0

6. The sum of four consecutive even numbers is 28. Find the numbers.

2, 4, 6, 8, 10

= 4, 6, 8 and 10 ⇒ 4 + 6 + 8 + 10 = 28

B0 M0 A0

7. $\frac{5}{6}$ Of a certain number is 4 greater than $\frac{3}{4}$ that number. Find the number.

~~6 − 5 , 4 − 3~~ $\frac{5}{6} \times Y$

$= 6 - 5 \times Y = 1 \times Y, \; 4 - 3 = 1 = \frac{1Y}{Y} = \frac{1}{1} = 1$

B0 M0 A0

2

19/28

POST-TEST

Code: 39

This test is part of a research on your achievement in solving linear equations word problems.

Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

Let the numbers be x and $x+5$ B1

$\Rightarrow x + x + 5 = 19$ M1

$2x + 5 = 19$

$2x = 19 - 5$ M1

$\frac{2x}{2} = \frac{14}{2}$

$x = 7$ ∴ ~~The numb~~

∴ The numbers are 7 and $(7+5) = 12$

03

2. The sum of four consecutive odd numbers is 16. Find the numbers.

Let the ~~first~~ numbers be y, $y+2$, $y+4$, $y+6$ B1

$\Rightarrow y + y + 2 + y + 4 + y + 6 = 16$

$\Rightarrow 4y + 12 = 16$ M1

$\Rightarrow 4y = 16 - 12$

$\Rightarrow \frac{4y}{4} = \frac{4}{4}$ M1

$y = 1$

∴ The numbers are, 1, (1+2), (1+4) and (1+6)

$\Rightarrow 1, 3, 5$ and 7

03

3. Majeed is now five times as old as Baba. In ten years' time, Majeed will be three times as old as Baba. How old are they?

Let Baba's age be x, and Majeed be $5x$ B1

in 10 years, Baba's age $= (x+10)$, Majeed's age $= 5(x+10)$

$\Rightarrow 5x + 10 = 3(x+10)$ M1

$\Rightarrow 5x + 10 = 3x + 30$

$\Rightarrow 5x - 3x = 30 - 10$ 03

$\Rightarrow \frac{2x}{2} = \frac{20}{2}$ M1

$x = 10$

∴ Baba's age = 20 year $(x+10)$

and Majeed age $= 5(10)$

= 50 years

09

4. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

Let the number be a

$\Rightarrow 15 - 7a = -4$

$\Rightarrow 15 + 4 = 7a$

$\Rightarrow 19 = 7a$

$\Rightarrow \frac{19}{7} = \frac{7a}{7}$

$a = \frac{19}{7}$

$\therefore$ The number is $\frac{19}{7}$

02

5. Five times a number is 4 more than the number. Find the number.

Let the number be x

$\Rightarrow 5x = x + 4$

$\Rightarrow 5x - x = 4$

$\Rightarrow 4x = 4$

$\Rightarrow \frac{4x}{4} = \frac{4}{4}$

$x = 1$

$\therefore$ the number is 1

02

6. A book and a bag cost GHC 240. How much did each cost, if the book cost five times as much as the bag.

Let the cost of the bag be r and the book be 5r

$\Rightarrow r + 5r = 240$

$\Rightarrow \frac{6r}{6} = \frac{240}{6}$

$r = 40$

$\therefore$ The cost of the bag is GH¢40.0 and the cost of the book is 5 x GH¢40.00 = GH¢200.00

03

7. Yaw is 7 years older than his wife Ama. The sum of their ages is 63. Find Yaw's age.

Let the wife age be y, and the Yaw's age = y + 7

$\Rightarrow y + y + 7 = 63$

$\Rightarrow 2y + 7 = 63$

$\Rightarrow 2y = 63 - 7$

$\Rightarrow \frac{2y}{2} = \frac{56}{2}$

$y = 28$

$\therefore$ Yaw's age $(7 + 28) = 35$ years

03

10

Page **2** of **2**

22/28

POST-TEST

Code: ...03...............

This test is part of a research on your achievement in solving linear equations word problems.

Data gathered will be used for purposes of research and therefore be honest.

Read each question carefully and solve it in the space provided. Please, show all working.

Thank you.

1. Two numbers differ by 5 and their sum is 19. Find the numbers.

Let the numbers be x and $x+5$ B1
$x+x+5=19$ M1
$2x+5=19$ ∴ the $x=7$
$2x=19-5$ $7+5=12$
$2x=14$ M1 The numbers are 7 and 12
$\frac{2x}{2}=\frac{14}{2}$
$x=7$ A0

03

2. The sum of four consecutive odd numbers is 16. Find the numbers.

Let x represent the numbers

$x, x+2, x+4, x+6$ B1 $x=1$
$x+(x+2)+(x+4)+(x+6)=16$ M1 $1+2=3$
$x+x+x+x+2+4+6=16$ $1+4=5$
$4x+12=16$ $1+6=7$
$4x=16-12$ ∴ The numbers are; 1, 3, 5, 7
$\frac{4x}{4}=\frac{4}{4}$ $x=1$ M1 A1

04

3. Majeed is now five times as old as Baba. In ten years' time, Majeed will be three times as old as Baba. How old are they?

Let x represent the variable ages
Majeed age $=5x+10$ Baba age $=x+10$ B1

$5x+10=3(x+10)$ M1 ∴ Majeed ages $=30$ years
$5x+10=3x+30$ Baba ages $=10$ years
$5x-3x=30-10$
$\frac{2x}{2}=\frac{20}{2}$ M1 $x=10$ ∴ Baba ages $=10$ years A1
Majeed age $=5(10)=50$ years

04

11

4. When seven times a certain number is subtracted from 15, the result is −4. Find the number.

let x represent the number B0

~~7x − 15 = −4~~

15 − 7x = −4 M1

15 + 4 = 7x

$\frac{19}{7} = \frac{7x}{7}$ M1

$x = 19/7$

~~A0~~ A1

03

5. Five times a number is 4 more than the number. Find the number.

let x represent the number B0

5y = 4 + y M1

5y − y = 4

$\frac{4y}{4} = \frac{4}{4}$ M1

y = 1 ∴ The number is 1 A1

03

6. A book and a bag cost GHC 240. How much did each cost, if the book cost five times as much as the bag.

let y represent the ~~number~~ book and bag

y + y = 240 B0

5y + y = 240 M1

$\frac{6y}{6} = \frac{240}{6}$ ∴ Each cost is GH¢40

y = 40 M1 A0

02

7. Yaw is 7 years older than his wife Ama. The sum of their ages is 63. Find Yaw's age.

let x represent the years B0

7 + x + x = 63 M1

7 + 2x = 63

2x = 63 − 7

$\frac{2x}{2} = \frac{56}{2}$ x = 28 M1

∴ Yaw's age = 7 + 28 = 35 years A1

03

11

Page 2 of 2

APPENDIX I

Introductory Letter

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF EDUCATIONAL STUDIES
DEPARTMENT OF BASIC EDUCATION
P. O. Box 25, Winneba, Ghana
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+233 (050) 9212015

Date: January 11, 2022

The Municipal Director

East Mamprusi Municipal Directorate

North East Region

Dear Sir/Madam,

LETTER OF INTRODUCTION

We forward to you, a letter from Mr. Majeed Imoro, a second year M.Phil student of the Department of Basic Education, University of Education, Winneba, with registration number 202114753.

Mr. Mr. Majeed Imoro is to carry out a research on the Topic "

Exploring the Effects of Problem-Based Learning on Junior High School Learners' Achievements in Solving Linear Equation Word Problems in one Variable in the East Mamprusi Municipality"

We would be grateful if permission is granted him to carry out this study in the Municipality.

Thank you.

Yours faithfully,

…………………………………………

MR. NIXON SABA ADZIFOME

(Ag. Head of Department)

www.uew.edu.gh