UNIVERSITY OF EDUCATION, WINNEBA

USING CONSTRUCTIVIST APPROACH TO ADDRESS SENIOR HIGH SCHOOL STUDENTS' DIFFICULTIES IN SOLVING LINEAR EQUATIONS WORD PROBLEMS: A CASE OF POTSIN T.I.AHMADIYYA S.H.S.

BAIDAO BINTU BABA

2018

UNIVERSITY OF EDUCATION, WINNEBA

USING CONSTRUCTIVIST APPROACH TO ADDRESS SENIOR HIGH SCHOOL STUDENTS' DIFFICULTIES IN SOLVING LINEAR EQUATIONS WORD PROBLEMS: A CASE OF POTSIN T.I. AHMADIYYA S.H.S.

BAIDAO BINTU BABA

(8160110002)

A THESIS IN THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY IN MATHEMATICS EDUCATION

OCTOBER 2018

DECLARATION

STUDENT'S DECLARATION

I, BAIDAO BINTU BABA, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……………………………………………

DATE: ……………………………………………………..

SUPERVISOR'S DECLARATION

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

NAME OF SUPERVISOR: PROFESSOR D. K. MEREKU

SIGNATURE: ………………………………………………

DATE: ……………………………………………………

ACKNOWLEDGEMENTS

I wish to express my gratitude to my supervisor Professor D. K. Mereku for his mentorship, guidance, supervision, objective criticisms, suggestions and corrections which contributed immensely to the completion of this thesis.

I am also grateful to my lecturers at the Department of Mathematics, Professor Samuel Asiedu-Addo, Professor. C. Okpoti, Professor. M. J. Nabie, (Head of Department, Mathematics Education, University of Education, Winneba), Dr P. O. Cofie, Dr. J. Nyala, Dr Charles Assuah, Mr. J. Apawu, for their wonderful guidance and counselling which has helped shaped my horizon and experiences.

I am indebted to Mr J. F. Arkoh, Head of Department, Mathematics, Potsin T.I Ahmadiyya Senior High School for his encouragement and support during my fieldwork in the department. The students of the control and experimental classes cannot be forgotten, without their interest, ardent commitment and involvement this study would not have been possible.

Finally, I express my sincere thanks to my family members, friends and my entire course mates, who have assisted me in diverse ways to climb further the academic ladder. I owe everything to you all and am grateful; thank you and God bless you all.

DEDICATION

This thesis is dedicated to my mum Mariam Abdulla, my dad Baba Sualihu of blessed memory, my dear husband Ibrahim Jamfaru and my son Abdul-Halim

TABLE OF CONTENTS

Content Page

CHAPTER ONE: INTRODUCTION

160

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study employed the quasi-experimental design to address Potsin T. I Ahmadiyya Senior High School Students' Difficulties in solving algebraic word problems in linear equations using constructivist approach. The researcher identified four major difficulties students encounter when solving algebraic world problems namely: students attempting but demonstrating misunderstanding of the problem; students attempting and unable to translate problem into algebraic model or equation(s); students attempting but fail to solve the equation to reach the solution; students attempting to solve the equation but failing to use the right methods or making errors. The study compared the effectiveness of constructivist approach and traditional methods in the teaching of algebraic word problems in linear equations on the performance of students. Two classes were purposively selected for the study. One intact class was used as control group and the other as the experimental group. The sample size consisted of 92 students comprising 43 in the control group and 49 in the experimental group. The experimental group was taught algebraic word problems using constructivist approach while the other control group underwent traditional way of teaching algebraic word problem. Pre-test and post-test were carried out simultaneously on all the groups using teacher-made achievement test. The test format was based on Ghana Education Service syllabus. Using a paired sample t-test, the findings showed that there is a statistically significant main positive effect for the students who used constructivist approach to learn algebraic word problem, [$M = 68.2$, $SD = 14.3$), $t(48) = 14.6$, $p = 0.000 < 0.05$]. Thus, the students taught with constructivist approach performed comparably better than their counterpart who did not use constructivist approach to learn algebraic word problem. Also, the constructivist method made lesson more interesting, practical and easy to understand. It was recommended that teachers should incorporate the use of constructivist in the teaching of algebraic word problem.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter consists of background to the study, statement of the problem, purpose of the study, research questions which served as a guide for the study, significance of the study, delimitations and limitation of the study and finally organisation of the rest of the study.

1.1 Background to the study

Mathematics is important in many areas of life. It is useful in the workplace, at school, at home, and in the community. Thus, a strong foundation in mathematics is a prerequisite for many careers and professions in today's growing technological society. Increasing evidence suggests that every country requires high levels of mathematical and technical skills for efficient development. There is no doubt that the advancement of technology has a significant mathematical contribution to effectively building a strong workforce. At all educational levels, the contribution of mathematics to understanding and application of many subjects are being recognized now more than ever before (Springer, 2007).

For this reason, most countries in the world including Ghana make mathematics compulsory in the educational system in their pre-university schools. In Ghana, a student who fails in core mathematics paper at the Basic School level, Basic education certificate examination (B.E.C.E.) or the Senior high school level, West African Secondary School Certificate Examination (W.A.S.S.C.E.) cannot progress to the next level of his/her education.

According to Nabie (2004), the fundamental objective of mathematics education is to enable children to understand, reason and communicate mathematically and solve problems in their everyday life.

The aim of teaching and learning mathematics according to (Curriculum Research and Development Division (2012), is to equip learners with the ability to describe, investigate and eventually solve mathematical problems through the use of their mathematical knowledge, skills, and techniques. Countries such as United States of America, China, Japan, Britain, Germany, Korea, India and a host of other nations have achieved their economic breakthrough through the efficient use of mathematics science and technology thereby scaling the poverty barrier. Sherrod, Dwyer, and Narayan (2009) indicated that the culture of mathematics and science in different nations determine their advancement. In other words, those nations in the world which have taken the culture of mathematics and science seriously are leading, whereas those nations, which have not, find themselves lagging behind and their very survival threatened. For this reason, the relevance of mathematics cannot be overemphasized. For Ghana to develop at faster pace, the quick development of science, mathematics and technology through literacy among its member is paramount. It is therefore in the right direction that the Curriculum Research and Development Division (CRDD) of the Ministry of Education (MoE) has put in place a structural syllabus to equip learners with the ability to describe, investigate and eventually solve mathematical problems through the use of their mathematical knowledge, skills, and techniques. However, mathematics learning has become a problem for many school-going children recently as the subject is seen as a difficult one. These difficulties are as a result of them not understanding mathematical concepts or don't see why mathematical procedures work or don't know when to use a given mathematical technique.

Mathematical achievement of Ghanaian children in recent times has been a subject of intense discussion among educators, policymakers and the public at large. Students' performance in mathematics at the Senior High School has not been encouraging of late. Candidates are reported to exhibit a poor understanding of mathematical concepts and are unable to form appropriate mathematical models which could be tackled with the requisite (WAEC, 2012). It has also been realized that many students have developed a negative attitude towards the study and learning of mathematics as a result of the way and manner certain concepts are presented to them.

The importance of algebra cannot be attributed to only academic purposes but also the world of work. It is a prerequisite for studying every branch of mathematics, science, and technology (Fey, 1989).It is against this background that algebra has been described as the "gatekeeper" for later mathematics courses. Kieran (1992) stated that learning and teaching of school algebra are conceived as mathematics that deals with symbolizing and generalizing numerical relationships and mathematics structures, and with operating within those structures. In addition to this, Van De Walle (2004) noted that algebraic reasoning involves representing, generalizing, and formalizing patterns and regularity in all as parts of mathematics. It has been a traditional phenomenon that students only begin learning algebra when they enter high school. Linchevski and Herscovicks (1996) indicated in their research that, learners at this level experience serious problems in understanding pre-algebraic concepts and that the teaching of algebra learning should not wait for high school freshmen. As a result of its significance for academic purposes, in the 80s, National Council of Teachers of Mathematics (NCTM, 2000) in the United States called for a spotlight on algebra across the grades, beginning as early as pre-school, so that students develop their algebraic skills and algebraic ways of thinking that are needed for success in high school and beyond. This recommendation which aimed at developing young children's capability for algebraic thinking had become an important strand of the recommendations in the Principles and Standards for School Mathematics (Blanton & Kaput, 2003). In line with the recommendation, developing algebraic thinking is a top priority in today's elementary mathematics curriculum since algebra is now second in importance after numbers and operations (Burns, 2002), hence the need for students to have a better understanding of the algebra concepts.

One of the main important components of mathematics training is teaching students how to solve word problems. Real-world problems that require mathematical skills to solve typically, do not come to us as equations ready to be solved but rather as a word or pictorial representations that must be interpreted symbolically, manipulated and solved. It is for this reason that solving word problems are introduced in the earliest stages of mathematics instruction (Cummins, 1991). Word problems are often used to refer to any mathematical exercise where significant background information on the problem is presented as text rather than in mathematical notation (Verschaffel, Greer, & De Corte, 2000). Word problems often involve a narrative of some sort, they are occasionally also referred to as story problems and may vary in the amount of language use (Moyer, Moyer, Sowder, & Threadgill-Sowder, 1984). Mathematical word problems, or story problems, have long been a familiar feature of school mathematics. For many students, the transformation of word problems into arithmetic or algebra causes great difficulty, and a number of studies have addressed the linguistic and mathematical sources of that difficulty from a psychological point (Cummins, 1991).

Mathematics word problems among mathematics problems mostly deal with the relating real-world phenomenon to mathematical concepts. In fact, such problems help students to use their mathematical knowledge in solving their daily life problems. Mathematics word problems are known as instruments which develop the students' ability and talent in solving mathematics problems (De Corte and Vershalffel, 1989). However, results obtained from numerous researchers indicate that most of the students in various academic levels are faced with many difficulties in trying to solve such problems.

Kieran (1992) sees generating equations from words as the major area of difficulty for high school algebra students. These students are able to use successfully calculation algorithms whereas they are not able to solve word problems which need the same algorithms (Mayer & Hegarty 1996). Geary (1994) says "children make errors when solving word problems than solving comparable number problems". The reason for such inability is the fact that solving such problems demands mathematical computations along with other kinds of knowledge including linguistic knowledge, which is required for understanding the problems.

The presence of a high percentage of word problems in mathematics textbooks led many researchers to conduct a more comprehensive search of the literature on word problems. It is found that these problems have been alternately referred to in the literature as story problems, word problems, and problem-solving situations and that helping students read and understand these word problems has been a reoccurring topic in professional literature for the last century. Researchers such as Geary (1994) and Weber (1996) reported that teachers also have many difficulties when solving arithmetic word problems. Weber (1996), wrote on the difficulties students and teachers had with arithmetic word problems, labelling them 'demon problems'.

One call for classroom attention to problem solving strategies came from the National Council of Teachers of Mathematics (NCTM, 2000) which contended in its widely-read and cited principles and standards of school mathematics that, "students need to develop a range of strategies for solving problems, such as using diagrams, looking for patterns or trying special values or cases''. These strategies need instructional attention if students are to learn them. The standards also suggested that teachers give students opportunities for the application of problem-solving strategies across all mathematics content areas. In (NCTM 2006) latest publication - Curriculum Focal Points for Pre-kindergarten through Senior High School Mathematics, problem-solving continues to be a key theme.

There are many factors which contribute to difficulties in solving word problems. In several studies, it has been shown that word problems become easier when they are embedded in a familiar context (De Corte and Vershalffel, 1989). The familiar may cause children to pay more attention and moreover it is easier to remember a familiar situation than unfamiliar one (Stern & Lehrn-Dorfer, 1992).

Although the influence of different factors in solving mathematics word problems have been studied, until now, not much research has been done in order to examine how best teachers' can enhance students' understanding of solving mathematics word problems using appropriate strategies. Students already have the notion that mathematics is a difficult subject and do not enjoy its teaching and learning, so until solutions have been found to the problems by the use of alternative methods, students would continue to run away from mathematics. Given the current state of learners' performance in Mathematics, it is reasonable to argue that the traditional teaching methods are not providing meaningful instructional options to address learners' difficulties in mathematics, particularly in algebraic word problems. Traditional teaching methods are known to limit learners' participation in the lesson and to be more teacher-centered in an attempt to chase the syllabus coverage. From experiences the researcher has gathered as a mathematics teacher, it has become very clear that, solution to the difficulties of form one General Arts Students of Potsin T.I Ahmadiyya Senior High School in solving algebraic word problems must be identified through the use of classroom practices and specific strategies developed so as to enhance students' understanding in solving word problems.

In my teaching experience, I have observed that some basic difficulties that learners encounter in SHS Mathematics lesson in classwork, class test, and end of term examination assessment, in Algebraic word problems, are related to the following:

1. Not understanding the language used in the problem
2. Difficulty in imagining and recognizing the context in which the word problem is set
3. Misinterpreting of the word problem thus not being able to write the algebraic form sentence for the word problem.

In the light of the foregoing background, the current study identified the need to search for the responsive instructional method to address learners' difficulties in word problem in terms of exposing the difficulties and thereby providing a treatment for the observed difficulties. On this basis, the study investigated the use of Constructivist-Based Instruction (CBI) to address Potsin T.I Ahmadiyya SHS students' difficulties in solving word problems involving linear equation. The researcher seeks students' perception/thinking about Constructivist teaching approach.

1.2 Statement of the Problem

Knowledge is not attained but constructed (Von Glasersfeld, 1991). This statement came from a new challenge to the concept of traditional knowledge. Today, we are facing the challenge from an educational paradigm shift in Ghana. The general public has criticized existing classroom environments, arguing that they are not ready to meet learner's needs and the demands of the industrial society in this 21st-century information society. Some complain about current educational practices, raising questions about the inability of Ghanaian students to perform creative thinking as well as problem-solving tasks when compared to other advanced countries.

Ghana's poor performance in mathematics from the results of Trends in International Mathematics and Science Study (TIMSS) in 2003 in which Ghana was ranked among the lowest in Africa and the world (Ghana was ranked 44th out 45 participatory countries in 8th grade mathematics), calls for some overhauling of the mathematics curriculum of both the Basic and Second Cycle Schools and a review of how mathematics is taught.

Similarly, the 2007 and 2011 TIMSS mathematics average score of 309 and 331 respectively for grade 8 students from Ghana were lower than the low international benchmark average of 400 (Mullis, Martin, Foy, & Arora, 2012).

In addition, the results from the West African Secondary School Certificate Examination (WASSCE) over the years in mathematics leaves much to be desired. Students have constantly recorded massive failures in mathematics and this has been a cause of worry for all stakeholders. Methods used in teaching mathematics in the majority of schools in Ghana since post-independence (1960), by observation and experience, have not undergone significant metamorphosis. An executive summary of Ghana's vision 2020 (captioned The First Step) states in the guidelines for formulation and implementation of policies programs under education (Section 5.1.12) that the vision will substitute teaching methods that promote inquiry solving word problem and problem-solving for those based on rote learning. This is one of the medium-term (1996-2000) policies under education that is yet to materialize and is long overdue.

As a practicing Mathematics teacher, I believe that in order to address learners' poor performance in the subject (Mathematics) especially word problems, it is necessary to explore learners' difficulties in solving algebraic word problems.

The chief examiner's report from the West African Examination Council (WAEC 2006) on West African Secondary School Certificate Examination (WASSCE, 2006.), revealed that students perform poorly in mathematics as less than 15% of the students score 50% and above. This poor performance was attributed to students' lack of basic knowledge in indices, algebraic expression, and logarithms. Students were unable to translate word problems into mathematical language and to use mathematical symbols to enable them to solve problems. The report added, questions related to algebra are often the lowest scoring questions on the paper or are continually avoided. In the recent West African Senior School Certificate Examination (WASSCE 2012, 2014, 2015, 2017.),the chief examiner's report again from the West African Examination Council (WAEC) observed that most of the candidates were unable to translate story/word problems into mathematical statements and to use mathematical symbols to enable them to solve problems. However, teachers were also advised to help students understand basic mathematical concepts and their applications.

The researcher also observed the difficulties her students have with translating word problems into algebraic equations and vice versa. Yin (1994) states that observational evidence is often useful in providing additional information about the topic being studied. It follows from this that, in order to improve students' performance in mathematics in general, the teacher should enhance a profound understanding and acquisition of algebraic word problem concepts and thinking skills. Such skills can be promoted at all school levels through the constructivist-based teaching approach. The purpose of this study is to identify which teaching method is suitable to address Senior

High School Students' Difficulties in Solving Word Problems Involving Linear Equations in order to improve their performance in Mathematics.

The researcher intends to use the constructivist-based teaching and learning as a treatment strategy in series of activities to address the difficulties students' encounter in solving word problems involving linear equations.

Given the current state of learners' performance in Mathematics, it is reasonable to argue that the traditional teaching methods are not providing meaningful instructional options to address learners' difficulties in mathematics, particularly in word problems (algebra).In the light of the foregoing background, the current study identified a need to search for a responsive instructional method to address learners' difficulties in word problems (algebra) in terms of exposing the difficulties and thereby providing a treatment for the difficulties. On this basis, this study is to investigate the effects of Constructivist teaching approach on high school students' of Potsin T.I Ahmadiyya Senior high School to address their difficulties in solving word problem involving linear equations.

1.3 The purpose and objective of the study

The purpose of the study was to determine the effect of Constructivist approach in addressing Senior High School Students 'difficulties in solving algebraic word problem.

The study was guided by the following specific objectives

1. To identify the difficulties that students encounter in translating word problems into algebraic linear equations and vice versa

2. To investigate the effects of constructivist-based teaching approach on students' achievements in algebraic word problems in linear equations?

3. To find out the perception of students about the constructivist -based teaching approach in learning word problems.

1.4 Research Questions

The following research questions were formulated to guide the study:

1. What difficulties do SHS students encounter in translating algebraic word problems to linear equations and vice versa?

2. What effects do constructivist-based teaching approach have on students' achievements in algebraic word problems in linear equations compare to the traditional teaching approach?

3. What perception do students have on constructivist-based teaching approach in teaching word problem?

1.5 Hypothesis

To determine the effect of using constructivist or conventional method as the teaching approach on the performance of students (research question 2), the following hypotheses was formulated.

Null Hypothesis (H_0): there is no significant difference between the pre-tests and post-tests performance of students taught using the constructivist teaching approach and that of students taught using traditional or conventional teaching approach.

1.6 Significance of the study

Overlooking the relevance of this research may not be laudable. The findings of this study are expected to reveal some of the deficiencies existing in the teaching and learning of mathematics especially solving algebraic word problems and would also serve as a guide for teachers to vary their methodology to enable students to understand word problems in linear equation better.

Society expects high schools graduates to be able to use mathematics to solve real-life problems and recognize different situations. This would make the student useful not to himself/herself only but also to the society in which he/she lives. It is the teaching and learning of mathematics that can prepare the student adequately to fit into the society. For example, a road sign (70) is a symbol, which tells drivers to limit their speed to not more than 70km/h. Furthermore, the idea of algebra enables us to create expressions, which represent generations for significant results and important patterns in mathematics and other fields of study. The study, when implemented, would let the students gain confidence and be able to solve other related word problems. It is hoped that the use of a constructivist-based method of teaching may have a positive impact on achievement in mathematics and enhance students' attitude towards learning mathematics. In addition, the finding of the research would help sharpen most of the students' analytical skills in understanding word problems. It would promote and sustain students' interest to learn mathematics as well as motivate slow learners to improve upon their learning. This study would further help deepen students' understanding of modelling algebraic word problems into equations and better equip those who plan curriculum and teach students to meet the needs of Senior High School students in mathematics.

Finally, the research would be of great importance to educational planners especially Ministry of Education, Ghana Education Service, West African Examinations Council, other beneficiaries of education as well as organizations that do have roles to play in the promotion and development of Mathematics Education in Ghana.

1.7 Delimitation of the study.

The study was delimited to the students of Potsin T.I Ahmadiyya Senior High School in the Gomoa East District of Central Region and two intact classes in the first year General Art class was used for the study. The main rationale for using the first year students in the study is that the topic is within the scope of the first year mathematics curriculum. Again, the study was confined to algebraic word problem.

1.8 Limitation of the study

In Educational Research large data cases increases reliability of the information that is gathered. Therefore, it would have been proper to cover the entire form one students of Potsin T.I Ahmadiyya Senior High School but due to the organization of lessons as the researcher is a tutor of the school and in view of other constraints such as time, the study was restricted to cover only two intact classes in the first year class of Potsin T.I Ahmadiyyaa Senior High School.

1.9 Organization of the study

The rest of the study will be organised as follows. Chapter two deals with the review of related literature on the theoretical framework of the study, Mathematical Word Problem and Problem Solving, Students' Difficulties in Solving Word Problems, Constructivist Method of Teaching Problem Solving Constructivist Activities in Teaching and Summary will be discussed.

Chapter three also deals with the instrument, data collection procedures and data analysis. Chapter four presents the results and discussion of the findings of the study. Chapter five is the final chapter of the study. It gives the summary of the study and draws conclusions on the key findings of the study. It outlines recommendations from the study and suggested areas for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter deals with the theoretical framework of the study and what other researchers have written on solving word problems involving algebraic linear equations. It also has a review of literature on various form of methods of teaching word problems in mathematics. The literature review will be discussed under the following sub headings:

1. Theoretical Framework
2. Mathematical Word Problem and Problem Solving
3. Students' Difficulties in Solving Word Problems
4. Constructivist Method of Teaching Problem Solving
5. Constructivist Activities in Teaching
6. Summary

2.1 Theoretical framework of the study

The theoretical framework is a collection of theories that support a research (Ofori & Dampson, 2011). Therefore, the theory supporting this study is Constructivist theory of teaching and learning of mathematics. In Constructivist learning theory, the learner is the source of meaning. This means that the knowledge already exists and is out there, but it is the learner's responsibility to discover it out. According to this theory, learners do not just receive information inertly but continuously generate new knowledge based on previous knowledge in conjunction with the new experiences they had (Hmelo, Cindy, & Chinn, 2007).

Unlike traditional approaches where students learn by memorizing whatever teachers say, constructivism gives learners an opportunity to bring their fresh ideas on board for discussion whereby the learner's ideas are being recognized and improved through various teaching and learning techniques that actively engage them. Also, constructivism allows for knowledge to be acquired as a result of interaction between teachers and students whereby the teacher facilitates the learner to take on a central role in constructing his/her own experience and knowledge rather than imposing knowledge on him/her. In this case, the acquisition of mathematical knowledge becomes a learner-based activity rather than a passive activity involving the memorisation and acceptance of an independent body of truths.

In addition, from the constructivist viewpoint, the learning process causes learners to become active constructors of meaning in the process of teaching (Wiggins & McTighe, 2006). Also, students are expected to be able to build arguments to support their reasoning in solving problems that involve word problem. To demonstrate this, the characteristics of the concepts they describe are expected to dominate learners' conversations as they express their understanding of the concept under discussion. In a similar way, learners' expressions of meaning held in written products are expected to describe their comfort level with the representation of ideas, generalization of information, willingness to explore, and reflections on new information.

The fundamental challenge of constructivism is, in changing the locus of control in learning from the teacher to the student. To the constructivists, learning must be placed in a rich context, reflective of real-world context, for this constructive process to happen and transfer to environments beyond the school classroom. How effectual or instrumental the learner's knowledge structure is in facilitating thinking in the content field is the measure of learning (Bednar, Cunningham, Duffy, & Perry, 1992)

2.2 Mathematical Word Problem and Problem Solving

According to (Stanic & Kilpatrick, 1989), problems have occupied a central place in the school mathematics curriculum since antiquity, but problem-solving has not. Traditionally we use problems as a means of teaching mathematics. More specifically, problems have most often been used as a vehicle to practice facts, rules, formulas, or procedures (Baroody, 1993).

Word problems are defined as the set of problems which in the educational contexts are solved through the application of various elementary 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 obtain a result (algebraic procedure) (Cerdan, 2008). Cerdan claims that it is not the structure of the problem which determines whether it is arithmetic or algebraic but rather the process is undertaken when translating its verbal formulation or algebraic expressions. Solving of Mathematical word problems is widely spread across different educational cycles. Word problems are first introduced at the Primary school level as with arithmetic operations.

At the Secondary School level, a new approach for solving a word problem that is algebra is introduced, and this is a much more effective approach since it can be applied to problems of all kinds.

Different theorists have also defined word problems in various ways. Some mathematics educators defined word problems by their structure, appearance and the inbuilt assumptions behind them (Lesh, Post & Behr, 1987). Word problems do have an easily recognizable structure and some assumptions are always made by both students and teachers such as assuming that information not mentioned in the problem statements will not be required for successful problem-solving. According to Boote, (1998) a word is defined by its use as a tool rather than by its characteristics. He went on further to say word problems can be useful as a means of illustrating the practical use of an algorithm or a modelling tool in Physics and Statistics. The characteristic features of a word problem are the use of words in the description of the problem and the fact that they refer to real-life context (Kurina, 1989; Semandi, 1995).

Polya (1962) described problem-solving as "finding a way out of a difficulty, a way around an obstacle, attaining an aim which was not immediately attainable"(p166). He further specified this conception of problems and problem-solving in terms of mathematics: "Our knowledge about any subject consists of information and know-how. What is know-how in mathematics? The ability to solve problems - not merely routine problems but problems requiring some degree of independence, judgment, originality, creativity" (p VI).

Schoenfeld (1985) on the other hand distinguished between mathematical tasks that are problems and those that are exercises, he claims that both are important but that students in many high school mathematics classrooms engaged in completing exercises and rarely, if ever, are challenged to solve problems. Lester and Kehle (2003) typify problem-solving as an activity that involves students' engagement in a variety of cognitive actions including accessing and using previous knowledge and experience. Successful problem solving involves coordinating previous experiences, knowledge, familiar representations, patterns of inference, and intuition in an effort to generate new representations so as to resolve the tension or ambiguity that prompted the original problem-solving activity.

What does it mean for students to organize previous knowledge and experiences to generate new knowledge? It is clear that if students are to be engaged in problem-solving activities they need to develop a way of thinking, consistent with mathematical practices in which problems or tasks are seen as impasses that need to be examined in terms of questions. Thus students need to construct their own learning.

Mayer & Hegarty (1996) explained problem-solving processes as using different form of knowledge leading to the goal of solving the problem. According to him, the types of knowledge applied in problem solving consisted of:

1. Linguistic and factual knowledge- about how to encode statements
2. Schema knowledge- about relations among problem types
3. Algorithmic knowledge- about how to present ‘distinct procedures, and
4. Strategic knowledge- about how to approach problems.

Kroll (1993) said that one of the main reasons for learning mathematics is to be able to use it in solving practical problems. For most students, however, learning how to apply mathematical skills to real life situation is the most difficult task to them. A common difficulty with word problem is trying to do everything at once. It is usually best to approach the problem in stages. But of course, the solution of a word problem depends upon the student's ability to translate the word problem into mathematical equations.

Frobisher (1994) is also of the view that not every question posed in the classroom is a mathematical problem, but rather a problem is a task presented in words with a question posed to define the goal a solver is expected to attain in carrying out the task.

Setek (1992) stated that one of the oldest applications of algebra is solving word problems. According to them, word problems require the use of algebra in order to find the solution in a systematic manner as opposed to trial and error. The group enumerated the tools that enhanced problem-solving as patience, reasoning and critical thinking. It is, therefore, necessary for the learner to be given the basic skills needed in translating word problems into mathematical equations.

According to Okpoti (2004) word problem is classified into a well-defined problem and ill-defined problem. To him, a well-defined problem is the one in which students are provided with four different facts. These are the initial state of the problem, the goal state of the problem, the legal state of the problem, and the operator restrictions which constraints the operators. This means that any word problem that contains all these facts presented to students to solve is said to be a well-defined problem because almost all the information needed by the students is clearly spelt out for him/her to work with. On the ill-defined problem, he stated that it is the one in which little or no information is provided on the initial state, the operator restrictions or a combination of these. This stands to mean that in an ill-defined problem, the part of the information needed, calls for the student's ability to think logically. The above discussion suggests that students need to be taught algorithmic skills before a word problem is given to them to solve.

Word problems according to Kim, Sharp & Thompson (1994), are to test our ability to use mathematical reasoning in a practical way. This means the solution to a word problem depends upon the student's ability to translate a worded sentence into a mathematical equation, that is we must observe what is given, what is required and what relationship exists among the given facts. The author stressed on the importance of units given in the word problem that is in relation to the solution of the problem.

Cooney, Edward and Hendor (1983) defined word problem solving as a process of accepting a challenge and striving hard to solving it. To them problem-solving is an intellectual skill that must be taught. The teacher is to encourage students in accepting the challenge and guides them to solve it. It is the authors' belief that when an individual understands a principle and has the opportunity to practice its recognition and employment in a variety of situations, then the individual is able to "transfer" the knowledge of the principle in subsequent situations. This means that the students need the technique of accepting the challenge being presented to them.

Polya (2004) in his book "How to solve it" suggested four phases in problem solving. These phases are:

1. Understanding the problem.
2. Devising plan to solve the problem.
3. Carrying out the plan to solve the problem.
4. Looking back at the complete solution to review and discuss it, then extension of the problem.

Leamy (1983) suggested the following approach in translating word problems into mathematical statements;

1. Read each problem carefully to find the facts which are related to the missing numbers.
2. Represent the unknown number by a variable usually letter.
3. Form an equation by translating two equal facts with at least one containing the unknown into algebraic expression and equate one expression to the other.

He went on further to outline some phrases that can be identified in word translation, and that the signs of operation may assume any one of several meanings. He cited the following:

1. The addition symbol (+) means sum, add, more than, increased by.
2. The subtraction symbol (—) means difference, subtract, takeaway.
3. The multiplication symbol (x) means product, multiply.
4. The division symbol (/) means divide, ratio

Another school of thought is Miller & O'Neill (2004). To them linear equation can be used to solve many real-world problems. However, with word problems students often do not know where to start. To help organize the problem-solving strategies they offer the following guidelines:

1. Read the problem carefully, familiarize yourself with the problem by identifying the unknown and if possible estimate the answer.
2. Assign labels to unknown quantities. Identify the unknown quantity or quantities and represent them by variables. Draw a picture and the formulas.
3. Develop a verbal model and an equation in words.
4. Write a mathematical equation. Replace the verbal model with mathematical equations using the variables.

5. Solve the equation, solve for the variable using the steps for solving linear equations.
6. Interpret the result and write the final answer in words.
7. Once you have obtained a numerical value for the variable, recall what it represents in the context of the problem. Use the value obtained to write an answer to the word problem in words.

The above discussions stand to mean that students' inability to solve word problems should be the sole responsibility of both the teacher and the student concerned. There are technicalities in word problems which students need to know before equation in word form is given to them. The semantic structure should be explained to the students to help them easily interpret word problems of any form. If students are taught the steps on how to interpret word problems into mathematical statements then they stand a better chance of solving them correctly.

Teachers of mathematics should, therefore, take the responsibility of taking their students through the required steps and strategies for solving word problems in mathematics for them to acquire the basic steps and skills required.

2.3 Students' Difficulties in Solving Word Problems

According to Newman (1983), difficulty in problem-solving may occur at one of the following phases, namely, comprehension, strategy know-how, transformation process skill and solution. Schoenfeld (1985) suggested four aspects that contributed to problem-solving performance. These are the problem solver's, mathematical knowledge, knowledge of heuristics, affective factors which affect the way the problem solver views problem solving, and managerial skills connected with selecting and carrying out appropriate strategies

Kroll (1993) in their study of problem-solving identified three major cognitive and affective factors; namely knowledge, control and beliefs, and effects that contributed to students difficulties in problem-solving. Lester (1994) on the other hand emphasized that difficulties experienced during problem-solving could also be caused by the problem solver's characteristics such as traits, disposition, and experiential background.

In the early 1970s research tended to attribute difficulties in solving problems to the various task variables such as content and context variables, structure variables, syntax variables and heuristic behaviour variables(Goldin & Mc Clintock, 1979). However, Lester (1994) contended that there was a general agreement that problem difficulty is not so much a function of various task variables but rather a function of characteristics of the problem solver. In other words, the knowledge one possesses, one's disposition and one's experiential background often influence problem-solving performance. These were also evident in a study conducted in Singapore by Kaur (1995) and Lee (2001). Kaur indicated that Singapore's students experienced problem-solving difficulties such as:

1. Lack of comprehension of the problem posed
2. Lack of strategy knowledge
3. Inability to translate the problem into a mathematical statement

Lee who conducted a local study on first year undergraduate students solving routine calculus problems found that the difficulties faced by the students were:

1. Lack of experience in defining problems
2. A tendency of rush toward a solution before the problem has been clearly defined
3. A tendency to think convergent
4. Lack of domain-specific knowledge

McGinn and Boote (2003) identified four primary factors that affected perceptions of problem difficulty. These were:

Categorization- ability to recognize that a problem fits into an identifiable category of problems which run a continuum from easily categorisable to uncategorisable

Goal interpretation- figuring out how a solution would appear which run a continuum from well-defined to undefined

Resource relevance- referring how readily resources were recognized as relevant from highly relevant to peripherally relevant, and

Complexity- performing a number of operations in a solution.

Mc Ginn and Boote suggested that the level of difficulty of the problem depended on the problem solvers perceptions of whether they had suitably categorized the situation, interpreted the intended goal, identified the relevant resources and executed adequate operations to lead toward a solution.

Not all the errors that students do make when solving word problems result from difficulties in representing and translating problem statements. Once the problem has been translated, problem-solving errors can and do still occur and these errors are often due to a bug (Lewis, 1981)

Sometimes, students get confused when they try to formulate a solution for an algebraic word problem. Kieran (1992) says that to solve a problem such as; when 2 is added to 4 times a certain number, the sum is 24; students would subtract 4 and divide by 2 using arithmetic. But solving the problem using algebra would require setting up an equation like $2 + 4x = 24$. There are therefore two different kinds of thinking involved in these two contexts which would sometimes confuse students. In arithmetic, students think of the operations, they use to solve the problem whereas, in algebra, they must represent the problem situation rather than the solving operations. This means apart from the difficulties encountered by students when translating word problems into algebraic language, there are other barriers such as inter interference from other systems, like not understanding the equal sign as a relationship, and' other misconceptions in simplifying algebraic expressions.

2.4 Constructivist Method of Teaching Problem Solving

According to the Curriculum Research and Development Division Teaching Syllabus for Senior High School Mathematics (2012), the first three general aims of teaching mathematics are to:

1. Develop the skills of selecting and applying criteria for classification and generalization.
2. Communicate effectively using mathematical terms, symbols and explanations through logical reasoning.
3. Use mathematics in daily life by recognizing and applying appropriate mathematical problem -solving strategies

On Algebra it states – Algebra is a symbolic language used express mathematical relationships.

Student need to understand how quantities are related to one another and how algebra can be used to concisely express and analyze those relationship (CRDD, 2012 pgs. 2-4). Students should be made to solve real- world and mathematical problems by writing and solving equations of the form x+y = z and ax = b for which a, b and x all real numbers . Specifically students should solve linear equations in one variable .Many researchers have identified three common challenges that students often face when attempting to solve equations;

1. Lack of symbolic understanding of variables and coefficients within an equation (Kilpatric & Izak, 2008; Poon & Leung, 2010)
2. Lack of understanding of the meaning of the equal sign (Knuth, Stephens, McNeil & Alibali 2006) and
3. Reliance on procedural knowledge without conceptual understanding (Capraro and Joffrion, 2006; Star 2005; Siegler 2003).

2.4.1 Constructivist Theory to Teaching and Learning

The constructivist theory to teaching and learning has been broadly addressed in a number of researches in mathematics education (Katic, Hmelo-Silver & Weber, 2009; Steele, 1995).

According to this theory, students do not just passively receive information but constantly create new knowledge based on prior knowledge in conjunction with new experiences. As opposed to the traditional approaches where students learn by copying word for word, what teachers say, constructivism has shifted to a more radical conception of teaching and learning whereby the learners' fresh ideas are brought to class, acknowledged, and enhanced through a variety of teaching and learning techniques that actively engage them.

A number of studies have shown the effectiveness of the constructivist approach in teaching and learning in contrast to the traditional drilling and reciting approach (Steele, 1995; Hmelo-Silver, Cindy, Duncan, & Chinn, 2007). A study by Steele, (1995) on "A Constructivist approach to mathematics teaching and learning’’ revealed that using constructivist learning strategies has positive gains. For example, such strategies tend to create an exciting environment for students to learn mathematics and enhance their self-esteem. According to this study, when students learn to construct their own knowledge, they tend to have control of mathematical concepts and think mathematically.

Another study by Katic, Hmelo-Silver & Weber (2009) on Material Mediation, suggests that materials can help to motivate and mediate the participants' collaborative problem-solving discussions. In this study, Katic, et al., teachers used a variety of resources to solve a mathematics problem and construct explanations about the learning process; they, then, posed questions about the problem to clarify their solutions. This is a method that is encouraged in social theories like constructivism, as it generally assists in keeping the learners on task.

Although constructivist learning theory does not tell us how to teach mathematics, a teacher with a constructivist background can facilitate learners' construction of knowledge by applying different constructivist teaching approaches that are in alignment with this learning theory. This type of mathematics teaching forms the basis of this study. Furthermore, researchers such as Fosnot (1989) and Brooks & Brooks (1999) suggest that a constructivist approach to learning builds on the natural innate capabilities of the learner. From this perspective, the learner is viewed as actively constructing understanding through the use of authentic resources and social interaction. Therefore, the focus is on cognitive development and deep understanding in which learning is nonlinear and students are encouraged to freely and actively search for solutions. Consequently, for significant changes to occur, students must be provided with skills to construct understanding. Hence, this study was designed to explore this educational perspective and to provide instructional guidelines to enable students to become more engaged in mathematics instruction.

Based on the studies of Brooks & Brooks (1999) and Fosnot (1989), there are propositions that students construct their own understanding by using prior knowledge to interpret information. In this view, the effective use of authentic resources can aid knowledge construction, and that peer discussion and negotiation is critical to the constructive process. It is the researcher's belief that these are feasible guidelines to be implemented among students to assess whether constructivist activities will improve performance and enhance students' problem solving skills.

2.4.2 Characteristics of Constructivist Teaching and Traditional Ideas about Teaching

The main aim of constructivist teaching is to assist students to take the advantage of their previous experience to construct their own knowledge. The characteristics of a constructivist teaching are as follows.

A constructivist classroom is a student-centered classroom. The student-centeredness of a constructivist classroom is clearly apparent in the teaching and learning of mathematics. In the constructivist classroom, the focus tends to shift from the teacher to the learners (Brooks & Brooks, 1999). One of the teacher's biggest responsibilities becomes that of 'asking good questions'. Again, in the constructivist classroom, both teacher and learners think of knowledge not as inert factoids to be memorized but as a dynamic and ever-changing view of the world we live in and the ability to successfully stretch and explore that view (Brooks & Brooks, 1999).

Recognizing the significance of the unique experiences that each learner brings to the mathematics classroom, the teacher in a response-centred approach seeks to explore the transaction between the learner and the' concepts to promote or extract a meaningful response (Rosenblatt, 1978). This places the student in a central position in the classroom since exploring transaction seems unlikely to occur unless the teacher is willing to relinquish the traditional position of sole authority, thereby legitimating the unique experiences that all members of the class bring to the classroom rather than just those experiences the teacher brings. The resulting perception and effect in the classroom are evident in students' recognition that the discussion is a legitimate one involving questions to which nobody knows the answer. It is not a treasure hunting game where they are trying to guess what is in their teacher's head, but a process that creates meaning and knowledge.

From a constructivist perspective, where the student is perceived as meaning-maker, teacher-centred, text-centred and skills-oriented approaches to mathematics instruction are replaced by more student-centred approaches where processes of understanding are emphasized. In constructivist teaching, instead of treating mathematics as subject matter to be memorized, a constructivist approach treats it as a body of knowledge, skills, and strategies that must be constructed by the learner out of experiences and interactions within the social context of the classroom. A constructivist student-centred approach places more focus on students learning than on teachers teaching. A traditional perspective focuses more on teaching. From a constructivist view, knowing occurs by a process of construction by the knower. Lindfors (1984) advises that how we teach should originate from how students learn. When comparing the traditional teaching methods to the constructivist-based teaching method, Applefield, Hubert & Moalem (2001) stated that in the traditional teaching approach, a bottom-up strategy, which involves isolating the basic skills, teaching occurs by separating and building these incrementally before tackling higher order tasks. This is an essentially objectivist and behavioural approach to instruction (teaching method) although cognitive information processing views often lead to similar instructional practices. Teachers give the input verbally or write on the board and the students follow their teachers' instructions. The effectiveness of the transmission is then tested by posing various exercises to the student. The students are not encouraged to discuss and interact with each other. This environment is mainly controlled by studying with pen and paper (Pierce & Ball, 2009).

According to Fletcher (2003) and Osafo-Affum (2001), irrespective of the level at which mathematics was taught; the role of the Ghanaian mathematics teacher has almost always been that of a lecturer and explainer, communicating the structure of mathematics systematically. Fredua-Kwarteng and Ahia (2015) stated that teaching and learning mathematics in Ghanaian classrooms is still dominated by the "transmission" and "command" models. According to them the learning culture of mathematics in Ghanaian schools are such that: students learn mathematics by listening to their teacher and copying from the chalkboard rather than asking questions for explanations. Consequently, mathematics is learnt by bringing up facts, theorems or formulas instead of probing for meaning and understanding of mathematical concepts. Students hardly ask the logic or philosophy questions underlying those mathematical principles, facts, or formulas.

Students go to mathematics classes with the object to calculate something. Therefore, if the classes do not involve calculations they do not think that they are learning mathematics. So students learn mathematics with the goal to attain computational fluency, not understanding (Fredua-Kwarteng & Ahia, 2015).

As a result, teaching and learning mathematics in the traditional methods do not motivate students; neither does it targets the development of understanding or support student-centred learning. Students are not involved in tackling problems with a number of possible alternative solutions.

In spite of its limitations, it is cheap and does not require much intensive advance lesson preparation on the parts of both teacher and students and can be conducted anywhere.

However, constructivist-based teaching method turns this highly sequential approach on its head. Instead of carefully structuring the elements of topics to be learned, learning proceeds from the natural need to develop understanding and skills required for completion of significant tasks. The distinctions between the traditional teaching methods and the constructivist-based teaching method are reflected in table 1.

Table 1: Distinctions between the Traditional Teaching Methods and the Constructivist-Based Teaching Method

Traditional Teaching Methods	Constructivist-Based Teaching Method
Begins with parts of the whole by emphasizing basic skills.	Begins with the whole and expand to parts.
Strict adherence to fixed curriculum.	Focus is on pursuit of learner questions and interests.
Textbooks and workbooks-oriented.	The use of primary sources and manipulative materials.
Teacher is a provider and learners are passive recipients.	Learning is interactive and builds on what learners already know.
Teacher assumes a directive and authoritative role.	Teacher interacts and negotiates with learners.
Assessment is via testing and emphasis on correct answers.	Assessment is via learner works observations, points of view and tests.
Knowledge is inert.	Knowledge is dynamic and changes with experiences. Process is as important as product.
Learners work individually and independently.	Learners work in groups to facilitate self-construction of knowledge.

2.4.3 Constructivism Use of a Process Approach

What is essentially involved in constructivist strategies and activities is a process approach to learning. Applebee (1993), remarks that "rather than emphasizing characteristics, of the final products, process-oriented instruction focuses on the language and problem-solving strategies that students need to learn in order to generate those products" (p. 5). And as students interact with their teacher and with each other as part of either whole class activities, small group activities, or individual activities, they practice using language in a variety of contexts developing and honing many different skills as they do so.

In a process approach, Langer and Applebee (1987) explain a context is created within which students are able to explore new ideas and experiences. Within this context, a teacher's role in providing information decreases and is replaced by a "strengthened role in eliciting and supporting students' own thinking" (p. 77) and meaning-making abilities. In a process approach to learning, ideas are allowed to develop in the learner's own mind through a series of related, supportive activities; where taking risks and generating hypotheses are encouraged by postponing evaluation; and where new skills are learned in supportive instructional contexts (Langer & Applebee, 1987, p. 69)

Applebee and Langer argue that in such contexts students have the best chances to focus on the ideas they are writing about and to develop more complex thinking and reasoning skills as they defend their ideas for themselves.

Constructivist activities in any subject area can range from very simple to sophisticated and complex depending on the teacher's learning objectives. If a teacher were to devise a constructivist activity, the first thing that she or he would have to do is establish an educational objective. The teacher would then need to think of a meaningful activity which would, at the same time, help students to reach the objective and to explore and construct knowledge based on what they're reading and what they already bring to the activity. The teacher would also need to re-examine the mechanics of how to run a class and would have to entrust a lot to the students. Constructivist teaching is an exceptionally interesting and exciting way to teach because students are involved in learning activities they appear to enjoy, and much more student-teacher contact is possible. It extends one's impact as a teacher.

2.4.4 Negotiation in Constructivist Teaching

Negotiation is an important aspect of a constructivist classroom. It unites teachers and students in a common purpose. Smith (1993) confirms that negotiating curriculum means "custom-building classes every day to fit the individuals who attend" (p. 1). Boomer (1992) explains that it is important when negotiating for teachers to talk openly about how new information may be learned and about constraints such as obligator curriculum. He comments on the meaning of negotiating the curriculum.

Negotiating the curriculum means deliberately planning to invite students to contribute, and to modify the educational program so that they will have a real investment both in the learning journey and the outcomes. Negotiation also means making explicit and then confronting the constraints of the learning context.

Cook (1992) explains why negotiating the curriculum with students is important:

“Learners will work harder and better, and what they learn will mean more to them if they are discovering their own ideas, asking their own questions, and fighting hard to answer them for themselves. They must be educational decision makers. Out of negotiation comes a sense of ownership in learners for the work they are to do, and therefore commitment to it. (p. 16)’’

A constructivist teacher offers his or her students options and choices in their work. Rejecting the common practice of telling students what to do, he or she engages their trust and invites them to participate in a constructivist process that allows them to be involved in decisions about their learning. Students actively involved in their own learning are a vital reality in a constructivist classroom. Students may participate in the construction of the curriculum by negotiating the themes that will be the focus of their work along with the selection of literature from a predetermined range of literature. Students may also participate in the design of their assignments, although the parameters for these may be established by their teacher. Finally, students may have some involvement in the way their assignments are evaluated.

2.4.5 Students and Teachers Interaction in a Constructivist Classroom

Another quality of a constructivist teaching is its interactive nature. Authentic student-student and student-teacher dialogue are very important in a constructivist classroom. Belenky, Clinchy, Goldberger, and Tarule (1986) inform us that constructivists distinguish didactic talk when participants report experiences but no new understanding occurs, from a real talk where careful listening creates an environment within which emerging ideas can grow. Perhaps this defines the difference between teacher talk in a direct instruction classroom and purposeful talk by students in a student-centred constructivist classroom where meaningful discussion occurs and meanings emerge. Belenky et al (1986) explain that in "real talk", domination is absent, while reciprocity, cooperation, and collaborative involvement are prominent. Consequently, constructivist activities in the classroom that focus on speaking and listening promote not only constructivist thought but also important connections between teacher and students.

2.6 Constructivist Activities in Teaching

In the constructivist classroom, students work primarily in groups and learning and knowledge are interactive and dynamic. There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. This is contrary to the traditional classroom in which students work primarily alone, learning is achieved through repetition, and the subjects are strictly adhered to and are guided by a textbook. Some activities encouraged in constructivist classrooms are:

1. Experimentation: students individually perform an experiment and then come together as a class to discuss the results.
2. Research projects: students research a topic and can present their findings to the class.
3. Field trips. This allows students to put the concepts and ideas discussed in class in a real-world context. Field trips would often be followed by class discussions.
4. Films. These provide visual context and thus bring another sense into the learning experience.
5. Class discussions. This technique is used in all of the methods described above. It is one of the most important distinctions of constructivist teaching methods.
6. Constructivist approaches can also be used in online learning. For example, tools such as discussion forums, wikis and blogs can enable learners to actively construct knowledge.

2.7 Summary

In this chapter, a literature survey was carried out to gain further insight into the study. Professional journals, scholarly books and other publications were used to gather information related to the study, providing in-depth knowledge about earlier research activities that have been carried out in the area.

The literature in this chapter denotes that while some approaches can provide students with guidelines to solve word problems, students should be immersed in activities to apply and develop critical thinking skills. Furthermore, background experiences, meaningful social learning context and visual representations must form the basis for knowledge construction. Reviewing various theoretical and empirical studies, aimed at providing guidelines for improving competencies, it was identified that the constructivist approach is more suitable for enhancing a student's performance.

The teaching and learning of algebra involve the combination of approaches and hence enable students to adopt the required concept. The concepts of approaches which are useful in the teaching of algebra, in general, are covered in the literature review.

Problem-solving should not be the only memorization of the facts but should also be based on procedures for the purpose of developing a deeper understanding of mathematical ideas and concepts. The use of the constructivist approach to teaching and learning, which is difficult in nature, helps students to get concepts better.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The purpose of this chapter is to provide the detail description of the methodology that was used in the study. Research methodology, according to Kothari (2004), is a way to systematically solve the research problem. The chapter covers the research design, the target population, sample and sampling techniques, construction of research instruments, pilot study conducted to ascertain the reliability and validity of the research, data collection techniques and data analysis procedure, treatment process, and ethical considerations for the study are discussed.

The study was guided by the following research questions.

- What difficulties do SHS students encounter in translating algebraic word problems to linear equations and vice versa?
- What effects do constructivist-based teaching approach have on students' achievements in algebraic word problems in linear equations?
- What perception do students have on constructivist approach in teaching algebraic word problem?

3.1 Research Design

A research design is an overall plan for collecting data in order to tackle the objectives of the study (Fraenkel & Wallen, 2000). Similarly, the ultimate goal of a good research design is to guide the researcher on the type of data to collect, how to collect, process and analyse them in order to answer the research questions or test the research hypothesis (MacMillan & Schumacher, 2001 p166),. This study used a quasi-experimental research design. Quasi-experimental research is a model that allows researchers to answer critical questions about the relationship between variables by determining whether there are significant differences between variables (Butin, 2010). Specifically, a non-equivalent quasi-experimental design was employed because intact classes of unequal number of students were used and the respondents were not randomly selected and allocated to the groups (Creswell, 2008)

The quasi-experimental research design involving pre-test and post-test was used to investigate the effect of the use of Constructivist as an instructional approach in teaching Algebraic Word Problems on the performance of students. According to Gall, Borg and Gall (2003), a quasi-experimental non-equivalent pre-test and post-test control group research design is the most important research design for investigating cause and effect relationships between two or more variables.

Quasi-experimental is used often in educational research because it is often impossible and sometimes unethical to randomly assign students to settings. In general, the strength of quasi-experimental research lies in their practicality, more feasible and generalizability. However, the quasi-experimental design lacks random assignment which contributes to a reduction in internal validity and casual claims become quite difficult to make. Also, without proper randomization, a statistical test can be meaningless (Shuttlework, 2008).

At the senior high school level, it was very difficult to be allowed to use true experimental design in Ghanaian classroom settings for this study. This was because no school would allow a researcher to disorganize classes assign to students who are already in their various classes into different academic programs for the purpose of research. Due to this, a random assignment of students to groups was impossible. This implies that other research designs that involve randomization were deemed unappropriated and unethical to use for this study.

Consequently, variables of this study were categorized into independent variables and dependent variable. In this study, there were two independent variables, which were the approaches used in teaching and learning Algebraic word problems, thus, the Constructivist approach and the traditional approach. The dependent variable of this study was students' scores on Algebraic word problems achievement test (WPAT) while the possible covariate of this study was students' scores on readiness test for word problems concepts (RWPC). These scores were analysed to establish whether a significant difference exists between the control group and experimental group or not.

In summary, the quasi-experimental design chose for this study is the non-equivalent 'pre and post' test with treatment. Two non-equivalent intact-classes of SHS form one students were used in the study. These comprise of Constructivist learning group and Traditional/ Control Group.

The basic design of the study showing how each group was involved is shown in Figure 3.1.

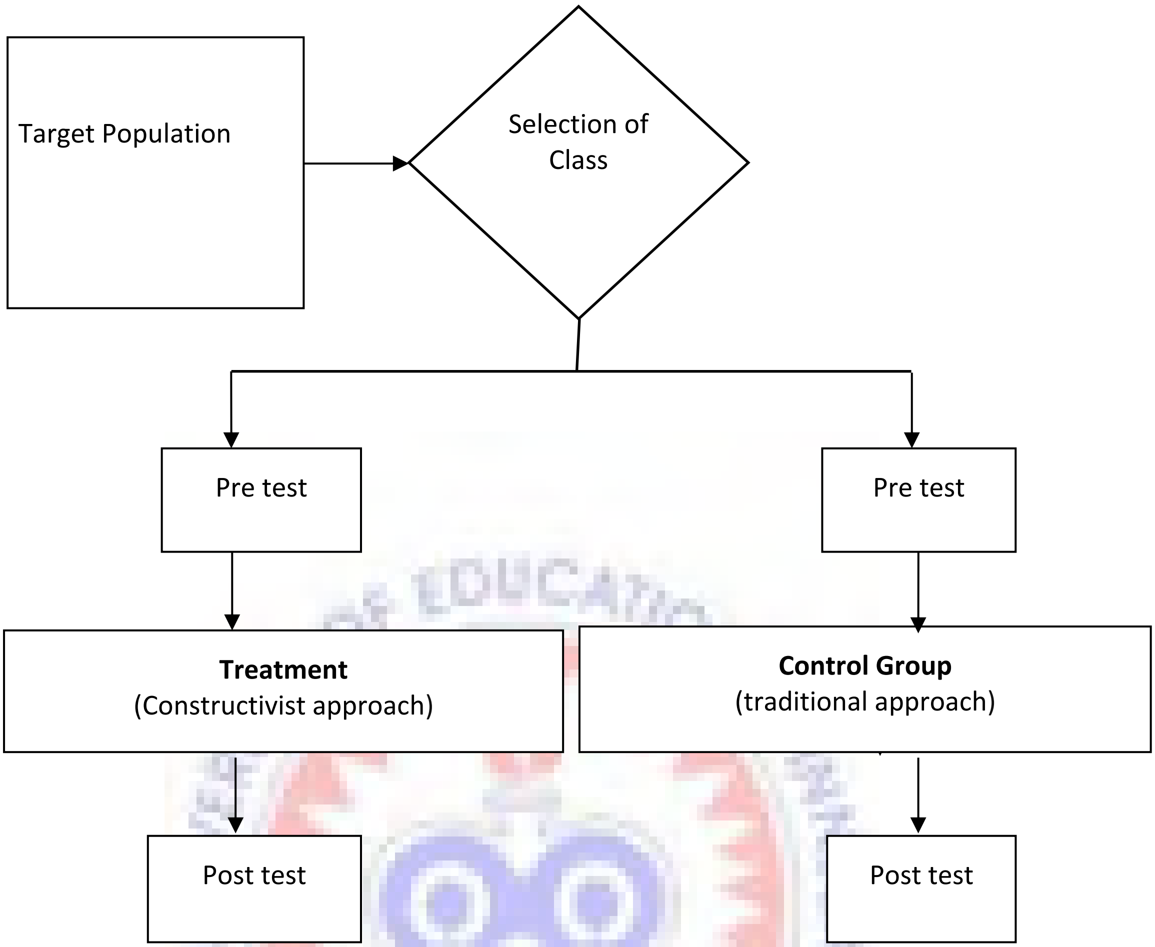


Figure 3.1: Basic design of the study

It can be deduced from the Figure 3.1 that the basic design of the study consists of four phases. These phases are pre-test stage, treatment stage, post-test and administering qualitative instruments (i.e. interview guide). The first phase was the pre-test which was carried out simultaneously on all the groups before administering the treatment. The second phase is the treatment stage of which the experimental group was taught using Constructivist approach while the control group was taught using traditional teaching methods. Next, the third phase was the post-test to both groups after three weeks of treatment. After the respondents went through the three phases, the test results were evaluated to determine whether Constructivist as an instructional approach affect student achievement in Algebraic word problem or not.

3.2 Population

The target population for this study was all first-year Senior High School 1 (SHS1) students of 2017/2018 academic year in the Central Region of Ghana. The accessible population consisted of a set of first-year students of Potsin T.I Ahmadiyya Senior High School in Gomoa East in the Central Region of Ghana The classes are 1GA3A and 1SC2, The reason for choosing the classes was that most of the mathematics teachers were of the view that the Science classes do far better than the General Arts classes hence the study to verify how wide is the difference with the implementation of the treatment.

3.3 Sample and Sampling Procedure

A purposive sampling technique was used to select two classes (1GA3A and 1Sc2). Creswell (2009) stated that purposive sampling is employed because of the special characteristics of the school in facilitating the purpose of the research. In purposive sampling, the units of the sample are selected not by a random procedure, but they are intentionally picked for the study because of their distinctive characteristics. In all, two intact classes were selected for the research one from the General Art programme and the other from the General Science programme by using purposive sampling technique.

The reason for selecting the intact classes from each programme was that all the lessons were taught during the instructional time. Also, the intact classes were used for study so that the contents treated would be beneficial to the entire class. Further, the usage of the entire class was to avoid disturbance during the school session. The form one classes were used because the topic treated in the study was among the form one topics in the mathematics syllabus for SHS and the school would not allow me to teach or reteach this topic in the other forms.

The rationale for the selecting of these programs was that traditionally the General Art classes have been classes whose students do not show much interest in the study of mathematics whereas the Sciences show much interest and that I would like to find out how wide the difference is. The sample size consisted of 92 students in the pre-test and 92 students in the post-test. The control group in the pre-test were 43 which was made up of 15 girls and 28 boys and the experimental group in the pre-test was 49 which was made up of 17 girls and 32 boys, also in the post-test the control group was 43 which was made up of 15 girl and 28 boys the experimental group was 49 made up of 17girls and 32boys. After the initial mathematics achievement test (pre-test) which was administered, the outcome of the test disclosed that both the students in the control and experiment group were comparable in aptitudes before the treatment was administered.

3.4 Research instruments

In view of the nature of research questions, two instruments thus achievement test and interview guide were used in gathering the data for the study. The achievement test was used to collect quantitative data while an interview guide was used to collect qualitative data. The qualitative data and results were used to assist in explaining and assigning reasons for quantitative findings. Each group (control and experimental) was given a pre-test before the treatment. After three weeks, a total of 12 hours treatment lesson (constructivist teaching by the researcher) and (traditional teaching approach by the control class teacher) was delivered to each group (control and experimental) a post-test was administered to both group duringthe fourth week.

3.4.1 Achievement Tests (Pre-Test and Post-Test)

The items on the teacher-made achievement test were constructed based on the lesson taught and the learning objectives in the SHS mathematics curriculum. The aim of this instrument was to provide a measurement of achievement. The teacher made-achievement test was preferred in this study to other types of tests due to the following reasons: it reflects instruction and curriculum; it is sensitive to student's ability and needs; it provides immediate feedback about student progress; and finally, it can be made to reflect small changes in knowledge (O'Malley, 2010).

The pre-test and post-test were each comprises of 2 parts Part 1 contains 10 multiples choice objectives questions and part 2 contain 5 essay questions. With the 10 multiple choice objectives part, the first 5, students were expected to select the responses most matching mathematical algebraic word problem sentences, the remaining 5, students were expected to translate algebraic mathematical sentences to an algebraic word problem. Finally, students were expected to solve all the 5 questions in the second part. Learners are expected to spend 80 minutes in both sections in the pre-tests and post-tests .Each question in part 1 carries 3marks a total of 30marks for part 1. Each question in part 2 also carries 4 marks and a total of 20 marks for part 2. In all, a total mark of 50 was awarded for the work. See Appendix E for the pre-test and the marking scheme for scoring the test. The pre-test was done to determine the initial entry points and compare the difference between the experimental and control group before treatment. See Appendix G for the post-test and the marking scheme for scoring the test. Post-test was used to measuring the students' achievement after the treatment.

3.4.2 Interview Guide

An interview is a tool for particular questions to be proposed by the researcher who manages the line of questioning so as to acquire a certain response (Creswell, 2009). Interviewing is one of the most influential techniques employed in an effort to comprehend an individual's perspective, beliefs and values. As a result of its interactive nature, interviewing has many benefits over other kinds of data gathering methods such as questionnaire (Best & Kahn, 2003; Legard, Keegan & Ward, 2003).

Aside from the achievement test, a semi-structured interview was used to address the research question: 'What are the views of students about the use Constructivist approach in teaching and learning of algebraic word problem?' According to Bryman & Bell (2007), a semi-structured interview follows a list of concerns and questions that the researcher wishes to cover during a period. The reason for choosing the semi-structured interview technique is basically due to researcher aim to encourage the interviewees to freely discuss their own views on the Constructivist approach of teaching Algebraic word problem. This method with open-ended questions allowed the researcher to adjust his questions depending on the attributes of the specific student and the given type of views they expressed. Semi-structured interviews provide the opportunity to regulate the order of the questions and the respondents have the possibility to expand their ideas and speak in great detail about diverse subjects rather than relying only on concepts and questions defined in advance of the interview (Bryman & Bell, 2007). In other words, semi-structured interviews are more flexible than standardised methods such as the structured interview or survey. Also, this semi-structured interview was chosen in this study to other qualitative instruments due to the following reasons: interviewees get the opportunity to check what is meant by a question and allows for long and complex responses; it has some flexibility making possible changes in the order of questioning, the questions asked and the topics discussed; it gives chance for probing follow up questioning seeking clarification or further explanation and finally, it provides in-depth inquiry (Merton, Fiske, & Kendall, 1996). However, one general problem when conducting qualitative interviews, with open-ended questions, is that the interview is characterised by the interest and opinions of the interviewer. Semi-structured interviews are rather organized in terms of what issue will be discussed during the interview but the follow-up questions will be depending on the opinions of the interviewer. Another problem that can occur is misunderstandings and misinterpretations of words. This could be no problem within this research since interviews have been conducted in English which students easily expressed themselves in. Nevertheless, in order to increase the reliability of the interview results, the items on the interview guide were strictly followed. All interviews have been recorded, subsequently transcribed material have been read to the respondents, statements have been amended according to the respondents´ comments and finally, the material has been approved by the interviewees.

The semi-structured guide containing 15 items (See Appendix H) was used to elicit information on the students' impressions about the use of the constructivist approach to teaching algebraic word problem, whether or not they enjoyed learning with the constructivist teaching approach and environment, new things they learnt, their challenges and recommendations. This interview helped in assigning and explaining the quantitative result.

3.5 Treatments of groups

The constructivist approach was applied to the experimental group whereas a traditional method of instruction was applied to the control group throughout this study. These approached are described in this section.

3.5.1 Control design: The traditional approach

This term was used in this study to refer to the teaching using chalk and board for teachers; pen and paper for students. The teacher gives the input verbally or writes on the board and the learners strictly follow the instruction the teacher gives and active participation of the students were not encouraged. The instruction involves lessons using lecture/discussion method to teach Algebraic Word Problem by their teacher. Teaching strategies relied on teacher explanation and textbook, with no direct consideration of the student's alternative conceptions. The students studied their textbook on their own before the lesson time the teacher structured the entire class as a unit solved examples on the chalkboard defined few keywords. The primary underlining principle was that knowledge resides with the teacher and that it is the teacher's responsibility to transfer that knowledge as fact to students. The majority of instruction time (75%-85%) was devoted to instruction and engaging in discussion stemming from the teacher's explanation and questions and solutions. The remaining time was spent on a worksheet study. Trials and exercises developed specifically for each lesson were used as practice activities they required solutions reinforced the concepts presented in the classroom sessions. While the students were studying worksheet exercises, the teacher circulated and provided assistance if needed. The students had the opportunity to ask questions, and worksheets were collected and corrected by the teacher, and the students reviewed their sheets after correction. This classroom typically consisted of the teacher presenting the fright way to solve the problems.

3.5.2 Experimental design: Constructivist approach

To promote change in the study of algebraic word problems Constructivist based teaching approach learning was prepared by the researcher and used with the experimental group lasting three (3) teaching weeks and 2weeks for the pre and post-tests. Series of treatment activities were planned by the researcher to improve the understanding of the students in algebraic word problems due to the non-performance of the students in the Pre-test. The challenges students encountered when translating the word problems into linear equations and vice vase had to be addressed. The activities were therefore put in place and implemented based on the outcome of the pre-test, which revealed that most of the students had problems in the area of understanding the algebraic word problems and hence translating them into linear equations before finally solving them.

The treatment process lasted for 3 weeks. The first week was used to administer the test items designed for the pre-test. The first step to identify students' difficulties through constructivism was to listen to what the students found interesting or difficult about algebraic word problems in the pre-test. Until this point, the students had not been provided with the level of choice necessary for students' interest and difficulties to develop as a starting point to address their learning needs. The researcher engaged the students in a roundtable discussion about what they found interesting or enjoyable or difficulties regarding algebraic word problems. This process was not easy, as many students had never had a question such as this posed during their schooling. This was challenging for many of the students, who frequently responded with statements such as "I'm not sure" or "I've never thought about it" and "Well, I'm good at addition, so I guess that's my favourite." "Solving linear equations is not difficult for me but then making sense of phrases like twice a certain number confused me a lot I don't get it". "The words….in 12 years' time, and she will be twice as old…. Consecutive number get me confused".

In the third week, the researcher took the opportunity to introduce the concept of algebraic word problems to the students using the appropriate terminologies in order to address the difficulties that were mentioned by the students and were identified by the researcher. The researcher based the teaching on the observations made during the roundtable discussion with the students and also from the result of the pre-test conducted. The researcher introduced the students to the use of constructivists based teaching in an algebraic word problem. The step the researcher took was to enhance the classroom environment toward a constructivist approach. For example, the researcher adjusted the existing physical arrangement (layout) away from idle rows used for the copying notes and lessening the use of pencil and paper towards a more active classroom. The new classroom layout specifically allowed for workspace and socialization and students are encouraged to think and explain their reasoning instead of memorizing and reciting facts.

In the fourth week, the researcher developed a completely new approach to teaching by designing comprehensive lessons using the constructivist approach. A constructivist classroom required a great deal of effort. The researcher's behaviour became more and more interactive although he was still the master of the subject- based content. Initially, the researcher did not abandon all of his previous traditional thematic units, instead of how he employed these resources changed.

In the fifth week, the students went through another set of questions designed by the researcher, to ascertain their understanding of the concept of algebraic word problem (Post-Test). Table 3.1 shows the differences in the two approaches of teaching algebraic word problem.

Table 2 Differences between constructivist-based and traditional classroom teaching approaches of teaching algebraic word problem.

Traditional Classroom	Constructivist Classroom

1.	Begins with parts of the whole – emphasized basic skills	Begins with the whole expanding to parts
2.	Strict adherence to fixed curriculum Textbooks and workbooks	Pursuit of student questions / interests Primary sources /manipulative material Learning is interaction-building on what students already know
3.	Instructor gives/ students receive Instructor assumes directive, authoritative	Instructor interacts/ negotiates with students
4.	Role	Point of view, tests, process is an important as product
5.	Assessment via testing/ correct answers	Assessment via student Works, observation
6.	Knowledge is inert	Knowledge is dynamic/ changes with experiences
7.	Students work individually	Students work in groups

Table 2 presents the differences between constructivist-based and traditional classroom teaching approaches to teaching algebraic word problem. It is observed that, in the traditional classroom, there is a strict adherence to a fixed curriculum while in a typical constructivist classroom, learning is related to the previous knowledge of students. Also, in the traditional classroom, learning is teacher-centred while the constructivist classroom is student-centred. Assessment in the traditional classroom is based on testing/correct answers while that of the constructivist classroom is based on students' works and observation. Knowledge in the traditional classroom is inert while that of the constructivist classroom is dynamic and changes with time.

Table 3 Structure of the constructivist-based lesson plan used with the experimental group

Lesson stages	Planned activities (in a CBTM lesson)

INTRODUCTION	✓	Researcher introduces topic to class;
(20 min)	✓	Explanation of key terms and concepts;
	✓	Questions asked to assess learners' prior knowledge of the topic; and,
	✓	Researcher establishes the difficulties students encounter and algebraic skills of learners.
BODY	✓	Learners arranged in groups;
(35 min)	✓	Example sheets given to groups;
	✓	Learners discuss solution steps;
	✓	Researcher monitors group discussion; and,
	✓	Self-explanation activity and probing takes place.
CONCLUSION	✓	Reflection;
(25 min)	✓	Class work/ group discussion of activity;
	✓	Evaluation of success rate;
	✓	Reflection on the lesson with more problems/tasks; and, Homework is given.
	✓	Homework is given.

Table 3 shows a constructivist-based lesson plan used in the experimental class. The lesson plans was categories into three (3) stages namely: introduction, body and conclusion.

The introduction stage elaborates on some activities the researcher took to introduce the concept. These involved explanations of key terms, asking students questions in order to assess their previous knowledge of the topic. The body comprised of the researcher grouping students into groups, giving out example sheets, and engaging students in group discussion. In the concluding stage, the researcher reflects on the topic and give students class work in order to evaluate the success rate. The researcher finally give students homework to bring the lesson to an end.

Table 4 The intervention schedule of activities in the classroom

Week	Activity (ies)	Remarks
Week 1	Pre-test assessment	Every student participated
Week 2	Discussion of the pre-test	Students discussed their difficulties with the researcher
Week 3	Introduce the concept of algebraic word problems Student's interact with the series of intervention activities	Students participated in the lesson
Week 4	Practical teaching using constructivist approach	Successfully done
Week 5	Assessment of intervention (post-test)	Every student participated

Table 4 presents the intervention schedule of activities in the classroom the researcher used in teaching out the treatment class. The researcher used a period of five (5) weeks for the intervention stage within which a pre-test was carried out to ascertain the difficulties of students. An intensive teaching was carried out using the constructivist teaching approach. Finally, the researcher organised a post-test to determine the effect of the constructivist teaching approach.

3.6 Validity and Reliability of the instruments

The validity of a test instrument is the extent to which the items in an instrument measures what it is set to measure. Validity is the exactness and precision of deductions based on the findings from the research (Mugenda & Mugenda, 2003). If a test does not serve its intended function well, then it is not valid. The validation of the instruments was carried out to check the correctness of the data collection instruments during the pilot study. This checks the appropriateness of the data collection instruments thus achievement test, and interview guide.

With regard to content validity, the test was constructed based on the instructional objectives of the lessons taught and the specific objectives in SHS mathematics curriculum to ensure the content validity. Also, comments were made about the content of the research instruments by the researcher's supervisor and were found to be acceptable. Test items were also given to some of SHS mathematics tutors to cross-check and contribute to the content areas that were tested in this study in order to further ensure that the content that was chosen was within the approved domain of the study for the SHS students concerned. Moreover, sixty-one (61) students were selected from one of the second year classes in a sister SHS (Apam Senior High School) and were asked to answer the test items, mainly to detect lack of clarity in the phrasing of the questions, and to give an indication for the time needed for its completion. This helped to refine these instruments. The interview guide was also examined and corrections made by the researcher's supervisor. Some M.Phil. Mathematics Education students also read through the interview guide and made suggestions that were incorporated before use.

On the other hand, reliability is the extent to which items in an instrument generate consistent responses over several trials with different respondents in the same setting or circumstance (Fraenkel & Wallen, 2000)

A Reliability test was carried out with the purpose of testing the consistency of the research instruments so that research instruments will be improved by revising or deleting items. To determine the reliability of the instrument the pilot study was conducted. Piloting determines whether questions and directions are clear to respondents/subjects and whether they understand what is required from them. Piloting is done to determine the feasibility of using a particular research instrument in a major study. It provides an opportunity to try out the instructions for completion of the instrument, especially if it is being used for the first time. Piloting entails a trial administration of a newly developed instrument in order to identify flaws and time requirements (Shilubane, 2010).

The researcher piloted the instrument on a small sample of 61 form one SHS students of Apam Senior High School. The piloting was done in this school because it has the same characteristics as one sampled for the study.

One of the advantages of conducting a pilot study is that it might give advance warning about where the main research project could fail, where research protocols may not be followed, or whether proposed methods or instruments are inappropriate or too complicated (Van Teijlingen, Rennie, Hundley & Graham, 2001). The instruments for the study were analyzed for consistency with the help of some mathematics education senior members in UEW-Winneba before they were piloted using one mathematics facilitator and 61 first-year mathematics learners at Apam S.H.S. The feedback of the pilot helped to improve the quality of the test instruments in terms of content coverage content validity and reliability. The test yielded a reliability coefficient of o.74 using Cronbach‟s Coefficient Alpha test. According to Mugenda and Mugenda (2003), the coefficient is high when its absolute value is greater than or equal to 0.7: otherwise, it is low. A high coefficient implies a high correlation between variables indicating a high consistency among the variables. No changes were deemed necessary in instruments because the researcher realized that questions students could not answer were not due to the ambiguity of questions but due to their low conceptual knowledge.

3.7 Data Collection Procedure

The research instruments were administered personally by the researcher to the respondents. A consent letter was attached to the introductory letter duly signed by the Head of the Mathematics Education Department at University of Education, Winneba was given to the headmistress of Potsin T.I Ahmadiyya Senior High School, the participating school. The headmistress willingly agreed to the request and gave the researcher acceptance letter. The acceptance letter opened the gate for data collection. The introduction letter and the acceptance letters are presented in Appendix A and B. A date was then fixed for the commencement of the study. A week before the main study, the pre-test was administered, marked and analysed to determine the entry level of each group, readiness and difficulties students faced in solving algebraic word problems. The main study took three weeks. Each week the researcher and the facilitator met the students in each class (control and experimental groups) twice for lessons, subjecting the experimental group to the constructivist approach and the other to the traditional approach. The groups of students were taken through the treatment. Lessons were designed on the algebraic word problem. During the teaching and learning stage, students were given one or two assessment questions in class to assess their short-term learning in each class lesson and were done for both control and experimental groups. These class exercises were marked by the researcher. Although, the scores in the class exercises were not added to the final scores of the post-test for the data analysis, yet the class exercises helped them in the post-test.

The data was in the form of pre-test and post-test each lasted for 1hour 20minutes. After the administration of the post-test in the last week, a 20 minutes interview was also conducted with four students from the treatment group to find out their views and perceptions about the constructivist teaching approach. The interviewees were assured of confidentiality and also given code names in order to prevent the exposure of their identities. Prior to each interview session, the interviewees and the researcher agreed on the time and venue of the interview. The permission of each interviewee was also sought before the interview sessions were recorded.

3.8 Data analysis

Descriptive statistics such as means, standard deviations, percentages, tables and bar charts were used to describe the general performance of students in both groups in the pre-test and post-test. Box plot and bar chart were used to give a pictorial representation of the performance of the students in the achievement tests. A pair sample t-test was used to test the null hypothesis. The purpose was to determine whether there were statistically significant differences between each student's scores in the pre-test and post-test.

Additionally, Cohen's d effect size estimates were calculated in which values of 0.20, 0.50, and 0.80 represent differences of small, medium, and large effect, respectively (Cohen, 1992).

Cohen's d is given by the formulae $= \frac{M_1 - M_2}{\sqrt{\frac{S_1^2 + S_2^2}{2}}}$; where M_1 and M_2 are the sample mean of the two groups and $\sqrt{\frac{S_1^2 + S_2^2}{2}}$ is known as the pooled standard deviations for the two groups.

$r = \frac{d}{\sqrt{d^2+4}}$; where r is the correlation coefficient.

Test of Assumption for the Pair Sample t-test

The pair sample t-test is a parametric test and therefore there are some assumptions that need to be met before it is used to analyse any quantitative data. The data that were collected in this study warranted the use of independent sample t-test due to the following motives. The scores from the achievement test were interval scale and continuous. Again, the distributions of the data for both pre-test and post-test scores were approximately normal (see Appendix J). The normality of the data was checked using Q-Q plot as part of the descriptive statistics.

Another assumptions that need to be met before the t-tests was used, was homogeneity of variance.

Table 5: Homogeneity of variance test for Pre-test and Post-test

	F	**Sig.**	
Pre-test scores	Equal variances assumed	.174	.702
	Equal variances not assumed		
Post-test scores	Equal variances assumed	.670	.415
	Equal variances not assumed		

The results in Table 5 reveals that the variances are equal since the p-values recorded are all greater than the alpha value of .05. This suggests that the homogeneity of variance assumption for running pair sample t-test was not violated.

In addition, interview data were collected from the students in the experimental group after the post-test to answer the research question “What are the views/perceptions of students about the use of constructivist approach in teaching and learning algebraic word problem?” The interview guide which focused on students’ experiences and opinions on the use of constructivist instruction and reflected their views about their participation in the lesson. All interviews were audio-taped, transcribed and analysed also, verbatim quotations were used to support the discussions.

3.8 Ethical considerations

Shamoo and Resnik (2009) defined ethics in research as the discipline that studies standards of conduct, such as philosophy, theology, law, psychology or sociology. In other words, it is a method, procedure or perspective for deciding how to act and for analyzing complex problems and issues. Protection of participants and their responses were assured by obtaining informed consent, protecting privacy and ensuring confidentiality. In doing this, the description of the study, the purpose and the possible benefits were mentioned to participants. The researcher permitted participants to freely withdraw or leave at any time if they deemed it fit. As a way of preventing plagiarism, all ideas, writings, drawings and other documents or intellectual property of other people were referenced indicating the authors, title of publications, year and publishers. In the case of an unpublished document, permission was sought from the owners.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents and discusses the results of the study. The purpose of the research work was to investigate the effect of constructivist approach on senior high school students' achievement in algebraic word problems and linear equations as well as the difficulty they have with such problems. Data was collected using pre-test, post-test and interview guide. The data obtained were organized and presented using descriptive statistics including frequency tables, standard deviation, minimum and maximum scores, measures of central tendency and inferential statistics including Independent Sample t-test. The results are presented and discussed in this chapter according to the research questions, which are:

- What difficulties do SHS students encounter in translating algebraic word problems to algebraic linear equations and vice versa?
- What effects do constructivist-based teaching approach have on students' achievements in algebraic word problems and linear equations?
- What perceptions do students have about the use of constructivist approach in teaching word problem

4.1 Demographic characteristics of the participants

The number of students who participated in the control and experimental groups of the study is presented in Table 6. In all, 92 students were engaged in the study with 43 students in the control group and 49 students in the experimental group. Of the 43 students in the control group, 15, which represents (35%), were female and the rest of 28, which represents (65%), were male. Again, concerning the experimental group of 49 students, 17, which represents (35%), were female while 32 representing (65%) were male. The average age of the students in both control and experimental groups was 16 years.

Table 6 Gender of participants

Gender	Control Group		Experimental Group		Total	
	N	%	N	%	N	%
Female	15	35	17	35	32	100
Male	28	65	32	65	60	100
Total	43	100	49	100	92	

Source: Field work, 2018

4.2 What difficulties do SHS students encounter in translating algebraic word problems to algebraic linear equations and vice versa? (Research Question1)

In an attempt to answer research Question 1, the researcher analysed the results of the pre-test with the aim of finding out the difficulties students encountered in the multiple choice part of the test in translating algebraic word problems to linear equations and vice versa. The researcher also made an in-depth analysis of the students' responses in the show working or constructed response part of the test in order to identify their difficulties in solving a word problem. The difficulties were classified and discussed under the following four (4) subcategories:

- students attempting but demonstrating misunderstanding of the problem
- students attempting and unable to translate problem into algebraic model or equation(s)
- students attempting but fail to solving the equation to reach the solution

- students attempting to solve the equation but failing to use the right methods or making errors.

4.2.1 Students attempting but demonstrating misunderstanding of the problem

Table 7 presents the distribution of students attempting but demonstrating of the problem. After critically reviewing students' responses, the researcher found out that some students demonstrated misunderstanding of the problem.

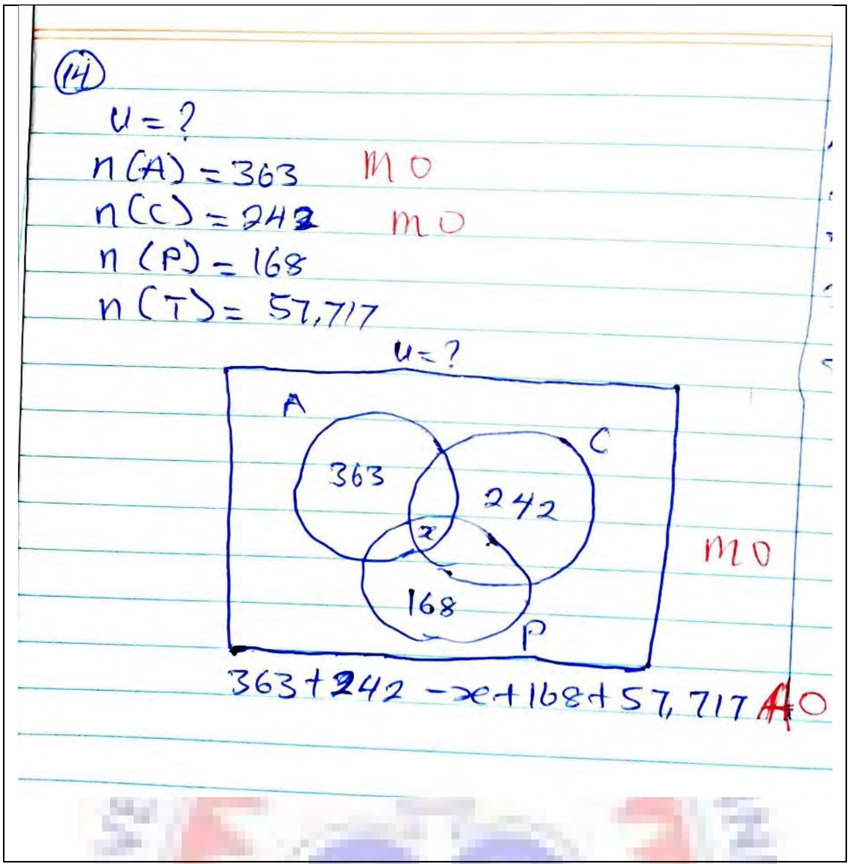
Table 7 Distribution of students attempting (N=number of students) but demonstrating misunderstanding of the problem

Item	Attempted question (N=92)	Understanding the problem			
		Have difficulty		Have no difficulty	
		N	%	N	%
Q11. The sum of four consecutive even numbers is twenty. What are the numbers?	92	62	67	30	33
Q12. The product of two integers is twelve, and one of the integers is one less than the other. What are the two integers?	92	80	87	12	13
Q13. A woman is six years older than five times her son's age. The sum of their ages is forty-eight. How old is the son?	92	77	84	15	16
Q14. Tickets for a flight from Accra to Kumasi are $363 for adults and $242 for children. A plane took off with a full load of 168 passengers, and the total ticket sales were $57,717. How many adults and how many children were aboard?	92	88	96	4	4
Q15. A hundred and eighty-meter cable must be cut into three pieces. The second piece must be three times as long as the first. The third piece must be forty meters longer than the first. Find the length of each piece.	92	89	97	3	3

Overall, the students were required to solve five (5) Algebraic word problems in linear equations. The results as illustrated in Table 7 revealed that all students attempted all the questions but not all were able to demonstrate an understanding of the problem. On

Question 11, only 33% (N = 30) of students demonstrated a clear understanding of the problem. For Questions 12 and 13, only 13% (N =12) and 16% (N = 15) of students respectively were able to demonstrate a full understanding of the word problems. For questions 14 and 15 which involved multiple steps and required higher critical thinking, only 4% (N = 4) and 3% (N = 3) of students respectively were able to demonstrate understanding. These findings revealed that an average of 86% of students do not understand the problem they have been asked to solve. Understanding the problem, the first step in problem-solving, according to Poyla (1957), is a major difficulty for most students. They cannot comprehend the requirements of the problem and seem to lack the mathematical experiences needed to understand the problem (see Appendix __for the graphical illustration of students attempting but demonstrating misunderstanding of the problem).

The exhibit in Box 1 is a sample of a student's response to Questions 14 showing a complete lack of understanding of the problem.



Box 1

Here, it is observed that, the student deviated from the main concept of the question which suggests that, he/she does not understand the problem. Therefore, it can be said that understanding of the problem is one of the students' difficulties in solving algebraic word problems.

4.2.2 Students attempting and unable to translate problem into algebraic model or equation(s)

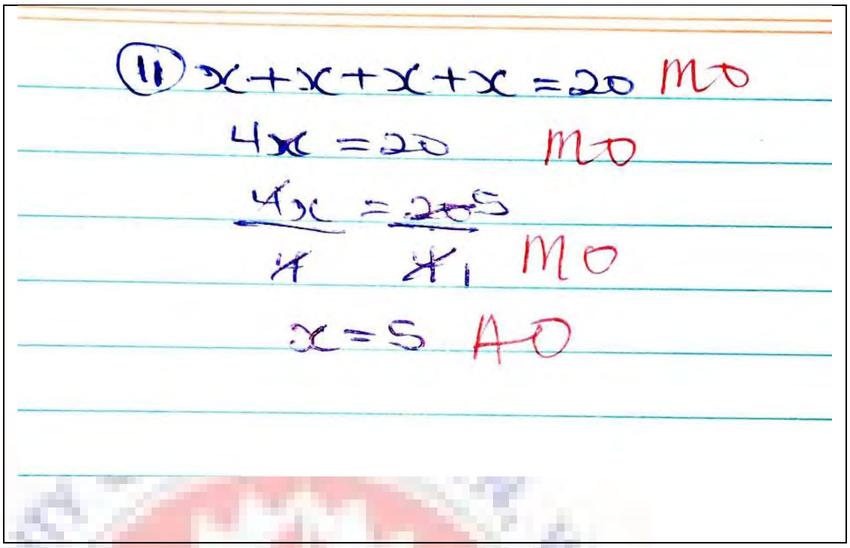
The distribution of students attempting and unable to translate problem into algebraic model or equation is presented in Table 8.

Table 8 Distribution of students attempting and unable to translate problem into algebraic model or equation(s) (N=number of students)

		Translating the problem			
		Have difficulty		Have no difficulty	
Item	Attempted (N=92)	N	%	N	%
Q11. The sum of four consecutive even numbers	30	5	17	25	83
Q12. The product of two integers	12	7	58	5	42
Q13. The sum of ages of a woman and her son's	15	6	40	8	60
Q14. Tickets for a flight from Accra to Kumasi for adults and children.	4	3	75	1	25
Q15. A hundred and eighty-meter cable cut into three pieces of varying lengths.	3	0	0	3	100

The results in table 8 suggest that, on the category of translating a word problem into an algebraic model, about 30 students attempted question 11. Out of this number, 83% (N = 25) of students successfully translated the given problem into the algebraic equation while the remaining 17% (N = 5) attempted but were unable to do it right. With regards to question 12, only 12 students made an attempt and 42% (N = 5) had it right while the remaining 58% had it wrong. Moving on to question 13, only 15 students made an attempt to translate the word problem into an algebraic model and 60% (N = 8) of them did it successfully. Interestingly, only 4 students attempted question 14 while 3 students attempted question 15. Of the 3 students that attempted question 14, only 1 did it right while all the 3 students that attempted question 15 had them right (see Appendix ___for the graphical representation students attempting and unable to translate problems).

The exhibit in Box 2 is a sample response of students who attempted and unable to translate the problem into an algebraic model or equation.



Box 2

In answering question 11, the student was not able to translate the word problem into an algebraic equation. It can be seen that the student understands the concept but he/she had difficulty in writing the correct algebraic expressions that model the problem.

4.2.3 Students attempting but fail to solve the equation to reach the slolution

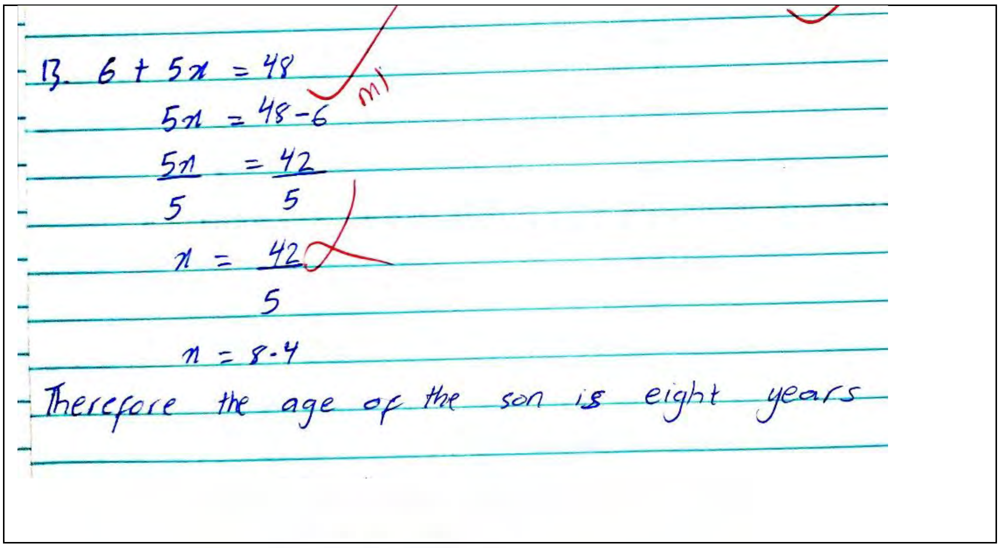
Table 4 shows the distribution of students attempting but failing to solve the resulting equation from the problem. The researcher identified a group of students who successfully translated the problems into algebraic equations but failed to solve them.

Table 9 Distribution of students attempting but failing to solve the equation to reach the solution (N=number of students)

Item	Attempted	Solving the problem			
		Have difficulty		Have no difficulty	
	(N=92)	N	%	N	%
Q11. The sum of four consecutive even numbers	25	6	24	19	76
Q12. The product of two integers	5	2	40	3	60
Q13. The sum of ages of a woman and her son's	8	2	25	6	75
Q14. Tickets for a flight from Accra to Kumasi for adults and children.	1	1	100	0	0
Q15. A hundred and eighty-meter cable cut into three pieces of varying lengths.	3	0	0	3	100

A close look at Table 9 revealed that 25 students attempted to solve the equation in question 11 and 76% (N = 19) of them did that successfully. On question 12, 5 students made the attempt to solve the resulting equation out of which 60% (N = 3) were able to solve the equation right. Moving further to question 13, only 8 students attempted to solve the algebraic equation and 75% (N = 6) of them were able to solve the equation successfully. Only 1 student attempted question 14 and had it wrong whereas 3 students made an attempt on question 15 and they were all able to solve the equation (see Appendix ___for the graphical representation of students attempting but failing to solve the equation to reach the solution).

The exhibit in Box 3 is a sample response of students who attempted but failed to solvethe equation.



Box 3

Box 3 presents a sample response of students attempting to solve the equation. It is observed that the student was able to translate the word problem into an algebraic equation. However, the student had difficulty in solving the resultant equation. This revealed one of the difficulties students face as they solve an algebraic word problem. The findings are consistent with WAEC (2012) Chief Examiner Report which indicated that students' performance in WASSCE core mathematics, most students avoided the questions on algebraic word problem and the few who attempted it; many were unable to solve the problem accurately because they were not able to write correct algebraic equation needed to solve the problem.

4.2.4 Students attempting to solve the equation but failing to use the right methods or making errors

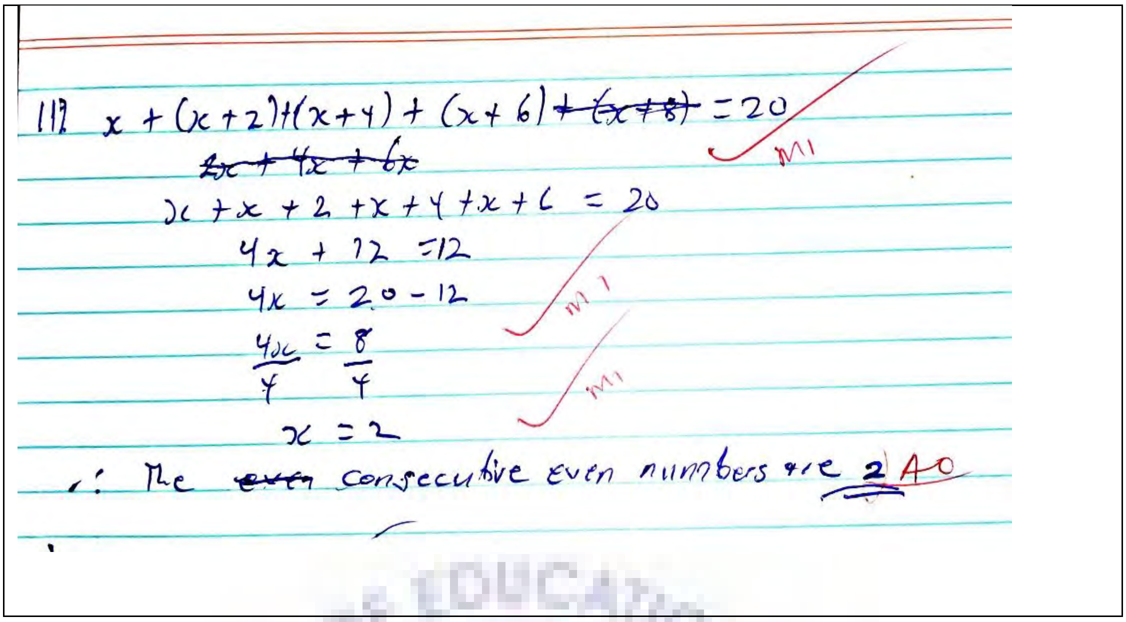
The distribution of students attempting but failing to use the right methods is presented in Table 10. After a critical review of students' responses, the researcher identified a group of students who attempted but failed to use the right methods.

Table 10 Distribution of students attempting but failing to use the right methods to reach the solution for the equation (N=number of students)

Item	Attempted (N=92)	Obtaining solution: Have difficulty N	%	Have no difficulty N	%
Q11. The sum of four consecutive even numbers	25	11	58	8	42
Q12. The product of two integers	5	2	67	2	33
Q13. The sum of ages of a woman and her son's	8	5	83	1	17
Q14. Tickets for a flight from Accra to Kumasi for adults and children.	1	0	0	0	0
Q15. A hundred and eighty-meter cable cut into three pieces of varying lengths.	3	0	0	3	100

In Table 10 the researcher further sorts to find out the students who attempted to solve the equation but failed to use the right methods to reach a solution. It was observed that out of the 25 students who attempted to solve question 11, only 42% (N = 8) were able to reach a solution for the equation using the right methods. On question 12, out of the 5 students who made the attempt, only 33% (N = 2) successfully arrived at a solution for the equation using the right methods. Question 13 had only 8 students attempting to solve the equation. Out of these, only 1 student obtained the right solution for the equation. The only student who attempted to solve question 14 failed to arrive at the solution whereas the 3 students who attempted question 15 successfully obtained the required solution (see Appendix ___for the graphical illustration of students attempting but failing to use the right methods to reach the solution for the equation).

The exhibit in Box 4 is a sample response of students who attempted but failed to use the right methods to reach the solution for the equation.


11) x + (x+2)+(x+4) + (x+6) + ~~(x+8)~~ = 20 M1
~~2x + 4x + 6x~~
x + x + 2 + x + 4 + x + 6 = 20
4x + 12 = 12
4x = 20 - 12 M1
4x/4 = 8/4 M1
x = 2
∴ The ~~even~~ consecutive even numbers are 2 A0

Box 4

Box 4 shows a typical example of students attempting to solve the equation but failing to use the right methods to reach the required solution. It is observed that the student understood the concept and successfully translated the problem into an algebraic equation. He/she solved the equation but failed to use the right method to reach the solution as required. Again, this demonstrates one of the difficulties students face as they solve algebraic word problem.

4.3 What effect does constructivist-based teaching approach have on students' achievements in algebraic word problems in linear equations? (Research question 2)

The second research question sought to determine the effect of constructivist-based teaching approach on students' achievement in algebraic word problems involving linear equations. To do this, the descriptive statistics of the achievements of the students in the control and experiment groups before and after the intervention were examined. Table

11 shows the descriptive statistics of percentage score obtained by students in the experimental and control groups.

Table 11 Descriptive statistics of students Taught with Constructivist Teaching Approach and those Taught without it.

Group	Test	Minimum	Maximum	Mean	Std. Deviation
Experimental	Pre-test	15	48	32	8.932
	Post-test	32	94	68	14.826
Control	Pre-test	18	60	33	9.288
	Post-test	22	83	42	14.290

Source: Fieldwork, 2018

The table compares the pre-test and post-test results of the students within the experimental group. In the experimental group, the results showed an improvement in students understanding of word problem involving linear equation in the post-test. The minimum score students obtained in the pre-test was 15, while the maximum score was 48. However, in the post-test, the minimum score was 32, while the maximum score was 94. The mean score of students in the pre-test was 32, while that of the post-test was 68, an increase of 36. With regards to the control group, the minimum score students obtained in the pre-test was 18, while the maximum score was 60. However, in the post-test, the minimum score was 22, while the maximum score was 83. The mean score of students in the pre-test was 33, while that of the post-test was 42, an increase of 9. This is an indication that in the post-test, every students' performance slightly increased in the control group.

To ascertain whether or not the difference observed in the means are statistically different, a paired samples t-test was conducted to test the null hypothesis that there is no significant difference between the pre-test and post-test scores of students in the experimental and control groups. Table 12 presents the results of the paired samples t-test on the pre-test and post-test performance of students taught with constructivist teaching approach.

Table 12 Results of the paired samples t –test on the pre-test and post-test performance of students in the experimental and control groups

Group	Test	Mean	Std. Dev.	Std. Error Mean	t	df	Sig.
Experimental	Pre-test	36.5	17.5	2.5	14.61	48	0.000
	Post-test						
Control	Pre-test	8.23	19	3	2.77	39	0.009
	Post-test						

Source: Field Data, 2018

With regards to the experimental group, the paired sample t-test results showed the mean score difference (M = 36.5, SD = 17.5) between the post test and pre-test was statistically significant. This was done to evaluate the effect of constructivist teaching approach on students' achievement in word problem. The results from Table 12 indicated a statistically significant increase in the students' achievement from the pre-test (M = 32, SD = 8.9) to the post-test (M = 68, SD = 14.3), t (48) = 14.6, $p < 0.05$. The effect size, measured by Cohen's d was found to be 3.02 with a correlation coefficient of 0.83 indicating a large effect size (Cohen, 1988).

i.e.

$$d = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2 + S_2^2}{2}}} = \frac{68-32}{\sqrt{\frac{(14.290)^2+(8.932)^2}{2}}} = 3.02$$

$$r = \frac{d}{\sqrt{d^2+4}} = r = \frac{3.02}{\sqrt{(3.02)^2+4}} = 0.83$$

This showed a very large effect on student success in solving word problem using the constructivist approach. Also, the results implied that after the students had gone through the intervention, they improved slightly in their understanding and achievement of the concept on word problem in linear equations. Thus, constructivist teaching approach had a positive impact on the students' achievement in word problem in linear equations.

Similarly, a paired samples t-test was employed to compare the pre-test and post test scores for the students taught with traditional teaching approach (control group). The paired sample t-test was examined to find out if the mean score difference (M = 23, SD = 19.035) between the post-test and pre-test of the control group was statistically significant. This was done to assess the effect of traditional method on students' achievement in algebraic word problem. The results from Table 12 indicated that the effect was statistically significant increase in the students' achievement from the pre-test (M = 33, SD = 9.288) to the post-test (M = 42, SD = 14.826), t (39) = 2.768, p = 0.009 < 0.05. In addition, the effect size, measured by Cohen's d was found to be 0.69 with a correlation coefficient of 0.33 indicating a large effect size (Cohen, 1988).

i.e.

$$d = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2 + S_2^2}{2}}} = \frac{42-33}{\sqrt{\frac{(14.975)^2+(9.288)^2}{2}}} = 0.69$$

$$r = \frac{d}{\sqrt{d^2+4}} = r = \frac{0.69}{\sqrt{(0.69)^2+4}} = 0.33$$

However, the effect size for the treatment group (0.83) was found to be larger than that of the control group (0.33). From this result, it can be seen that students also gained from traditional teaching approach of learning algebraic word problem. This outcome is an indication that a well-structured traditional approach of teaching can also improve students' performance in learning algebraic word problem.

4.4 What perceptions do students have about the use of constructivist approach in teaching word problem?

In order to find out the authenticity of the use of constructivist approach in learning of algebraic word problem in linear equations, the researcher interviewed six students to solicit for their views. There were 11 items on the interview guide which focused on students' experiences and opinions of the use of constructivist approach and reflected their views about their participation in the lesson. All interviews were audio-taped, transcribed and analyzed. Through the interviews a number of themes emerged from the students respondents. These themes are discussed below.

4.4.1 The approach makes algebraic word problem learning more interesting and exciting

The student participants were also asked to describe how the use of constructivist approach aid their learning of algebraic word problems. It was evident from the responses that, five (5) participants accepted that the use of constructivist makes learning more interesting and exciting since it helps students to learn in a more meaningful way. Some of the students commented that:

> *"It helps me to know how data are deduce from a given story and equations are formed since algebraic word problem mostly deals with story problems. In this way I am able to learn word problem in a more meaningful way" (Interviewee 2).*

> *"In fact at first I was finding it difficult to understand how to deduce data from the given story I did not understand how to form equation from it but now the approach has help me to learn word problem in a more meaningful way" (Interviewee 2).*

This finding is concomitant with the findings of Blunck and Yager (1990), which also evidenced that students in classes taught with a constructivist approach improved more in their understanding of the nature of science when compared to students in classes taught with a textbook oriented approach.

4.4.2 Constructivist approach helps facilitate easy learning and understanding of algebraic word problem

The participants were also asked to share their views with the researcher on how the use of constructivist will help improve their performance in mathematics six (6) student participants responded that the use of constructivist approach will help increase their academic performance particularly in mathematics since it helps them to comprehend lessons well. The students therefore expressed the need for their teachers to use constructivist approach during mathematical lessons. This was confirmed by one of the participants who opined that: *"yes because it helps easy understanding of algebraic word problem in linear equation"*.

Responses from the students suggest that, when teachers actively engage students in the learning process, they learn better and constructively.

4.4.3 Constructivist approach makes lesson practical

The researcher tried to find out from the students if they would like to use constructivist approach to learn algebraic word problem in linear equation and explain the reasons behind their decision. From the respondents, it was evident that six(6) of the students expressed interest to use constructivist approach to learn because it makes lesson practical and helps easy understanding of algebraic word problem in linear equation. For instance of the respondents' commented that:

"Yes, the reason why I am saying this is that using the approach to learn algebraic word problem in linear equation makes lessons more practical and this will make me get general understanding of every concepts"

The views from students suggest that, when mathematics is taught in a more practical way, it becomes easier to understand every concept. In this regard, Baviskar, Hartle & Whitney (2009) opined that constructivist learning environment need enough resources which are needed for practical work to enhance students' learning.

4.5 Discussion of results

The first research question aimed at identifying the difficulties SHS students encounter in translating algebraic word problems to algebraic linear equations. After a critical analysis of the pre-test, the researcher came across four major categories of difficulties namely:

- students attempting but demonstrating misunderstanding of the problem
- students attempting and unable to translate problem into algebraic model or equation(s)
- students attempting but fail to solving the equation to reach the solution
- students attempting to solve the equation but failing to use the right methods or making errors.

The findings revealed that an average of 86% of students do not understand the problem they have been asked to solve. Understanding the problem, the first step in problem-solving, according to Poyla (1957), is a major difficulty for most students. They cannot comprehend the requirements of the problem and seem to lack the mathematical experiences needed to understand the problem.

Concerning students attempting and unable to translate a problem into algebraic model or equation(s), 64 out of the 92 students attempted to translate a word problem into an algebraic equation. The findings revealed that an average of 57% of students had difficulty in translating a word problem into algebraic model or equations.

The third difficulty identified was students attempting but failing to solve the equation to reach the solution. It was found out that only 42 students attempted to solve the equation resulting from the translation of word problem into an algebraic equation.

The last difficulty identified was students who attempted but failed to use the right methods reach a solution for the equation. It was revealed that out of the 42 students who attempted to solve the equation, only an average of 42% of students reached a solution for the equation using the right methods.

These findings are consistent with a study by Macgregor and Stacey (1997) who noted that one of the difficulties for learners is how to interpret these symbols correctly. They were of the view that, mathematical ideas often need to be reformulated before they can be represented as an algebraic statement and symbolic notation. The rules for interpreting and manipulating mathematical symbols are not always in accord with the way relationships are conveyed through the English language. Lannin (2005) supported this argument by stating that learners often fail to understand the meaning linked with the formal symbols they use including the operational symbols.

The researcher came up with an intervention to aid students in solving word problems involving algebraic linear equations in order to minimise the students' difficulties in an experiment in which one group was treated with the constructivist approach and the other with traditional approach. The outcome from the intervention portrayed that there was a statistically significant difference between the mathematics achievement mean scores of the experimental group and that of the control group [$t(48) = 14.611$, $p < 0.0000$]. This finding implied that the experimental group performed better than the control group in the word problem achievement test. This implies that when students are taught using constructivist teaching approach, their performance would improve better than students taught using traditional method. Using a constructivist teaching approach through group work and discussion, to solve a word problem involving algebraic linear equations has an effect on the student's performance as shown in this research. These findings agree with researchers such as Fosnot (1989) and Brooks, (1999) who suggest that a constructivist approach to learning builds on the natural innate capabilities of the learner.

These findings are consistent with several other studies which support the constructivist approach in science-related disciplines (for examples, see, Cobb & Yackel, 1996; Dangel, 2011; Fox, 2001). Also, Hmelo-Silver, Duncan and Chin (2007) cited several studies supporting the success of the constructivist problem-based and inquiry learning methods. For example, Hmelo-Silver et al. (2007) described a project called GenScope, which was an inquiry-based science software application.

Students, who were in the experimental group using the GenScope software, showed significant gains over the control groups. The largest gain was shown by the students who were enrolled in the basic courses. Hmelo-Silver et al. (2007) cited a study by Geier on the effectiveness of inquiry-based science for middle school students as demonstrated by their performance on high-stakes standardised tests. The improvement was 14% for the first cohort of students and 13% for the second cohort. Hmelo-Silver et al. (2007) also found that inquiry-based teaching methods greatly reduced the achievement gap for African-American students.

Kim (2005) found that using constructivist teaching methods for the 6th Graders resulted in better learner achievement than traditional teaching methods. The Kim's study also found that learners preferred constructivist methods over traditional ones, however, he did not find any difference in student self-concept or learning strategies between those taught by constructivist and those taught in traditional methods.

Bhutto & Chhapra (2013), who also researched on the effect of teaching of algebra through social constructivist approach on 7th Graders' learning outcomes in Sindh in Pakistan, found that the experimental group that was taught through social constructivist approach excelled in achieving statistically significant learning outcomes than the control group that was taught through traditional one-way teaching.

In a nutshell, the findings from this study show that students taught with constructivist teaching approach performed better than those taught with the traditional method. Also, the students taught with constructivist teaching approach were able to solve questions on word problem involving linear equation in one variable. Finally, having observed the great prospects that constructivist teaching approach has on this learners, it would be appropriate to use it more often in teaching and learning of word problems involving linear equations in one variable in Ghanaian classrooms.

The research question three explored the views of students about the use of constructivist approach in teaching and learning algebraic word problems. The findings from the study show that constructivist approach in teaching helped students for easy understanding of mathematics, it helped facilitate easy learning and understanding of algebraic word problem and made learning word problem more interesting and exciting. These findings are consistent with Mainali and Key (2012) who used a four-day introduction workshop to explore the teachers' impressions and beliefs about the use of constructivist in mathematics teaching and learning. They found out that the respondents who took part in the study had positive impressions, feelings, and beliefs about the use of constructivist in the classroom. These findings corroborate a study by Adams (2008) who also found that the students taught by the constructivist model were found to have perceived mathematics as relevant and useful to everyday experience and also appreciated its importance in their day-to-day life.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter consists of the summary of the study, the key findings, conclusion and recommendations based on the findings.

5.2 Summary of the Study

The study used constructivist approach to address Potsin T.I Ahmadiyya Senior High School students' difficulties in solving algebraic word problem in linear equation. The research design used in this study was quasi experimental design especially non-equivalent quasi experimental design was used in the study to investigate the effect of two teaching strategies (constructivist approach and traditional method) on the performance of the students. The target population was all SHS form 1 in Potsin T.I Ahmadiyya Senior High School.

Purposive sampling techniques procedure was used to select the two intact class for the study in which one with class size 49 constituted the experimental group and the other with class size 43 constituting the control group. The data collection was done by the researcher

Pre-test and post-test as well as interview guide were used to collect data before and after the treatment period which took three weeks.

Descriptive statistics such as boxplots, percentages, frequency, tables, means, and standard deviations were used to describe the general performance of students and paired sampled t-test were used to compare the mean mathematics achievement scores between the control and experimental groups.

The research question one intended to identify the difficulties SHS students encounter in translating algebraic word problems to algebraic linear equations. After a critical analysis of the pre-test, the researcher came across four major categories of difficulties namely:

- students attempting but demonstrating misunderstanding of the problem
- students attempting and unable to translate problem into algebraic model or equation(s)
- students attempting but fail to solving the equation to reach the solution
- students attempting to solve the equation but failing to use the right methods or making errors.

The researcher took the participant through an intervention phase to aid students in solving word problems involving algebraic linear equations in order to minimise the students' difficulties in an experiment in which one group was treated with the constructivist approach and the other with traditional approach. The outcome from the intervention portrayed that there was a statistically significant difference between the mathematics achievement mean scores of the experimental group and that of the control group [$t(48) = 14.611$, $p < 0.0000$].

Results of interviews from students suggest that, when mathematics is taught in a more practical way, it becomes easier to understand every concept.

5.3 Conclusion

The success of this study using the constructivist approach revealed that classroom teachers should include constructivism within the learning environment. The results of the test show that when students are given the opportunity to construct their own knowledge under the guidance of a teacher, they will be able to learn mathematics with little difficulty. Since students learn better when they do things by themselves, search for information and learn on their own under the guidance of a teacher, the constructivist approach should be part of the classroom teachers' methods of imparting knowledge to the students.

True school transformation requires an authentic commitment to developing an investigative environment for both students and teachers. This authentic commitment involves creating a democratic environment, providing learning activities that are interactive and student-centred and the teacher facilitating the learning process where students would be encouraged to be responsible and autonomous.

This study illustrates that when a teacher is committed to improving students' success in learning mathematics, he or she can transform the learning climate through the use of constructivism which will go a long way to benefit a majority of the students academically. It should be noted that although this study was a success, it may not be a template for every teaching/learning environment. Students with special needs might need different strategies to keep them on track.

5.4 Recommendations

For the effective implementation of the constructivists teaching approach, the following recommendations are made for teachers in their teaching.

- Teachers should consider the background knowledge of their students before introducing new concepts. This is because most of the difficulties students faced in learning algebraic word problem in linear equations were based on their background knowledge and their ability to interpret the story problem. Learning should be established based upon the prior knowledge and experience of the students

- Remember that learning is a social process and students should not learn in isolation. Teachers should facilitate the exchange of student ideas.

5.5 Suggestions for Further Research

The following suggestions are made to be considered for further research:

- ✓ The study should be replicated to include private SHS in Ghana and
- ✓ Similar study should be conducted in other regions in Ghana and the results compared with the findings of this research.

REFERENCES

Adams, P. (2008). Considering "best practice": The social construction of teacher activity and pupil learning as performance. *Cambridge Journal of Education, 38*(3), 375-392.

Applebee A. N. (1993). *Literature in the secondary school*: students of curriculum and Instruction in the United States. Urbana, IL: National Council of Teachers of English.

Applefield, J.M, Hubert, R & Moalem, M. (2001). Constructivism in Theory and Practice toward a Better Understanding. *High School Journal* 84, 35-53.

Baroody, A. J. (1993). *Problem solving, reasoning and communicating*, K-8: Helping Children to Think Mathematically. New York: Merril

Baviskar S. N., Hartle, R. T., & Whitney, T. (2009). Essential criteria to characterize constructivist teaching: Derived from a review of the literature and applied to five constructivist-teaching method articles. *International Journal of Science Education, 31*(4), 541-550.

Bednar, A. K., Cunningham. D, Duffy, T. M. & Perry, J. D. (1992) Theory into Practice. How Do We Link? *Constructivism and the Technology of Instruction: A conversation, 8*(1), 17-34.

Belenkv, M.F., Clinchy, B.M., Goldberger, N.R., & Tarule, J.M. (1986). *Women's ways of knowing: the development of self, voice and mind*. (Vol. 15). New York: Basic books

Best, J. W., & Kahn, J. V. (2003). *Research in education* (7 ed.). New Delhi: Prentice-Hall of India.

Bhutto, S., & Chhapra, I. U. (2013). Educational Research on "Constructivism" – An Exploratory View. *International Journal of Scientific and Research Publications, 3*(12), 1-7.

Blanton, M & Kaput, J. (2003) Characterizing a classroom practice that promotes algebraic reasoning. *Journal for Research in Mathematics Education,* 36 (5) 412-446, pp. 35-25

Blunck, S. M., & Yager, R. E. (1990). The Iowa Chautauqua Program: A model for improving science in the elementary school. *Journal of Elementary Science Education, 2*(2), 3-9.

Boomer, G. (1992). Negotiating the Curriculum Reformulated. *Negotiating the Curriculum*: *Educating for 21st centruy, 276-289.*

Boote, D (1998). Physics Word Problems as Exemplars for Enculturation. *For the Learning of Mathematics* 18(2), 28-33

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms.* ASCD.

Bryman, A., & Bell, E. (2007). *Business research methods* (2 ed.). Oxford: Oxford UniversityPress.

Burns, R. (2002). Class composition and student achievement in elementary schools. *American Educational Research Journal, 39(1),* 207-233

Butin, D. (2010). *Service-learning in theory and practice: The future of community engagement in higher education*. Springer.

Capraro. M. M., & Joffrion, H. (2006). Algebraic equations: can middle-school students meaningfully translate from words to mathematical symbols? *Reading Psychology*, 27, 147-164

Cerdan, F. (2008). Estudies Sobre la Familla de Problems Arithmetico-Algebraicos. Unpublished Doctoral Dissertation. Universidal de Valencia

Cobb, P., & Yackel, E., (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational psychologist, 31*(3-4), 175-190.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd Ed.). Hillsdale, NJ: Erlbaum.

Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science, 1*(3), 98-101.

Cook, J. (1992). Negotiating the Curriculum: Programming for Learning. *Educating in the 21st century*, 15-31.

Cooney. T. V., Edward, J. D. & Hendor, K. B. (1983). Dynamics of Teaching Secondary School Mathematics. Illinois Waveland Press, Inc

Creswell, J. W. (2008). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Merrill.

Creswell, J. W. (2009). *Research Design: Qualitative, quantitative and mixed methods approach* (3 ed.). Thousand Oaks, CA: Sage.

Cummins, J. (1991). Language development and academic learning. *Language, culture and cognition, 161, 75.*

Curriculum Research and Development Division. (2012). *Teaching syllabus for mathematics (Senior High School).* Accra: Ministry of Education.

Dangel, J. R. (2011). An analysis of research on constructivist teacher. *In education, 17*(2).

De Corte, E., & Verschaffel, L. (1989). Teaching word problems in the primary school: What research has to say to the teacher? *New developments in teaching mathematics, 85-106.*

Fey, J. T. (1989). *School algebra for the year 2000.* In S. Wagner & C. Kieran (Eds.), Research issues in the learning and teaching of algebra (pp. 199-213). Reston, VA: National Council of Teachers of Mathematics; Hillsdale, NJ: Lawrence Erlbaum.

Fletcher, J. (2003). Constructivism and mathematics education in Ghana. *Journal of the Mathematical Association of Ghana*, 29-38.

Fosnot, C. (1989). *Enquiring teachers, enquiring learners: A constructivist approach for teaching. New York: Teachers College Press.*

Fox, R. (2001). Constructivism examined. *Oxford review of education, 27*(1), 23-35

Fraenkel, J. R., & Wallen, N. E. (2000). How to design and evaluate research in education. New York: McGraw.

Fredua-Kwarteng, Y., & Ahia, F. (2015). Confronting National Mathematics Phobia in Ghana (Part 2). *Retrieved January 31, 2018.*

Frobisher, L. (1994). Problem, Investigation and Investigative Approach. *Issues in Teaching Mathematics*, 150-173.

Gall, M., Borg, W., & Gall, J. (2003). Quantitative and qualitative methods of research in psychology and educational science. *Nasr A, Arizi H, Abolghasemi M, Pakseresht MJ, Kiamanesh A, Bagheri Kh, et al. (Persian translator). 1st edition. Tehran: Samt,* 189-190.

Geary, D.C, (1994). *Children's Mathematical Development: Research and Practical Applications* Washington D.C: American Psychological Association.

Goldin, G. A., & McClintock, C. E. (Eds.). (1979). Task variables in mathematical problem solving. Columbus, Ohio: ERIC/SMEAC

Hmelo, S. E., Cindy, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem based and inquiry learning: A response to Kirscher

Katic, E. K., Hmelo-Silver, C. E., & Weber, K. H. (2009). Material Mediation: Tools and Representations Supporting Collaborative Problem-Solving Discourse.

International Journal of Teaching and Learning in Higher Education, 21(1), 13-24

Kieran, C. (1992). *'Learning and teaching of school algebra'.* In D. Grouws (Ed.), Handbook of research on mathematical teaching and learning (pp. 390 - 419). New York: Macmillan.

Kilpatrick, J., & Izsak, A. (2008). A History of Algebra in the School Curriculum. *Algebra and algebraic thinking in school mathematics, 70,* 3-18

Kim, J. S. (2005). The effects of a constructivist teaching approach on student academic achievement, self-concept, and learning strategies. *Asia pacific education review, 6*(1), 7-19.

Kim, M. K., Sharp, J. M., & Thompson, A. D. (1998). Efects of integrating problem solving, interactive multimedia, and constructivism in teacher education. *Journal of Educational Computing Research, 19*(1), 83-108.

Knuth, E. J., Stephens, A. C., Mcneil, N. M., & Alibali, M. W. (2006). Does understanding the equal sign matter? Evidence from solving equations. *Journal for research in Mathematics,* 297-312.

Kothari, C. R, (2004). *Research methodology: Methods and techniques.* New Age International Publishers.

Kroll, D. L. (1993). Insights from research on mathematical problem solving in the Middle grades. *Research ideas for the classroom: Middle grades Mathematics*

Kurina, F. (1989). Praha SPN. Czech Lawrence Erlbaum associates

Langer, J. A., & Applebee, A. N. (1987). *How Writing Shapes Thinking: A Study of Teaching and Learning.* NCTE Research Report No. 22. National Council of Teachers of English, 1111 Kenyon Rd., Urbana, IL 61801.

Lannin, J. K. (2005). Generalization and justification: The challenge of introducing algebraic reasoning through patterning activities. *Mathematics Thinking and learning, 7*(3), 231-258.

Leamy, J. (1983). Stein's Refresher Mathematics, annotated teachers's ed. (Ts, Tt)

Lee, T. Y. (2001). Problem solving in calculus. Unpublished Postgraduate Diploma Dissertation, Nannyang Technological University: Singapore.

Legard, R., Keegan, J., & & Ward, K. (2003). *Qualitative research practice: A guide for social science students and researchers* . London: Sage.

Lesh, R., Post, T. R., & Behr, M. (1987). Representations and translations among representations in mathematics learning and problem solving. *In Problems of* *representations in the teaching and learning of mathematics*. Lawrence Erlbaum.

Lester, F. K. (1994). Musings about mathematical problem-solving research: 1970-1994. *Journal for research in mathematics education, 25*, 660-660.

Lewis, C. (1981). Skills in Algebra. C*ognitive skills and their acquisition*, 85-110.

Linchevski, L. & Herscovicks, N. (1996). Crossing the cognitive gap between arithmetic and algebra: Operating on the unkown in the context of equations. *Education Studies in Mathematics, 30:* 39-45

Lindfors, J. (1984). How children learn or how teachers teach? A profound confusion. *Language Arts*, 61(6), 600-606.

MacGregor, M., & Stacey, K. (1997). Students 'understanding of algebraic notation: 11-15. *Educational studies in mathematics, 33*(1), 1-19

MacMillan, J. H., & Schumacher, S. (2001). Descriptive Statistics. *Research in Education: A Conceptual Introduction,* 204-236

Mainali, B. R., & Key, M. B. (2012). Using dynamic geometry software GeoGebra in developing countries: A case study of impressions of mathematics teachers in Nepal. *International Journal for Mathematics Teaching & Learning.*

Mayer, R. & Hegarty, M. (1996). *The process of understanding mathematical problems*. *The Nature of Mathematical thinking,* 29-53

McGinn, M. K. & Boote, D. N. (2003). A first-person perspective on problem solving in a history of mathematics course, *Mathematical Thinking and Learning.* 5(1), 71- 107

Merton, R. K., Fiske, M., & Kendall, P. L. (1996). *The focused interview: A manual of problems and procedures.* New York: Free PESS.

Miller, J., & O'Neill, M. (2004). *Algebra for college with mathzone.* New york: McGraw-Hill.

Moyer J. C, Sowder L, Threadgill-Sowder J., & Moyer M. B. (1984). Story problem formats: Verbal versus telegraphic. *Journal for Research in Mathematics Education,* 342-351

Mugenda, O., & Mugenda, A. (2003). Research Methods: Quantitative & Qualitative Approaches. Nairobi, Rev editions.

Mullis, I. V. S., Martin, O. M., Foy, M. P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics*, Boston: TIMSS and PIRLS international study centre.

Nabie J. M. (2004) *Fundamentals of the psychology of learning mathematics*. 2nd Edition Mallam, Accra: Akonta Publications.

NCTM. (2000). *Principles and standards for school mathematics.* Reston, V. A:. National Council of Teachers of Mathematics

NCTM (2006). Curriculum Focal Point For Prekindergarten through Grade 8 Mathematics: A quest for coherence. Reston, Va: National Council of Teachers of Mathematics.

Newman, A. (1983). *The Newman language of mathematics kit- Strategies for diagnosis and remediation.* Sydney, Australia: Harcourt Brace Jovanovich Group.

Ofori, R., & Dampson, D. G. (2011). *Research methods and statistics using SPSS.* . Amakom-Kumasi: Payless Publication Limited

Okpoti. C. A. (2004). Basic School Pupils' Strategies in Solving Subtratcing Problems. *Mathematics Connections, 4*

O'Malley, P. (2010). Students evaluation: Steps for creating teacher-made test. *In Assessment Group Conference-School programme. Maryland: Kennedy Krieger Institute.*

Osafo-Affum, B. (2001). Mathematics crisis in our schools. *Mathematics Connection*, 4-6

Pierce, R., & Ball, L. (2009). Perceptions that may affect teachers' intention to use technology in secondary mathematics classes. *Educational Studies in Mathematics, 71*(3), 299-317.

Polya, G. (1962). *Mathematical Discovery*, 1962. John Wiley & Sons

Polya, G. (2004). *How to Solve it. A New Aspect of Mathematical Method* (No. 246). Princeton university press.

Rosenblatt, L. (1978). *The reader, the text, the poem: The transactional theory of the Literary work*. Carbondale, IL: Southern Illinois University Press

Schoenfeld, A. H. (1985). *Mathematical problem solving*. Orlando, FL: Academic Press.

Semandi, Z. (1995). Developing Children's Understanding of Verbal Arithmetical Problems. *The international symposium on elementary math teaching,* 27-32.

Setek, W. M. (1992). *Fundamentals of mathematics.* New York: Macmillan.

Shamoo, A. E., & Resnik, D. B. (2009). *Responsible conduct of research.* Oxford University Press.

Sherrod SE, Dwyer J, Narayan R. (2009). Developing science and mathematics integrated activities for middle school students. *International Journal of Mathematical Education in Science and Technology*;

Shilubane, H. N. (2010, November 20). *University of Venda.* Retrieved May 4, 2015, from University of Venda web site: http://uir.unisa.ac.za/bitstream/handle/10500/1450/04chapter3.pdf?sequence=5

Shuttlework, M. (2008). *How to choose between different different research methods: Experiment Resource.* Retrieved February 23, 2016, from http://www.experiment-resources.com/different-research-methods.html

Siegler, R. S. (2003) Implications of cognitive science research for mathematics education. In J. Kilpatrick, W. B. Martin, & D. E. Schiftler, (Eds.), A research companion to Principles and standards for school mathematics (p. 219-233).Reston, VA: *National Council of Teachers of Mathematics.*

Smith, K. (1993). Becoming the "guide" on the side. *Educational Leadership*, 51(2), 35- 37.

Springer, T. A. (2007). *Linear algebraic groups / T. A. Springer (*2ed), Boston: Birkhauser

Stanic, G., & Kilpatrick, J. (1989). Historical perspectives on problem solving in the mathematics curriculum. *The teaching and assessing of mathematical problem solving, 3,* 1-22.

Star, J. R. (2005). Reconceptualising procedural knowledge. *Journal of Research in Mathematics Education,* 36, 404-411

Steele. D. F. (1995). A constructivist approach to mathematics teaching and learning by a fourth-grade teacher (Doctoral dissertation, University of Florida).

Stern, E. & Lehrn-Dorfer, A. (1992). The Role of situational context in solving problems. *Cognitive Development,* 7, 259-268.

Van De Walle J.A. (2004). *Elementary and middle school mathematics*: Teaching developmentally (5th edition).New York: Pearson Education Inc.

Van Teijlingen, E. R., Rennie, A. M., Hundley, V., & Graham, W. (2001). The importance of conducting and reporting pilot studies: the example of the Scottish Births Survey. *Journal of advanced nursing, 3*(3), 289-295.

Verschaffel L, Greer B, De Corte E. (2000) *Making sense of word problems*. Lisse, Netherlands: Swets & Zeitlinger.

Von Glasersfeld, E. (1991). An exposition of constructivism: Why some like it radical. *In facets of systems science,* (pp. 229-238). Springer, Boston, MA.

WAEC. (2007). *West African Senior School Certificate Examinations.* Chief Examiner's report. Accra:WAEC

WAEC. (2012). *West African Senior School Certificate Examinations.* Chief Examiner's report. Accra:WAEC

WAEC. (2014). *West African Senior School Certificate Examinations.* Chief Examiner's report. Accra:WAEC

WAEC. (2015). *West African Senior School Certificate Examinations.* Chief Examiner's report. Accra:WAEC

WAEC. (2017). *West African Senior School Certificate Examinations.* Chief Examiner's report. Accra:WAEC

Weber, M. G. (1996). Demon of Arithmetic Reading Word Problems. Reading on Reading instruction, 314-318.

Wiggins, G., & McTighe, J. (2006). Examining the teaching life. *Educational Leadership, 63*(6), 26-29.

Yin, R. (1994).*Case study research: Design and methods* (2nd Ed.). Thousand Oaks, CA: Sage Publications.

APPENDICES

APPENDIX A

Permission for consent of participants' schools

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF MATHEMATICS EDUCATION

June 13, 2017

POTSIN T.I. AHMADIYYA S. H
P. O. BOX 38, GOMOA POTSIN
RECEIVED

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION

I write to introduce to you the bearer of this letter, BAIDAU BINTU BABA, a postgraduate student in the University of Education, Winneba. He is reading for a Master of Philosophy degree in Mathematics Education and as part of the requirements of the programme, he is undertaking a research titled – *Using Constructivist based teaching method to address P.AMASS students' difficulties in solving word problems involving Algebraic Linear Equations.*

He needs to gather information to be analysed for the said research and he has chosen to do so in your institution. I would be grateful if he is given the needed assistance to carry out this exercise. Thank you.

Yours faithfully,

Prof./Dr K. Mereku
Head of Department

APPENDIX B

SIGNED CONSENT FORM OR LETTER

بسم الله الرحمن الرحيم

In the name of Allah, Most Gracious, Ever Merciful

POTSIN T.I. AHMADIYYA SENIOR HIGH SCHOOL

P. O. Box 29, Gomoa Potsin, Central Region. Tel. 0201516047 / 0203053467

Email: potsinamass@yahoo.com

Our Ref: P-ASH/PM/02/060 *Date:* 5th May, 2018

Your Ref: ……………………

TO WHOM IT MAY CONCERN

LETTER OF CONSENT
(MISS BAIDAO BINTU BABA)

We refer to your letter dated June 13, 2017 regarding a research undertaking by the student named above, we inform you that approval has been given to you to carry out the research in our school.

The school community shall accord you the necessary co-operation and support to enable you carry out the exercise.

Thank you.

……………………

Ms. Zainab Adams

HEADMISTRESS
POTSIN T.I. AHMADIYYA S.H.S
P. O. BOX 29
GOMOA POTSIN

APPENDIX C

Details of the constructivist-based lesson plan to be used in the experimental

LESSON PLAN 1

SUBJECT: Core Mathematics

DURATION: 80 minutes

Topic:	Variables and Expressions
Content:	Vocabulary variables algebraic expression factors product power base exponent evaluate
Goals:	At the end of the lesson students will be able to write algebraic expressions
Objectives:	*Write mathematical expressions for verbal expressions. *Write verbal expressions for mathematical expressions.
Materials:	Mathematics Syllabus and Textbook for Senior High Schools.
Introduction:	Mathematical Background (5 minutes) – Review of previous Knowledge. Before getting started, I will write the expression x + y on the board and ask students to read the expression out loud. Most will respond, "x plus y." I will then challenge students to come up with other ways to say the expression. Examples include, the sum of x and y, x added to y, and so on. I will lead students to conclude that many algebraic expressions can be represented by more than one verbal or written expression.
Development:	I will explain to students that algebraic expressions often involve grouping symbols such as parentheses. Therefore, it is important to be able to recognize the "clue" words in a written expression that indicate grouping

	symbols. Also, I will explain that the given clue words do not necessarily mean that parentheses are required when translating from English to Algebra. For example, sum is listed as a clue word for parentheses. However, the expression the sum of x and y is translated as x + y without parentheses.
Practice:	I will have students add the definitions/examples of the vocabulary terms to their Vocabulary Builder worksheets and will include any other items that they find helpful in mastering the skills in this lesson.
Accommodations:	Differentiated Instruction: Verbal/Linguistic - The transition from verbal expressions and vice versa comes easier to some students. When I identify students who may be having trouble writing mathematical or verbal expressions, I will pair them with another student as a mentor for practicing these skills.
Checking For Understanding:	1. Explain the difference between an algebraic expression and a verbal expression. 2. Write an expression that represents the perimeter of the rectangle.
Closure:	Review the concept.
Evaluation:	Open-ended Assessment: I will challenge students to write an algebraic expression that they think will be very hard to change into a verbal expression. Then have students exchange expressions and translate into verbal expressions.

LESSON PLAN 2

SUBJECT: Core Mathematics

TOPIC: Variables and Equations

DURATION: 80 minutes

Learning Objectives

1. Assign values to a variable.
2. Collect information about variables and be able to use the information to solve for an unknown variable.

Materials Needed:

For each group of 3 students: 8 small containers and 80 small countable objects code sheet prepared by teacher. I will explain to students that today we will play a game in which they try to solve other teams' "Secret numbers."

Review: I will go over solving equations and ensure everyone remembers how to solve equations. I will then explain that today they will learn how to write equations.

Procedure:

1. I will divide the class into groups of 3 or 4 and instruct each group to select a recorder to keep an account of the events beginning in step 6. Afterwards, I will distribute 8 containers and 80 counters to each group.
2. Each group will be assigned a different letter of the alphabet and each of the group's 8 containers will be labeled with the lowercase form of that letter. If the same lesson is taught repeatedly, the same containers can be used over and over.
3. Each group will choose a "secret number" between one and ten and inform the teacher of their choice. The teacher will keep a record of all "secret numbers" on his code sheet.
4. I will have each group place the "secret number of counters in each of their eight containers.
5. Each group will now have 8 containers, each of which contain the same number of counters and the same letter of the alphabet. I will discuss ways to express the

total number of counters in all 8 containers. For example: $m + m + m + m + m + m + m + m$ or $x + x + x + x + x + x + x + x$. I will build on that idea: $8m \text{ or } 8x$.

6. I will then have each group exchange some containers with one other group. For example,'s. Each group records its holdings in the following manner: $m + m + m + m + m + x + x + x$ or $5m + 3x$ and $x + x + x + x + x + m + m + m \text{ or } 5x + 3m$.
7. Each group will confer with the teacher who checks the code sheet to tell them the total number of counters their groups is holding. For example, the first group has $5m + 3x$ counters. The teacher tells them they have 22 counters.
8. I will discuss if necessary how to write an equation to express the total number of counters. For example, $5m + 3x = 22$.
9. Each group will then solve the equation they have developed to solve for the unknown variable.
10. Students will continue to trade until they have discovered each group's "secret number" or until time has run out.
11. I will encourage students to keep solutions within their group so each group can make their own discoveries on their own.

Closure:

I will have students return to their desks and explain to them that they now should be familiar with how to write algebraic expressions to represent real objects.

Assessment: Students will be finally assessed through informal observation and formal written evaluation on a written test.

LESSON PLAN 3

SUBJECT: Core Mathematics

TOPIC: Solving Word Problems

DURATION: 80 minutes

Learning Objectives

Students will be able to

1 Use the four arithmetic operations to solve word problems.

2 List the variables or keywords in a given word problem.

3 Translate algebraic statements into algebraic expression and vice versa.

Presentation

Introduction (10 minutes)

1. I will create a scenario to introduce the concept of word problems. Example: I am going to the Accra Mall and I plan on bringing 11 students with me. Six more students want to join us. How many of us are going to the Mall?
2. The product of four and seven
3. The quotient of 12 and 3
4. The difference between 7 and 5
5. Some students will come to the front of the class to help in making these demonstration
6. I will later go over the answer to my created problem.
7. The activity will be repeated with a different word problem and will call on different students to answer the problem to promote class participation.

8. I will ask students to reflect on what word problems are and have a class discussion. Students will be reminded that a **word problem** is a situation explained in words that can be solved using Maths

Explicit instruction/teacher modeling (10 minutes)

Activity 1

1. I will have students identify the operations that are being used for individual word problems and ask students what clues from the text led them to their answer.
2. I will then write these word clues on the board. *Example: addition = join, together, more; subtraction = difference, take away, less etc.*
3. The following word problem will then be presented to the students: "Six students turned in their homework early. Five more students rushed to the homework bin and turned it in. How many students turned in their homework?"
4. Ask students to identify the mathematical operation in the word problem and to identify the clue word that led them to their answer.
5. Repeat with a subtraction word problem example.

Activity 2

Each word problem involves some kind of change process as a result of applying mathematical operations on a number in obtaining the solution. For example, in addition, the change process is illustrated by the increment to the initial number in generating final answer.

Teacher assists students with some keywords/ clues in word problems. This is shown on table 1.1

Table 1.1: list of keywords in word problems.

ADDITION	SUBTRACTION	MULTIPLICATION	DIVISION
Add, sum, total, plus, In all, both, together, how many in all, increase by, older than, more than, another, raised by. Join etc.	Subtract, difference, take away, less than, remain, decreased by, how much less, fewer, reduce, smaller than, left over.	Times, product, doubled, multiplied by, twice as, by, of, factor of.	Quotients, divided by, half of, split, share, parts, and ratio, separated.

Table 1.1 which enables students to know various keywords used when solving word problems

Activity 3

Teacher guides students to explore through a game.

Step 1: Fold a piece of paper in half vertically. Open up your paper and then fold your paper in half horizontally. Open the paper up and lay it flat on your desk.

Step 2: Label each section of your paper as shown below.

ADDITION(+)	SUBTRACTION(-)
MULTIPLICATION(×)	**DIVISION (÷)**

Step 3: Place each word or phrase from the list below into one of the sections on your paper. Be prepared to explain your placement of each word or phrase.

Less than	sum	decreased by
Quotients	more than	divided by
Times	difference	increased by
Minus	product	fewer than

ADDITION(+) **Sum** **More than** **Increased by**	**SUBTRACTION(-)** **Minus** **Difference** **Fewer than** **Decreased by** **Less than**
MULTIPLICATION(×) **Times** **Product**	**DIVISION (÷)** **Quotients** **Divided by**

Activity 4

Teacher guides students to explore through a game.

Step 1: Fold a piece of paper in half vertically. Open up your paper and then fold your paper in half horizontally. Open the paper up and lay it flat on your desk.

Step 2: Label each section of your paper as shown below.

ADDITION(+)	**SUBTRACTION(-)**
MULTIPLICATION(×)	**DIVISION (÷)**

Step 3: Eight algebraic expressions are listed below. There are two representing each operation. Place the algebraic expressions into the box that describes each operation.

$i. x - 4$ $ii. x \div p$ $iii. 5 \times w$ $iv. 14 + m$

$v. 30 - g$ $vi. 10k$ $vii. y + 11$ $viii. \frac{h}{2}$

ADDITION(+) $14 + m$ $y + 11$	**SUBTRACTION(-)** $x - 4$ $30 - g$
MULTIPLICATION(×) $5 \times w$ $10k$	**DIVISION (÷)** $x \div p$ $\frac{h}{2}$

Activity 5

Teacher guides students to solve examples involving the operational keywords under the four arithmetic operations.

ADDITION

Examples are as follows:

What is the sum of 6, 9 and 12?

(Expected answer $6 + 9 + 12 = 27$)

9 is increased by 14

(Expected answer $9 + 14 = 23$)

Five more than three times a number

(Expected answer $3n + 5$)

5 more than a number

(Expected answer $(x + 5)$)

SUBTRACTION

Examples are as follows:

The difference between 10 and 5

(Expected answer $10 - 5$)

24 decreased by 8

(Expected answer $24 - 8 = 16$)

7 less than a number t

(Expected answer $t - 7$)

A number subtracted from 15

(Expected answer $15 - m$)

25 less than a number x

(Expected answer $x - 25$)

MULTIPLICATION

Examples are as follows:

The product of four and seven

(Expected answer $4 \times 7 = 28$)

The product of twelve and five

(Expected answer $12 \times 5 = 60$

Eight times a number

(Expected answer $8 \times y = 8y$)

A number times 9

(Expected answer $n \times 9 = 9n$)

DIVISION

Examples are as follows:

Divide 100 by 5

(Expected answer $100 \div 5$)

A number divides 9

(Expected answer $a \div 9$)

The quotient of 7 and a number.

(Expected answer $7 \div x$)

Activity 6

Teacher guides students to write a given algebraic expression into word statement

1. $\frac{3y+4}{2}$

Answer: Triple a number plus four is divided by two.

2. $2(x-10)$

Answers: A number less ten is doubled.

3. $8x-7$

Answer: Seven subtracted from eight times a number.

4. $5\left(\frac{1}{3}y\right)$

Answer: One-third a number times five

5. $30-(x+8)$

Answers: The sum of a number and 8 subtracted from 30

Guided Practice/Interactive Modeling (10 minutes)

Activity 7

Teacher assists students to write algebraic expression from a given word statement.

Underline the keywords in each expression, and then write the algebraic expression implied by each phrase below.

6. ***8 times a number decreased by 3.***

Solutions: 8 times a number decreased by 3

So the algebraic expression is $8y-3$.

7. ***Triple a number plus 5***

Solution: (Triple a number) plus 5

So the algebraic expression is $3x + 5$

8. $\frac{1}{2}$ ***Of a number minus 6.***

Solution: $\frac{1}{2}$ of a number minus 6.

So the algebraic expression is $\frac{1}{2}x - 6$

9. ***A number divided 4 increased by 11***

Solution: a number divided 4 increased by 11

So the algebraic expression is $\frac{y}{4} + 11$

10. ***15 times the sum of a number and 23***

Solution: 15 times the sum of a number and 23

So the algebraic expression is $5(x + 23)$

Activity 8

Teacher ask students to pair matching algebraic expressions with the Mathematical Translations Matching activity sheet. . Have students check their work by comparing with a partner. Discuss as a class.

The Mathematical Translations Matching activity sheet

three less than six times a number	five more than a number
Two third of a number is decreased by 11	five times the sum of *n* and seven
a number diminished by six	the quotient of fifty and five more than a number
seven more than one half a number	three times a number minus eight

Students are to match the correct algebraic expressions with the statements in activity sheet

Matching algebraic expressions.

$n-6$	$\frac{1}{2}x+7$
$y+5$	$\frac{2}{3}y-11$
$3x-8$	$6n-3$
$\frac{50}{n+5}$	$5(n+7)$

Solution

Algebraic statements	Algebraic expressions
three less than six times a number	$6n-3$
Two third of a number is decreased by eleven	$\frac{2}{3}y-11$
a number diminished by six	$n-6$
seven more than one half a number	$\frac{1}{2}x+7$
five more than a number	$y+5$
five times the sum of n and seven	$5(n+7)$
the quotient of fifty and five more than a number	$\frac{50}{n+5}$
three times a number minus eight	$3x-8$

Independent Working Time (10 minutes)

Teacher gives students trial questions to solve by themselves and teacher goes round to supervise.

Q1. Write an algebraic expression for each phrase.

Question	Expected answer
a. Five times *k*	5k
b. Seven more than *x*	x+7
c. *f* divided by two	$\frac{f}{2}$
d. A number *y* decreased by seventeen	y-17
e. Eleven plus w times four	4(11+w)

Q2. Write a phrase for each algebraic expression.

Expected answer

a. $12 + t$ — a. the sum of twelve and *t*

b. $8x$ — b. the product of eight and *x*

c. $u - 5$ — c. Five less than *u*

d. $3x – 2$ — d. three times *x* minus two

Summary / Review Assessment and Closing (15 minutes)

1. Where students are also able to list the variables and keywords in a given word problems statements.
2. At the end of the lesson, I will check and review the in class assignment.
3. Any missed problems will be reviewed, and will show how to solve for better understanding.
4. Students will be asked to share what they learned in today's lesson.

Teacher gives students homework

Homework for students

Question 1. Copy and complete the table.

The first one is done for you.

Table 1.3

Keywords	Operational Symbol	Operational Word
Difference	-	Subtraction
Quotient		
Increased by		
Twice as much		
Half of		
Doubled		
Divided into		
Older than		
Decreased by		
How many in all		

Expected answers

Table 2.3

Keywords	Operational symbol	Operational word
Difference	-	Subtraction
Quotient	÷	Division
Increased by	+	Addition
Twice as	×	Multiplication
Half of	÷	Division
Doubled	×	Multiplication
Divided by	÷	Division
Older than	+	Addition
Decreased by	-	Subtraction
Less than	-	Addition

Question 2(a)

Write a phrase for each algebraic expression

a) $12 + t$

b) $8x$

c) $u - 5$

d) $3x - 2$

e) $\frac{2}{y} + 5$

Question 2(b).

Underline the keywords in each phrase. Then, translate the following into algebraic expressions.

i. Four less than a number b

ii. Six more than a number r

iii. The quotient of eleven and a number t

iv. Three-fifths of a number y

v. A number z times eleven

vi. Six less than a number x

vii. Eight more than twice a number.

Expected answers from students

Question 2 (a)

Question	Expected answer
a. $\mathbf{12 + t}$	*a.* the sum of twelve and t
b. $\mathbf{8x}$	*b.* the product of eight and x
c. $\mathbf{u - 5}$	*c.* five less than u
d. $\mathbf{3x - 2}$	d. three times x minus two
e. $\mathbf{\frac{2}{y} + 5}$	e. two divided by y increased by 5

Question 2(b)

	Question	Expected answer
i.	**Four less than a number b**	$b - 4$
ii.	**Six more than a number r**	$6 + r$
iii.	**The quotient of eleven and a number**	$\frac{11}{t}$
iv.	**Three-fifths of a number y**	$\frac{3}{5}y$
v.	**A number z times eleven**	$z \times 11 = 11z$
vi.	**Nine less than a number x**	$9 - x$
vii.	**Eight more than twice a number**	$8 + 2x$

LESSON PLAN 4

SUBJECT: Core Mathematics

TOPIC: Algebraic Word Problems

DURATION: 80 minutes

OBJECTIVES

By the end of the lesson, the student will be able to:

i. read and get the meaning of a given word problem.

ii. identify a situational characteristic of a given word problem.

Relevant Previous Knowledge

Students are able to:

- read a given word problem.
- identify the key mathematical clues and operations from a given word problem.

References

Aki-Ola Series (3rd Edition). Core Mathematics For Senior High Schools, Pages 157 – 184.

Core Mathematics (1^{st} Edition) For Senior High Schools Students' Book, Pages152-160

Review of RPK of students

Question.

Translate the following algebraic statements into algebraic expressions.

Expected answers

1. 3 less than a number $n-3$
2. eleven more than a number $t+11$
3. eight times a number $8 \times x = 8x$

4. A number divided by four. $\frac{y}{4}$

5. a number subtract six $y - 6$

Teacher goes round to check student work.

Teaching and learning activities

Explicit Instruction/Teacher Modelling (10 minutes)

Activity 1

Example 1: Ama is eight years less than twice Appiah's age. The sum of their ages is forty. How old is Ama?

Teacher assists students read and explain a given word problem and its situation type or characteristics in the examples below.

Teacher asks student to read and explain how he/she understands the given word problems, teacher then listen and assists students who may encounter difficulties.

Teacher asks students to find the situational type of the word problem. For example, the situational type of example 1 is an "age word problem".

Example 2: Etornam is four times as old as Boah. Nii is three years older than Etornam. The sum of their ages is 21. How old is Etonam?

Teacher asks students to read and explain how he/she understands the given word problems, teacher then listen and assists students who may encounter difficulties.

Teacher asks students to find the situational type of the word problem. In this case, the situational type for example 2 is an "age word problem".

Example 3: Fati's age is $\frac{3}{4}$ of Ahmed's age. The sum of their ages is 91. How much older is Ahmed than Fati?

Teacher asks students to read and explain how he/she understands the given word problems, teacher then listen and assists students who may encounter difficulties.

Teacher asks students to find the situational type of the word problem. In this case, the situational type for example 3 is an "age word problem".

Example 4: Three people contribute to the capital a company in the ratio 3:2:5. If the least contributor pays 30,000, find the total capital.

Teacher asks students to read and explain how he/she understands the given word problems. Teacher then listens and assists students who may encounter difficulties.

Teacher asks students to find the situational type of the word problem. In this case, the situational type for example 4 is a "money word problem".

Example 5: Together, Abeiku and Esi earn ₵33,280 per year. Esi earns ₵4,160 more per year than Abeiku earns.

i. *How much Abeiku does earns per year?*
ii. *How much Esi does earns per year?*

Teacher assists students by allowing the students to explain the question in their own words and then helps them to identify the situational type of the word problem. In this case the situational type for example 5 is "money word problem".

Guided Practice/Interactive Modeling (10 minutes)

Activity 2

Teacher puts students into groups of five allows students read, explain and ask questions among themselves as the teacher observes the students and correct them when necessary. Students are to comprehend the following examples.

Example 6: Kwesi, Ama and Adwoa shared GH ₵720.00. Ama received twice as much as Adwoa and Kwesi received three times as much as Ama. How much did each receive?

Students in their groups read and understand the given word problem by explaining it into their own words and then guides themselves to identify the situational type of the word problem. In this case the situational type for example 6 is "money word problem".

Example 7: The sum of three consecutive numbers is 75. Name the numbers

Students in their group's comprehend the given word problem by allowing them to explain it in their own words and then assists themselves to identify the situational type of the word problem. In this case the situational type for example 7 is consecutive digits word problem.

Example 8: The sum of four consecutive numbers is 626. Find the four number

Students in their groups comprehend the given word problem by giving them the chance to explain the word problem in their own words and then assist each other to identify the situational type of the word problem. In this case the situational type for example 8 is "consecutive digits word problem".

Example 9: Name two numbers which one of the numbers is three more than twice the other number, and their sum is 57.

Students read and understand the given word problem by explaining it in their own words and then guides each other to identify the situational type of the word problem, in this case the situational type for example 9 is "consecutive digits word problem".

Example 10: the area of a square of land is $81m^2$ *. Find the perimeter of the square of land*

Students comprehend the word given problem by giving themselves the opportunity in their various groups to explain it in their own words and then helps themselves to identify the situational type of the word problem. In this case the situational type for example 10 is "geometry word problem".

Example 11: The length of a rectangle is 10 m more than its breadth. If the perimeter of rectangle is 80 m, find the dimensions of the rectangle.

Students read and understand the given problem by allowing one students from each group to explain it in his/her own words and then identifying the situational type of the word problem. In this case the situational type for example 11 is "geometry word problem".

Independent Working Time (10 minutes)

Activity 3

Teacher asks students to read, explain and identify the situational type for the given word problems.

Trial questions for students to comprehend and come out with the situational types of the following word problems

Q1: *One number is 8 more than the number. The sum of the numbers is 23.*

What are these two numbers?

Students are supposed to comprehend of the given problem and explain it into their own words and then identify the situational type of the word problem.

Expected answer: the situational type for Q1 is "consecutive digits word problem".

***Q 2:** A school sold 300 tickets to a football game. Tickets were GH ₵9 for adults and GH ₵5 for children. If the total revenue was GH ₵2340, how many of each ticket type were sold?*

Students are supposed to comprehend of the given word problem and then explain it in their own words and then identify the situational type of the word problem.

Expected answer: the situational type for Q2 is a "money word problem".

Q3: *How old am I if 400 reduced by 2 times my age is 244?*

Students are to comprehend of the given word problem and explain it into their own words and then identify the situational type of the word problem.

Expected answer: the situational type for Q3 is an "age word problem".

Summary / Review Assessment and Closing (15 minutes)

Activity 4

Teacher assists students to extract or list the variables or keywords/clues in a given word problem.

Table

Example	**Situational type**	**Keywords**	**Operational symbol**	**Operational word**
1. Amu is seven years older than Alice. In three year Amu will be twice as old as Alice. Find their present age?	Age word problem	Older than and twice	+ and ×	Addition and Multiplication
2. Halim is four times as old as Boah. Nii is three years older than Halim. The sum of their ages is 21. How old is Halim?	Age word problem	Times, older than and sum	×, +,+	Multiplication and both Addition
3. Together, Helena and Esi earn ₵ 33,280 per year. Esi earns ₵ 4,160 more per year than Helena earns. How much do Helena and Esi each earn per year?	Money word problem	More than,	+	Addition
4. Kwesi, Ama and Adwoa shared GH ₵ 720.00. Ama received twice as much as Adwoa and Kwesi received three times as much as	Money word problem	Twice, times	× and ×	Both multiplication

Ama. How much did each received				
5. The sum of four consecutive numbers is 626. Find the four numbers.	Consecutive digits word problem	Sum	+	Addition
6. One number is 8 more than of another number. The sum of the numbers is 23. What are the numbers?	Consecutive digits word problem	Sum	+	Addition
7. The length of a rectangle is 10 m more than its breadth. If the perimeter of rectangle is 80 m, find the dimensions of the rectangle	Geometry word problem	More than	+	Addition

LESSON PLAN 5

SUBJECT: Core Mathematics

TOPIC: Algebraic Word Problems

DURATION: 80 minutes

OBJECTIVES

By the end of the lesson, the student will be able to:

i. construct mathematical equations.

ii. solve equations by selecting and applying appropriate algorithms.

Relevant Previous Knowledge

Students are able to:

- read and explain a given word problem.
- extract the key mathematical operations from a given word problem.

References

Aki-Ola Series (3rd Edition). Core Mathematics For Senior High Schools, Pages 157 – 184.

Comprehension Core Mathematics (1st Edition) For Senior High Schools Students' Book, Pages152-160

Teaching and learning activities

Activity 1

Review: Teacher gives exercises to review their RPK

Write the following algebraic equations into mathematical statements

	Questions	Answers
i.	x+8=66	sum a number is 66
ii.	6x-4=32	the product a number and 6 minus 4 is 32
iii.	$\frac{n}{7} = 4$	the quotient of number and 7 is 4
iv.	2y=5(y+6)	the product of 5 and sum of 5 and a number is twice the
v.	12-z=8z	

Explicit Instruction/Teacher Modelling (10 minutes)

Activity 2

When the student understands the given word problem and knows what need to be solved, he/ she needs to construct the related equation for the word problem and solve.

Teacher guides students to construct mathematical equations by selecting and applying appropriate algorithms and solving them through the examples below.

Example 1: Five years ago, Adu was half the age he will be in eight years. How old is adu now?"

Expected solution

Let a = Adu' age no

Teacher allows students to read and understand the given word problem. She then guides the students to identify the situational characteristics of the problem, which in this case is "an age word problem".

Students find the keywords that represent operations and numbers. This problem is written with respect to Adu's age now.

"(<u>Five years ago</u>) (Adu was) (<u>half the age</u>) (<u>he will be in eight years</u>.) How old is Adu now?"

$$a - 5 \quad = \quad \frac{1}{2} \quad (a + 8)$$

"Five years ago Adu was half the age he will be in eight years. How old is Adu now?"

Students represent Adu's age by 'a'

If Adu is 10 years old now, he would have been 10 – 5 = 5 years old, 5 years ago. Since 'a' was used to represent his age now, his age 5 years ago would be represented by a – 5. Similarly Adu's age in 8 years would be a + 8. Lastly, the word "half" simply means $\frac{1}{2}$. However, we must multiply his age in 8 years by $\frac{1}{2}$, because the word "half" is the same as saying "half of" number.

Students write the question in an algebraic equation form.

$$a - 5 = \frac{1}{2}(a + 8)$$

Solving for the equation

$$a - 5 = \frac{1}{2}a + \frac{1}{2} \times 8$$

$$a - 5 = \frac{a}{2} + 4$$

Then multiply both sides of the equation by 2

$$2a - 10 = a + 8$$

$$2a - a = 8 + 10$$

$$a = 18$$

Checking of answer

The last thing that we need to do is check our answer using the word problem.

If Adu's is 18 now, he was 13 five years ago, and he will be 26 in eight years.

"(<u>Five years ago</u>) (Adu was)<u> (half the age)</u> (<u>he will be in eight years</u>.) How old is Adu now?

$13 \qquad = \qquad \frac{1}{2} \qquad \times \qquad 26$

$$13 = \frac{1}{2}(26)$$

$$13 = 13$$

Setting of mathematical word problem questions should be realistic. That is if you solve an age word problem and the answer is negative, then the implication could be that the mathematical word problem questions was not realistic or the process of solving would be wrong somewhere or you may have translated the algebraic expression incorrectly.

In most cases the latter is what happens to most students. Therefore ending a solution with a negative answer in terms of someone's age would require the need for the student to go over the question once more before solving again.

Example 2: Five more than twice a number is three times the difference of that number and two. What is the number?

Expected Solution

Students read and understand the given word problem, by identifying the situational characteristics of the problem, which in this case is "number word problem".

First, students choose a letter to represent the unknown value.

Let n = unknown value

Students underline all the keywords in the sentence. Make sure you double underline the word "is", because it represents the equal sign.

Five more than twice a number is three times the difference of that number and two. What is the number?

"More than" means addition. More specifically, "five more than" means we add 5 to something. "Twice a number" is 2 times the variable. So, five more than twice a number is the same as

$5 + 2n$ .Three times" means we multiply something by 3. "Difference" means subtraction. More specifically, "the difference of that number and two" means we group the subtraction of the variable and 2. So, three times the difference of that number and two is the same as

$3(n-2)$.

Since those two phrases are separated by the word "is", the equal sign is used to separate the two phrases.

$2n + 5 = 3(n - 2)$

Solving of equation

$$2n + 5 = 3n - 6$$

$$6 + 5 = 3n - 2n$$

$$11 = n$$

Checking of answer

The unknown number is 11.Twice the number is 22, and five more than that is 27. The difference of the number and two is 9, and three times that is 27. Since 27 = 27, it is realized that the number 11 is the correct answer.

Example 3: Ama is seven years older than Appiah. In three years time Ama will be twice as old as Appiah. Find their present age?

Expected Solution

Students to read and explain the given word problem, and identify the situational characteristics of the problem. In this case is an "age word problem".

Let x represent s Appiah's age

Then Ama's present age is $x + 7$ since Ama is older than Appiah then the addition operation will be use. In three years Jennifer's age will be $x + 3$ while Ama's age in three years will be $x + 7 + 3$.

Teacher guides students to construct mathematical equations and solve them by selecting and applying appropriate algorithms.

From the example, since in two years Ama will be twice as old as Appiah we will have the equation

$$x + 10 = 2 \times (x + 3)$$

Solving of equation

Teacher guides students to solve the equation

$$x + 10 = 2x + 6$$

$$x - x + 10 - 6 = 2x - x + 6 - 6$$

$$4 = x$$

The answer now is $x = 4$, put $x = 4$ back into the equation above

$$4 - 4 + 10 - 6 = 2 \times 4 - 4 + 6 - 6$$

$$4 = 4$$

Example 4: The sum of the three consecutive odd numbers is 57. Find the numbers.

Expected Solution:

Students to read and explain the given word problem, by identifying the situational characteristics of the problem. In this case is "consecutive digits word problem". students represents first odd number by a variable x. thus x= first odd number, since the odd numbers have difference of 2. Then the second and the third will be $(x + 2)$ and $(x + 4)$ respectively. Therefore the three consecutive odd numbers which is equal to 57 should be written a

$$x + (x + 2) + (x + 4 = 57)$$

Solving of equation stage

x +$(x + 2) + (x + 4) = 57$

$$3x + 6 = 57$$

$$3x + 6 - 6 = 57 - 6$$

$$3x = 51$$

$$x = 17$$

Checking of the answer

Teacher assists students to verify answers by substituting the solution ($x = 17$) into the original equation. $17 + (17 + 2) + (17 + 4) = 17 + 19 + 24 = 57$

Therefore the three odd numbers are 17, 19 and 21

Example 5: The sum of two numbers is 30. The difference between $\frac{1}{2}$ of one of the numbers and $\frac{1}{3}$ of the other is 5. Find the two numbers.

Expected Solution

Students read and explain the given word problem and identify the situational characteristics of the problem, which in case this is "number word problem"

Students represent the first number by x and the second number be $30 - x$ then half of one $= \frac{1}{2}x$ and one third of the other $= \frac{1}{3}(30 - x)$

$$\frac{1}{2}x - \frac{1}{3}(30 - x) = 5$$

Solving of equation stage

$\frac{1}{2}x - \frac{1}{3}(30 - x) = 5$

$$\frac{1}{2}x \times 6 - 6 \times \frac{1}{3}(30 - x) = 5 \times 6$$

$3x - 2(30 - 2x) = 30$

$3x - 60 + 2x = 30$

$3x + 2x = 60 + 30$

$5x = 90$

$$x = 18$$

$x = 18$ Finding the value of x, One of the numbers =18 and 30 – 18 = 12 Therefore the other number =12

Checking the answer

Teacher assists students in the group to verify answers by substituting the solution (x= 18) into the original equation

$$\frac{1}{2}x - \frac{1}{3}(30 - x) = 5$$

$$\frac{1}{2}(18) - \frac{1}{3}(30 - 18) = 5$$

$$9 - 10 + 6 = 5$$

$$5 = 5$$

Since RHS = LHS, hence $x = 18$ is the solution.

Activity 2

Teacher gives students some examples to try as she goes round to supervise

Trial Question

Q1: A father and daughter together took GH ₵ 578 each week from the profit of their shop as their wages, the father having twice as much as the daughter. How much did each per week?

Expected Solution

Students to read and explain the given word problem, by identifying the situational characteristics of the problem, which in this case is 'money word problem

Students represent the daughter's wage by x cedis. Then the father's wage is 2x cedis. But their total wage is 150 cedis

solving of equation stages

$$2x + x = 578$$

$$3x = 578$$

$$x = 192.67$$

Check

Since $x = 50$ we now have,

$$2 \times 192.67 + 192.67 = 578$$

$$385.33 + 192.67 = 578$$

$$578 = 578$$

Hence the father took GH ₵ 385.33 and the daughter also took GH ₵ 192.67per week.

Q2: Selorm is three times as old as she was eight years ago. How old is she now?

Expected solutio

Students read and explain the given word problem and identify the situational characteristics of the problem, which in this case is "an age word problem".

Represent Selorm by x years old now. Then her age eight years is $(x - 8)$ years. Three times as old as she was eight years ago is $3(x - 8)$.

Equation

$$x = 3(x - 8)$$

Solving of equation

$$x = 3(x - 8)$$

$$x = 3x - 24$$

$$24 = 2x$$

$$12 = x$$

Check for solutions

$$12 = 3 \times 12 - 24$$

$$12 = 36 - 24$$

$$12 = 12$$

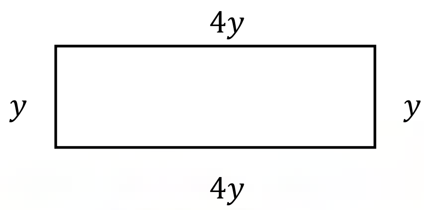
Hence Selorm is 12 years old now?

Q3: Nkansah wants to fence in a rectangular plot land to be used as a dog pen. The length of the rectangle is to be 4 times the breath. If the perimeter of the rectangle is 180cm, what are the dimensions of the pen?

Expected solution

Students to read and understand the given word problem, and identify the situational characteristics of the problem, which in this case is "geometry word problem".

Students represent the breath by y, since the length is 4 times the width, then we have the $length = 4y$



$$Perimeter = 4y + y + 4y + y$$

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

$$= 2(length \times breadth)$$

$$perimeter = 2(length) + 2(breadth)$$

Equation

$$180cm = 2 \times 4y + 2 \times y$$

Solving the equation

$$180 = 8y + 2y$$

$$10y = 180$$

$$y = 18$$

The question asked "what are the dimensions of the pen?

$breadth = y$

$breadth = 18cm$

$length = 4y$

$length = 4 \times 18$

$length = 72cm$

Guided Practice/Interactive Modeling (10 minutes)

Activity 2

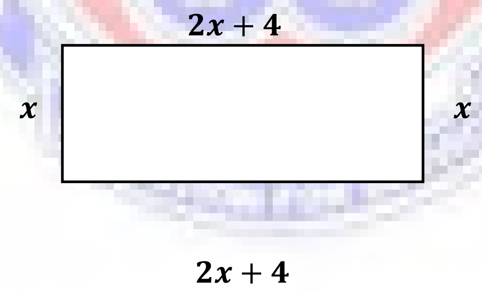
Teacher put students into groups of five to solve the questions below and teacher goes round to supervise.

Q4: *The length of a rectangle is 4 metres more than twice its breadth. If the perimeter of the rectangle is 38metres, what is its breadth?*

Expected solution

Students read and explain the given word problem and identify the situational characteristics of the problem, which in this case is an age word problem.

Breath = x, length = $2x + 4$



$$Perimetre = 2 \times length + 2 \times breadth$$

Equation

$$38 = 2(2x + 4) + 2x$$

Solving of equation

$$38 = 2(2x + 4) + 2x$$

$$38 = 4x + 8 + 2x$$

$$38 = 6x + 8$$

$$38 - 8 = 6x + 8 - 8$$

$$30 - 6x$$

$$x = 5metres$$

The breadth is 5 metres.

Also

$$2x + 4$$

$$2 \times 5 + 4 = 14$$

Hence the length is 14 metres

Checking of answers

$$38 = 6 \times 5 + 8$$

$$38 = 38$$

.**Q5:** Fatima is six years older than Korkor, and the average of their ages twice korkor's age. How old is each person?

Expected solution

Students to read and explain the given word problem, by identifying the situational characteristics of the problem, which in this case is "an age word problem".

Let Korkor's age be y years. Then Fatima will be $(y + 6)\ years$.

Thus, $\frac{y+y+6}{2} = 2y$

Solving equation

$$2y + 6 = 4y$$

$$6 = 2y$$

$$3 = y$$

Checking for solution

$$2 \times 3 + 6 = 4 \times 3$$

$$12 = 12$$

Hence korkor is 3 years old and Fatima is $(3 + 6) = 9$ years old.

Closure: teacher concludes the lesson by summarizing the salient points and gives students some work to be done at home.

Homework.

APPENDIX D

PRE-TEST

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENNT OF MATHEMATICS EDUCATION

PRE-TEST

Subject: Core Mathematics

Code:

Name: Class:

This test is part of a research on your ability to solve algebraic word problem. Data gathered will be used for purposes of research and therefore be honest and show all working on the second part of the paper. Thank you

Read each of the following Algebraic Word Problems to decide and select which of the responses is the most correct matching Algebraic Equations. DO NOT solve the problem.

This test is part of a research on your ability to solve algebraic word problem. Data gathered will be used for purposes of research and therefore be honest and show all working on the second part of the paper. Thank you

Read each of the following Algebraic Word Problems to decide and select which of the responses is the most correct matching Algebraic Equations. DO NOT solve the problem.

1. The sum of trice a number and four is forty two

   a) $3n = 4 + 42$

   b) $3n + 4 = 42$

   c) $3n - 20 = 42$

   d) $42 - 4 = 3n$

2. If twice a number is decreased by two the result is twenty-five.

   a) $x - 2 = 25$

b) $x + 2 = 25$

c) $2x - 2 = 25$

d) $\frac{2x}{3} = 25$

3. The quotient of a number and eight is six.

a) $\frac{n}{8} = 6$

b) $\frac{8}{n} = 6$

c) $\frac{n}{6} = 8$

d) $\frac{8}{n} = 6$

4. Twice a number is five times the sum of the number and seven.

a) $2x + 5 = x + 7$

b) $2x = 5(x + 7)$

c) $3x + 7 = 2x$

d) $7 + 3x = 2x$

5. Twelve minus a number is equal to four times that number

a) $n - 12 = 4n$

b) $12 - n = 4n$

c) $4n - n = 12$

d) $4n = 12n$

Read each of the following Algebraic equations to decide and select which of the responses is the most correct translation to Algebraic Word problem. DO NOT solve the problem

6. $\mathbf{10 - x = 5}$

a) The difference between ten and a number is five

b) the difference between ten and five is a number

c) the sum of ten and five is a number

d) the quotient between a number and ten is five.

7. $\mathbf{40 + 3y = y - 7}$

a) trice a number added to forty is trice the number decreased by seven

b) a number added to forty is the sum of the number and seven

c) the sum of a number and forty is decreased by seven.

d) If trice a number is added to forty, the result is the number decreased by seven

8. $\mathbf{0.10(n + 7) = 5}$

a) 10% of a number plus seven is five

b) 10% of a number and seven is 10% of five

c) 10% of a number and seven is five

d) 10% of the sum of a number and 7 is 5.

9. $\mathbf{x + y = 14}$**..........(1)**

$\mathbf{xy = 33}$**............... ..(2)**

a) the sum of two numbers is fourteen and their product is thirty-three.

b) the product of two numbers is fourteen and their sum is thirty-three

c) the quotient of two numbers is thirty-three and their sum is fourteen

d) the sum of two numbers is thirty-three and their product if fourteen.

10. $\mathbf{x + (x + 2) + (x + 4) = 75}$

a) three consecutive composite numbers add to seventy-five.

b) three consecutive odd integers add up to seventy-five.

c) three consecutive even numbers add up to seventy-five.

d) three consecutive prime numbers add up to seventy-five.

Read and solve each of the following Algebraic Word Problems. Show all working steps

11. The sum of four consecutive even numbers is twenty. What are the numbers?

12. The product of two integers is twelve, and one of the integers is one less than the other. What are the two integers?

13. A woman is six years older than five times her son's age. The sum of their ages is forty-eight. How old is the son?

14. Tickets for a flight from Accra to Kumasi are $363 for adults and $242 for children. A plane took off with a full load of 168 passengers, and the total ticket sales were $57,717. How many adults and how many children were aboard?

15 A hundred and eighty-meter cable must be cut into three pieces. The second piece must be three times as long as the first. The third piece must be forty meters longer than the first. Find the length of each piece.

APPENDIX E

PRE-TEST MARKING SCHEME

Question number	Answers/steps	Mark
1	$3n + 4 = 42$	3
2	$2x - 2 = 25$	3
3	$\frac{n}{8} = 6$	3
4	$2x = 5(x + 7)$	3
5	$12 - n = 4n$	3
6	The difference between ten and a number is five	3
7	If trice a number is added to 40, the result is the number decreased by seven	3
8	10% of the sum of a number and 7 is 5	3
9	the sum of two numbers is fourteen and their product is thirty-three	3
10	three consecutive odd integers add up to 75	3
11	Let the first number be x $\Rightarrow\ x + (x + 2) + (x + 4) + (x + 6) = 20$ $4x + 12 = 20$ $4x = 20 - 12$ $4x = 8$ $x = 2$	M1 M1 M1

	Therefore the numbers are: 2, 4, 6, 8	A1
12	Let the numbers be x and y $xy = 12 \quad ---(1)$ $x = y - 1 \quad ---(2)$ Putting $x = y - 1$ into equation (1) $\Rightarrow y(y-1) = 12$ $y^2 - y = 12$ $y^2 - y - 12 = 0$ $(y-4)(y+3) = 0$ y is either 4 or -3 but y cannot be negative Putting $y = 4$ into equation (1) $4x = 12$ $x = 3$ Therefore the numbers are 3 and	 M1 M1 M1 A1
13	Let the son's age be $= x$ Then the Mum's age $= 5x + 6$ $\Rightarrow x + 5x + 6 = 48$ $6x + 6 = 48$ $6x = 42$ $x = 7$ Therefore the son's is 7 and the mum's age is $5\times 7 + 6 = 41$	M1 M1 M1 A1

14	Let x represents number of adult and y number children $x + y = 168 \quad ------(1)$ $363x + 242y = 57{,}717 \quad ---(2)$ From (1), $x = 168 - y$ Substituting (3) into (2) we will have $363(168 - y) = 57717$ $60984 - 363y + 242y = 57717$ $60984 - 121y = 57717$ $60984 - 57717 = 121y$ $3267 = 121y$ $y = 27$ from (1) $x + y = 168$ $x = 168 - 27 = 141$ There were 27 children and 141 adults aboard	M1 M1 M1 A1
15	Let x represent the length of the first piece $3x$ represent the length of the second piece.	M1 M1 M1

	$x + 40$ represent the length of the third piece. : $x + 3x + x + 40 = 180$ $$5x + 40 = 180$$ $$5x = 140$$ $$x = 28$$ Therefore, the first piece is 28 m, the second piece is 84 m, and the third piece is 68 By substituting the numbers in the concluding statement back into the original equation, we can make sure that these numbers truly add to 180 $$x + 3x + x + 40 = 180$$ $(28) + 3(28) + (28) + 40 = 180$ $$28 + 84 + 68 = 180$$ $$180 = 180$$	A1
Total marks		$50\times 2 = 100$

APPENDIX F

POST-TEST

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENNT OF MATHEMATICS EDUCATION

POST-TEST

Subject: Core Mathematics

Code:

Name:

Class:

This test is part of a research on your ability to solve algebraic word problem. Data gathered will be used for purposes of research and therefore be honest and show all working on the second part of the paper. Thank you

Read each of the following Algebraic Word Problems to decide and select which of the responses is the most correct matching Algebraic Equations. DO NOT solve the problem.

1. The sum of trice a number and four is forty two

   a) $3n = 4 + 42$

   b) $3n + 4 = 42$

   c) $3n - 20 = 42$

   d) $42 - 4 = 3n$

2. If twice a number is decreased by two the result is twenty-five.

   a) $x - 2 = 25$

   b) $x + 2 = 25$

c) $2x - 2 = 25$

d) $\frac{2x}{3} = 25$

3. The quotient of a number and eight is six.

a) $\frac{n}{8} = 6$

b) $\frac{8}{n} = 6$

c) $\frac{n}{6} = 8$

d) $\frac{8}{n} = 6$

4. Twice a number is five times the sum of the number and seven.

a) $2x + 5 = x + 7$

b) $2x = 5(x + 7)$

c) $3x + 7 = 2x$

$d)\ 7 + 3x = 2x$

5. Twelve minus a number is equal to four times that number

a) $n - 12 = 4n$

b) $12 - n = 4n$

c) $4n - n = 12$

d) $4n = 12n$

Read each of the following Algebraic equations to decide and select which of the responses is the most correct translation to Algebraic Word problem. DO NOT solve the problem

6. $10 - x = 5$

a) The difference between ten and a number is five

b) the difference between ten and five is a number

c) the sum of ten and five is a number

d) the quotient between a number and ten is five.

7. $40 + 3y = y - 7$

a) trice a number added to forty is trice the number decreased by seven

b) a number added to forty is the sum of the number and seven

c) the sum of a number and forty is decreased by seven.

d) If trice a number is added to forty, the result is the number decreased by seven

8. $0.10(n + 7) = 5$

a) 10% of a number plus seven is five

b) 10% of a number and seven is 10% of five

c) 10% of a number and seven is five

d) 10% of the sum of a number and 7 is 5.

9. $x + y = 14$……………………..(1)

$xy = 33$………………..(2)

a) the sum of two numbers is fourteen and their product is thirty-three.

b) the product of two numbers is fourteen and their sum is thirty-three

c) the quotient of two numbers is thirty-three and their sum is fourteen

d) the sum of two numbers is thirty-three and their product if fourteen.

10. $x + (x+2) + (x+4) = 75$

a) three consecutive composite numbers add to seventy-five.

b) three consecutive odd integers add up to seventy-five.

c) three consecutive even numbers add up to seventy-five.

d) three consecutive prime numbers add up to seventy-five.

Read and solve each of the following Algebraic Word Problems. Show all working steps

15. The sum of four consecutive even numbers is twenty. What are the numbers?

16. The product of two integers is twelve, and one of the integers is one less than the other. What are the two integers?

17. A woman is six years older than five times her son's age. The sum of their ages is forty-eight. How old is the son?

18. Tickets for a flight from Accra to Kumasi are $363 for adults and $242 for children. A plane took off with a full load of 168 passengers, and the total ticket sales were $57,717. How many adults and how many children were aboard?

15 A hundred and eighty-meter cable must be cut into three pieces. The second piece must be three times as long as the first. The third piece must be forty meters longer than the first. Find the length of each piece.

APPENDIX G

MARKING SCHEME FOR POST-TEST

Question number	Answers/steps	Mark
1	$3n + 4 = 42$	3
2	$2x - 2 = 25$	3
3	$\frac{n}{8} = 6$	3
4	$2x = 5(x + 7)$	3
5	$12 - n = 4n$	3
6	The difference between ten and a number is five	3
7	If trice a number is added to 40, the result is the number decreased by seven	3
8	10% of the sum of a number and 7 is 5	3
9	the sum of two numbers is fourteen and their product is thirty-three	3
10	three consecutive odd integers add up to 75	3
11	Let the first number be x $\Rightarrow\ x + (x + 2) + (x + 4) + (x + 6) = 20$ $4x + 12 = 20$	M1 M1

	$4x = 20 - 12$ $4x = 8$ $x = 2$ Therefore the numbers are: 2, 4, 6, 8	 M1 A1
12	Let the numbers be x and y $xy = 12 \quad - - - (1)$ $x = y - 1 - - - (2)$ Putting $x = y - 1$ into equation (1) $\Rightarrow y(y - 1) = 12$ $y^2 - y = 12$ $y^2 - y - 12 = 0$ $(y - 4)(y + 3) = 0$ y is either 4 or -3 but y cannot be negative Putting $y = 4$ into equation (1) $4x = 12$ $x = 3$ Therefore the numbers are 3 and 4	 M1 M1 M1 A1
13	Let the son's age be = x Then the Mum's age = $5x + 6$ $\Rightarrow x + 5x + 6 = 48$ $6x + 6 = 48$	M1 M1 M1

	$6x = 42$ $x = 7$ Therefore the son's is 7 and the mum's age is $5\times 7 + 6 = 41$	 A1
14	Let x represents number of adult and y number children $x + y = 168 \quad ------(1)$ $363x + 242y = 57{,}717 \quad ---(2)$ From (1), $x = 168 - y$ Substituting (3) into (2) we will have $363(168 - y) = 57717$ $60984 - 363y + 242y = 57717$ $60984 - 121y = 57717$ $60984 - 57717 = 121y$ $3267 = 121y$ $y = 27$ from (1) $x + y = 168$ $x = 168 - 27 = 141$ There were 27 children and 141 adults aboard	 M1 M1 M1 A1
15	Let x represent the length of the first piece $3x$ represent the length of the second piece.	M1 M1

	$x + 40$ represent the length of the third piece. : $x + 3x + x + 40 = 180$ $$5x + 40 = 180$$ $$5x = 140$$ $$x = 28$$ Therefore, the first piece is 28 m, the second piece is 84 m, and the third piece is 68 By substituting the numbers in the concluding statement back into the original equation, we can make sure that these numbers truly add to 180 $$x + 3x + x + 40 = 180$$ $(28) + 3(28) + (28) + 40 = 180$ $$28 + 84 + 68 = 180$$ $$180 = 180$$	M1 A1
Total marks		$50\times 2 = 100$

APPENDIX H

INTERVIEW GUIDE FOR STUDENTS

This study is being carried out on the topic "Using Constructivist Approach to Address Potsin T .I Ahmadiyya Senior High School Students' Difficulties in Solving Algebraic Word Problems In Linear Equations" as part of the requirements for the award of Master of Philosophy Degree in Mathematics Education. Please response to the interview questions as accurately as possible. All responses will be held in strict confidence. Thanks very much in anticipation of your cooperation.

1. How do you prefer to learn, alone or in a group?
2. Why do you prefer to learn alone or in group?
3. What aspects of your learning of the algebraic word problem went well and supported your understanding? Please explain.
4. What aspects did you find difficult in the lesson.
5. Does the use of constructivists makes learning more interesting? How?
6. Do you think you can perform much better in mathematics if your teachers use constructivists approach? Please explain
7. Would you like most of your mathematics lessons to be taught using constructivist approach?
8. Have you ever had a really bad experience with mathematics? If so, what happened?
9. What could teachers do to help students in learning mathematics especially algebraic word problem in linear equation?
10. When working a word problem, do you think you know the meaning of most of the vocabulary words in each problem before now? Please give some examples.

11. Why is it important to know the meanings of vocabulary words you see in mathematics?
12. Did you enjoy working word problems before this school year? If no, why do you think this was the case?
13. Has your attitude, perception, or thinking about word problems changed during this term? If yes why do you think so?
14. What advice would you like to give to mathematics teachers about the way they teach mathematics, especially word problems?
15. What advice would you like to give to students about the way they learn mathematics, especially word problems?

Thank you

APPENDIX I

EXAMPLE OF INSTRUCTIONS FOR THE ACTIVITIES FOR THE GROUPS DURING THE INTERVENTION

1. a) Read the problem thoroughly and carefully and note what is given in the question and what is required to find out or what you are solving for.

   b) Denote the unknown by any variable as x, y… (any variable)

2. Translate the problem into a system of equations using key terms to describe the mathematical operations required or translate the problem to the language of mathematics or mathematical statements. Terms such as 'increased by', 'total of', and 'more than', 'combined together', 'sum', 'added to', etc. signal operations that involve ADDITION.

Phrases such as 'decreased by', 'difference between', 'less than', 'fewer than', 'reduced by', 'difference of', etc. means the operations involve SUBTRACTION.

Words and phrases such as 'of', 'product of', 'times', 'multiplied by', etc. indicate operations that require MULTIPLICATION.

Terms such as 'per', 'out of', 'ratio of', 'quotient of', 'percent', etc. indicate operations that require DIVISION.

When words like 'is' or 'will be' are featured in a word problem, this indicates the total amount of the unknown expressions must be EQUAL.

3. Form the linear equation in one variable using the conditions given in the problems

4. Solve the equations for the unknown

5. Check the proposed solution by plugging the answers into the equation, or verify to be sure whether the answer satisfies the conditions of the problem.

. Below are some of the work the teacher did together with the students.

1. The sum of three consecutive multiples of 4 is 444. Find these multiples.

Solution:

If x is a multiple of 4, the next multiple is x + 4, next to this is x + 8.

Their sum = 444

According to the question,

$x + (x + 4) + (x + 8) = 444$

$\Rightarrow x + x + 4 + x + 8 = 444$

$\Rightarrow x + x + x + 4 + 8 = 444$

$\Rightarrow 3x + 12 = 444$

$\Rightarrow 3x = 444 - 12$

$\Rightarrow x = 432/3$

$\Rightarrow x = 144$

Therefore, x + 4 = 144 + 4 = 148

Therefore, x + 8 - 144 + 8 – 152

Therefore, the three consecutive multiples of 4 are 144, 148, 152.

2. The denominator of a rational number is greater than its numerator by 3. If the numerator is increased by 7 and the denominator is decreased by 1, the new number becomes 3/2. Find the original number.

Solution:

Let the numerator of a rational number = x

Then the denominator of a rational number = x + 3

When numerator is increased by 7, then new numerator = x + 7

When denominator is decreased by 1, then new denominator = x + 3 - 1

The new number formed = 3/2

According to the question,

(x + 7)/(x + 3 - 1) = 3/2

⇒ (x + 7)/(x + 2) = 3/2

⇒ 2(x + 7) = 3(x + 2)

⇒ 2x + 14 = 3x + 6

⇒ 3x - 2x = 14 - 6

⇒ x = 8

The original number i.e., x/(x + 3) = 8/ (8 + 3) = 8/11

3. The sum of the digits of a two digit number is 7. If the number formed by reversing the digits is less than the original number by 27, find the original number.

Solution:

Let the units digit of the original number be x.

Then the tens digit of the original number be 7 - x

Then the number formed = 10(7 - x) + x × 1

………………………….. = 70 - 10x + x = 70 - 9x

On reversing the digits, the number formed

……………………………= 10 × x + (7 - x) × 1

……………………………. = 10x + 7 - x = 9x + 7

According to the question,

New number = original number - 27

⇒ 9x + 7 = 70 - 9x - 27

⇒ 9x + 7 = 43 - 9x

⇒ 9x + 9x = 43 – 7

⇒ 18x = 36

$\Rightarrow x = 36/18$

$\Rightarrow x = 2$

Therefore, $7 - x \quad = 7 - 2 \quad = 5$

The original number is 52

4. A motorboat goes downstream in river and covers a distance between two coastal towns in 5 hours. It covers this distance upstream in 6 hours. If the speed of the stream is 3 km/hr, find the speed of the boat in still water.

Solution:

Let the speed of the boat in still water = x km/hr.

Speed of the boat downstream = (x + 3) km/hr.

Time taken to cover the distance = 5 hrs

Therefore, distance covered in 5 hrs = $(x + 3) \times 5$ (D = Speed × Time)

Speed of the boat upstream = (x - 3) km/hr

Time taken to cover the distance = 6 hrs.

Therefore, distance covered in 6 hrs = $6(x - 3)$

Therefore, the distance between two coastal towns is fixed, i.e., same.

According to the question,

$5(x + 3) = 6(x - 3)$

$\Rightarrow 5x + 15 = 6x - 18$

$\Rightarrow 5x - 6x = -18 - 15$

$\Rightarrow -x = -33$

$\Rightarrow x = 33$

Required speed of the boat is 33 km/hr.

5. Divide 28 into two parts in such a way that 6/5 of one part is equal to 2/3 of the other.

Solution:

Let one part be x.

Then other part = 28 - x

It is given 6/5 of one part = 2/3 of the other.

⇒ $6/5x = 2/3(28 - x)$

⇒ $3x/5 = 1/3(28 - x)$

⇒ $9x = 5(28 - x)$

⇒ $9x = 140 - 5x$

⇒ $9x + 5x = 140$

⇒ $14x = 140$

⇒ $x = 140/14$

⇒ $x = 10$

Then the two parts are 10 and 28 - 10 = 18.

6. A total of $10000 is distributed among 150 persons as gift. A gift is either of $50 or $100. Find the number of gifts of each type.

Solution:

Total number of gifts = 150

Let the number of $50 is x

Then the number of gifts of $100 is (150 - x)

Amount spent on x gifts of $50 = $ 50x

Amount spent on (150 - x) gifts of $100 = $100(150 - x)

Total amount spent for prizes = $10000

According to the question,

$50x + 100 (150 - x) = 10000$

$\Rightarrow 50x + 15000 - 100x = 10000$

$\Rightarrow -50x = 10000 - 15000$

$\Rightarrow -50x = -5000$

$\Rightarrow x = 5000/50$

$\Rightarrow x = 100$

$\Rightarrow 150 - x = 150 - 100 = 50$

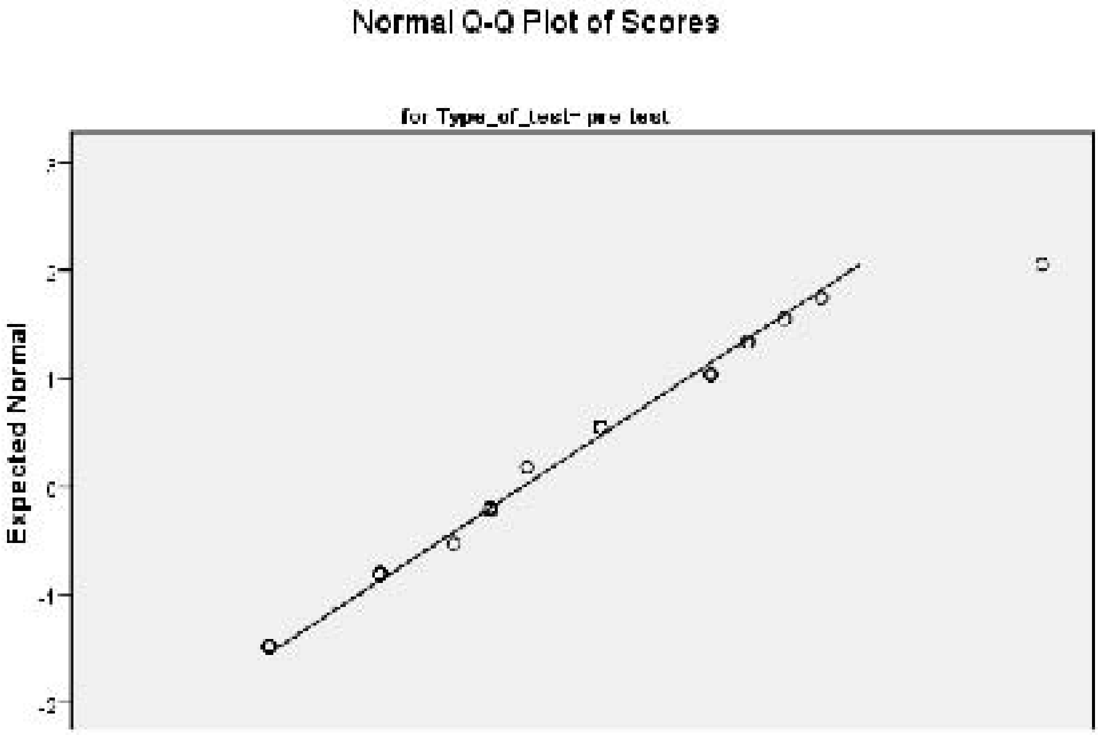
Therefore, gifts of $50 are 100 and gifts of $100 are 50.

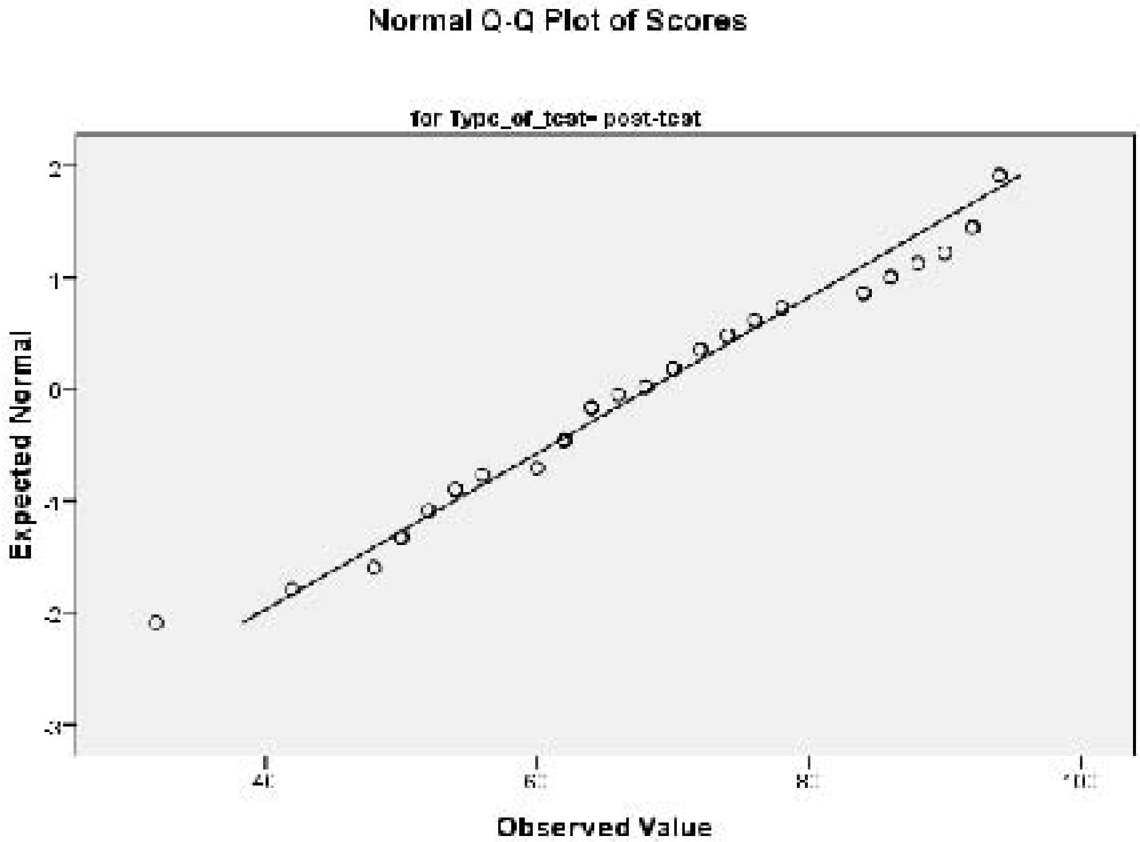
The above step-by-step examples demonstrate the solved problems on linear equations in one variable.

The above step-by-step examples demonstrate the solved problems on linear equations in one variable.

APPENDIX J

THE DISTRIBUTION OF THE PRE-TEST AND POST-TEST SCORES





APPENDIX K

THE GRAPHICAL REPRESENTATION OF THE DIFFICULTIES OF STUDENTS IN SOLVING WORD PROBLEMS

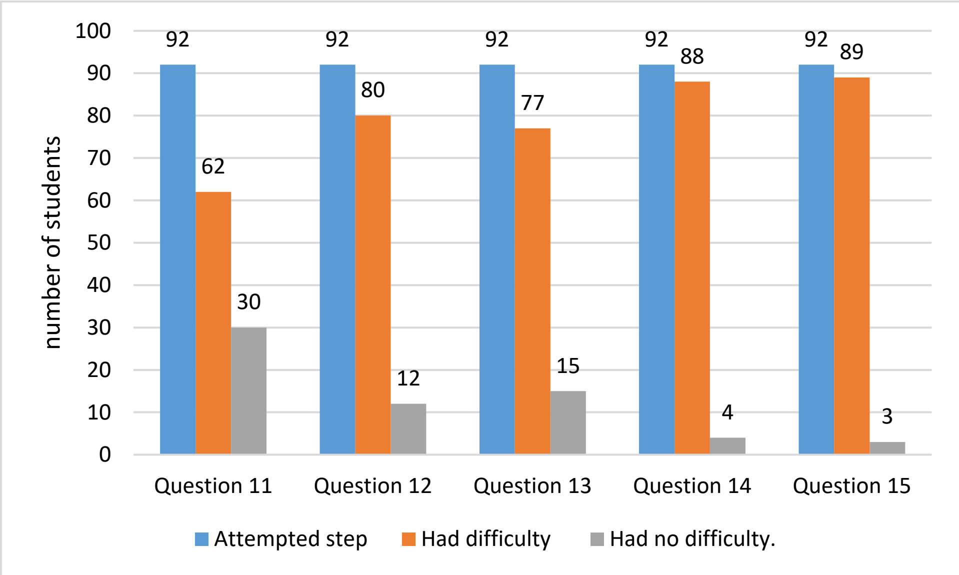


Figure 1 Frequency distribution of students attempting but demonstrating misunderstanding of the problem

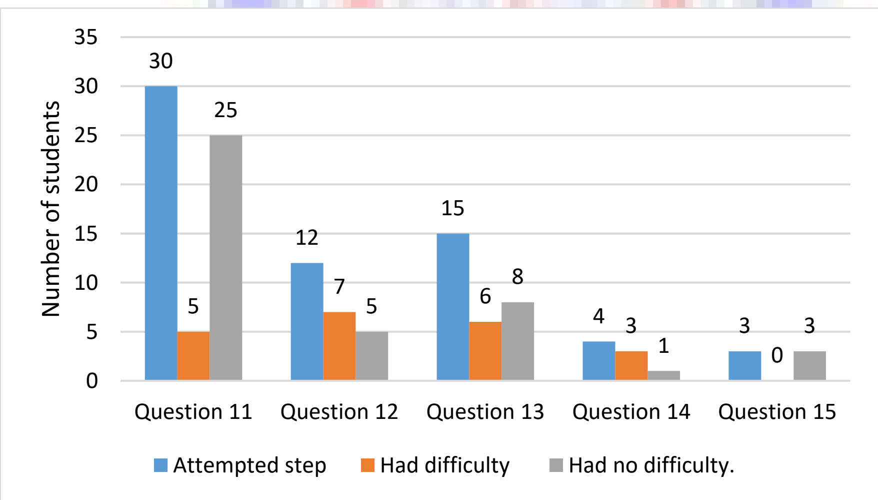


Figure 2 Distribution of students attempting and unable to translate problems

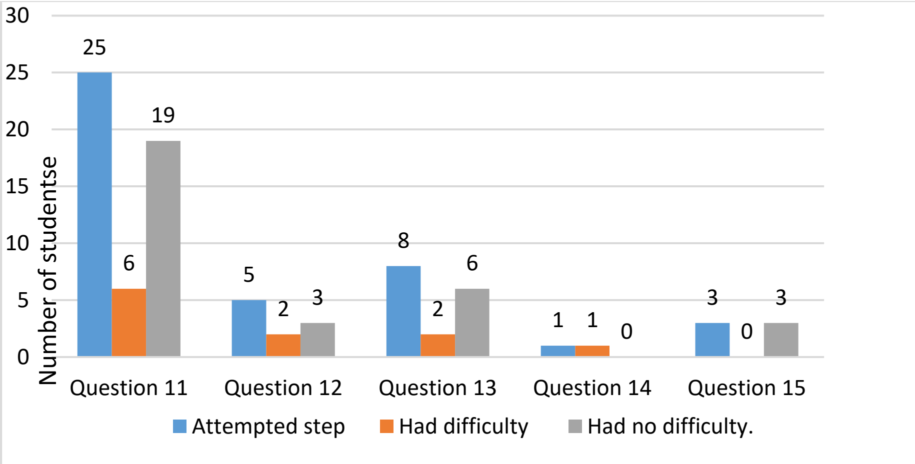


Figure 3 Distribution of students attempting but failing to solve the equation to reach the solution

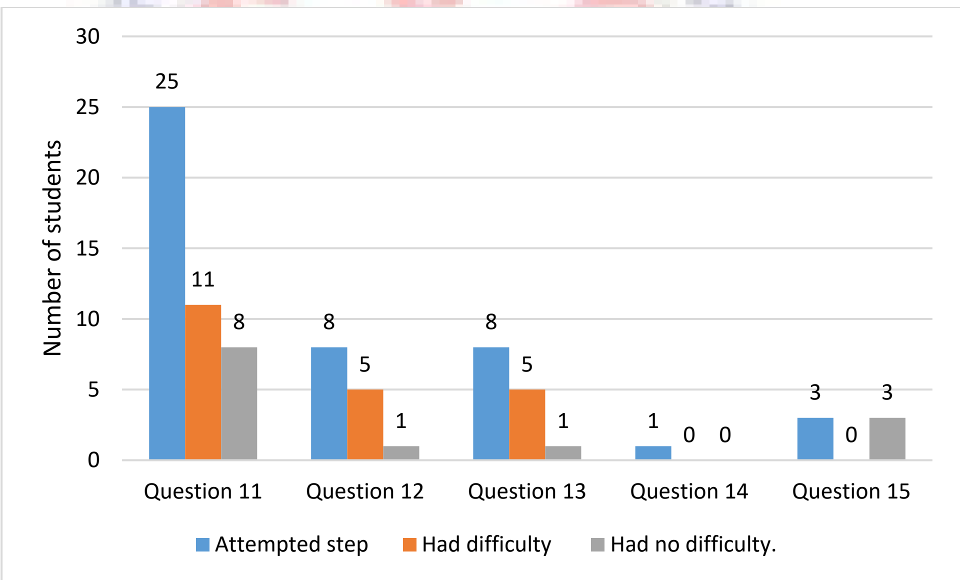


Figure 4 Frequency distribution of students attempting but failing to use the right methods to reach the solution for the equation.