UNIVERSITY OF EDUCATION, WINNEBA

ENHANCING STUDENTS' UNDERSTANDING IN TRANSLATING WORD PROBLEMS INTO ALGEBRAIC EQUATIONS ; A CASE STUDY AT NAVRONGO COMMUNITY VOCATIONAL TRAINING INSTITUTE IN THE GHANA

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NOVEMBER, 2014

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FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF MATHEMATICS EDUCATION

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A DISSERTATION 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 REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION IN (MATHEMATICS)DEGREE

NOVEMBER, 2014

DECLARATION

CANDIDATE'S DECLARATION

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

Candidate's Name: Tuffour, George Kwabena

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Signature Date

SUPERVISOR'S DECLARATION

This project report has been read and approved as meeting the requirements of the School of Graduates Studies, University of Education, Winneba.

Supervisor's Name: Dr. P. O. Cofie

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Signature Date

DEDICATION

To the Almighty God for His faithfulness in fulfilling His promise to me, to my assistant pastors, and members of Truth Ministry for their love, support and prayers throughout the study.

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First of all, my sincere thanks go to the almighty God whose love, protection, mercies and guidance has brought me this far.

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ABSTRACT

Word problem solving on linear equation in one variable is a complex process for many students. The purpose of this research was to use Constructive Teaching and Learning Approach to improve the performance of students in translating word problem into linear equation in one variable and finding the solution of the resultant algebraic equation. T he research is an action research and the design used were unstructured interview, pre-test, and post test Students were interviewed to get an sight into their word problem solving strategies and how they used these strategies in solving word problem involving linear equations in one variable tasks. There was intervention carried out using the constructivist approach to teaching/learning. The analysis of the pre-test and posttest is based on quantitative data collected using descriptive and inferential statistics. The posttest mean score is 59.77 as against the pre-test mean score of 28.46. The major finding shows that the use of the constructive teaching and learning approach in teaching finding solution to word problems on linear equations is effective on students achievement. It is therefore recommended that appropriate courses need to be introduced in the Colleges of Education for the training of teachers in the skills of designing, developing and applying the Constructive Teaching and Learning Approach as well as other concrete materials in teaching translating of word problem into linear equations in one variable at the basic level of education.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Chapter 1 is an introductory part of the study which presents the background to the study, the problem statement, purpose of the study, research questions, delimitations and limitations of the study, significance of the study, operational definition of terms, and organization of the study.

1.2 Background to the Study

Many educationalists have defined what mathematics is. Moursund (2006) for example defines mathematics as an inherently social activity, in which a community of trained practitioners (mathematical scientists) engages in science of patterns based on observation, and experimentation, to determine the nature of regularities in systems. In the view of Barrows (1994), on the other hand says, mathematics is the study of patterns and relationships; a science and a way of thinking, an art, characterized by order and internal consistency, a language of carefully defined terms and symbols; and a unique powerful set of tools to understand and change the world.

These tools include logical reasoning, problem-solving skills, and the ability to think in abstract.

Mathematics all over the world is largely being used as a critical filter for students seeking admissions to second circle and tertiary institutions as well as professionals institutions such as colleges of educations, nursing colleges and polytechnics in Ghana (Adetunde, 2009). Further, if we look at the educational system in Ghana right from kindergarten, the learning of mathematics is one of the basic tools impressed upon. This shows that mathematics forms the foundation of any solid educational system.

Adesoji (2008) reports that there is a strong correlation between mathematics and the physical sciences such as physics and chemistry. The report further indicates that there is a steady decline in numbers of students opting for physics in Nigeria. This is because most of the experiments in physics involve problem-solving skills, drawing of graphs, interpretation of mathematics statements and calculation which most students resent. Hersh (1997) also made an observation and states that mathematics is a human activity, a social phenomenon, part of human culture, historically evolved, and intelligible only in a social context.

Mathematics exists all around us. It can be regarded as a science of numbers, patterns, quantity and space. It is widely regarded as one of the most important subjects and a central aspect of the school curriculum in every society. It is the view of Orton and Frobisher (1996) that more lessons of mathematics are taught in school subjects and colleges throughout the world than any other curriculum. They stated that; whenever conscience are expressed about attainment of students in England and Wales on comparisons, whether legitimate or not, it is made with pupils/students in other countries , and that mathematics is usually singled out as being particularly worrying problem In Ghana, Mathematics, English Language and Science are compulsory subject for all learners up to Form 3 of the Senior High School (Eshun-Famiyeh,2005). Moreover, a lot of concerns are frequently expressed by mathematics educators about the low achievement in both

Junior and Senior High levels of education in Ghana. Many other researchers (Rakes, Valentine, McGatha & Ronau, 2010; Hiebert & Carpenter,1992; Angelo & Cross,1993; Smith, 2001) also share the same sentiments about the poor performance in mathematics. It appears most educators regards mathematics as a very important subject and expects that every child demonstrates a high level of attainment in it.

Mathematics, apart from the fact that it forms a major part of the school curriculum in Ghana , also has a variety of applications in several fields of human endeavor. In everyday life for instances, both the schooled and the unschooled depend on mathematics knowledge and ideas for transactions in vocational, commerce, industry and business, as is (Harris 1991).

As a subject taught in schools, the importance of mathematics is also emphasized by the fact that children who may seek for jobs and those hoping to have further education must demonstrate a certain degree of attainment in it. In Ghana many parents do expect their children to succeed in the subject, with the hope that job opportunities or further education and training might be secured. This is because firstly, the minimum requirement for employment into any skilled job includes at least a pass in core mathematics at the Senior High School (SHS) level. Secondly, a pass in core mathematics is a requirement for entry into Tertiary or Higher Institution. Many students who perform very well in other subject but fail to obtain a pass in core mathematics are deprived of admission to higher education and sometimes not employed into skilled job. This is evident in the large number of students who register and re-sit core mathematics examination year after year in Ghana.

As an essential subject matter in mathematics taught in schools, word problem is important in everyday life. Many forms of activities in employment, science and technology, medicine, the economy, environment and development, and in public decision-making come in the form of word problem. Different cultures have contributed to the development and application of mathematical word problems. Today, the subject matter transcends cultures, cultural boundaries and its importance is universally recognized (Orton & Frobisher, 1996).

The technological challenges of the 21st century are assuming a respectable role in the society and the tools for sciences in the modern society are rooted firmly in a culture of mathematics and science. According to Sherrod Dwyer and Narayan (2009), it is clear that those nations in the world which have taken the culture of mathematics and science seriously are leading, whereas those economics, in which this culture has played little or no role, find themselves lagging behind and their very survival threatened.

In accordance with this, mathematics in Ghana is one of the important subjects that are to be learnt by all students from the Basic School to the higher level of education. Because of its importance, Algebra is one of the topics in Core mathematics syllabus for Senior High School students to study. It involves algebraic expressions, linear equations in one or two variables, quadratic equations etc.(Curriculum Research Development Division 2007)

The researcher's experience as a mathematics tutor at Navrongo Community Development Vocational Training Institute (CDVTI), a second cycle school for three years has made the researcher to identify a conceptual problem that students in the Institute have in solving word problem on linear equations in one variable, especially Form 2 students. This conceptual problem seems to have started from the JHS. At the basic level of education as pointed by Mereku (2001), the Ghanaian mathematics teacher is regarded as a demonstrator of process and transmitter of information and taught largely through lecturing and teacher-centered approaches. This denies the student from experiencing the learning of mathematics using manipulative materials. It is no wonder, therefore that student's performance in mathematics in Ghana remains among the lowest in Africa and the world (Kraft, 1994: TIMSS, 2007).

Further interactions with the researcher colleague's at the Community Development Vocational Schools revealed that many of them do not use the constructive teaching and learning approach .forgetting that vocational school students use the same mathematics curriculum as their counter parts at SHS in the teaching and learning of word problems in one variable. Also the West African Examination Council Chief Examiners' report (2001; 2002; 2006) also pointed out that majority of Senior High School (SHS) candidates refrained from answering questions involving word problem in one variable, and that those who attempt do so poorly.. This report was supported by Mereku (2001), who stated that little attention is focused on the practical aspect of teaching word problems at Basic Level of education. It is noted that students find questions relating to translating word problem into linear equation extremely difficult. When they have other options they go for them even when they do not get the answers right.

The errors students make when attempting to write simple linear algebraic equations have been studied for many years and by a large number of researchers, an early example being Paige and Simon (1966). Some of the mechanisms involved in the translation process, which cause the errors, remain elusive. to the students. The translation process to a greater extent depends on an understanding of the meaning of algebraic variables and this has also been a focus of much research. MacGregor and Stacey (1997) have shown that students' misunderstandings about the meaning of algebraic symbols, depends not only on cognitive development but on various environmental factors, one being the type of instruction used to introduce algebraic symbols.

Clement (1982), identify two processes for translating word problems into algebraic equations, which lead to errors, syntactic translation and static comparison. The process of syntactic translation, where students use the word order in the story to form the equation, frequently results in the relationship between the two variables being reversed.

One paramount issue that comes to force concerning the improvement in education involves the use of constructive learning and teaching approach. The challenge in education today therefore is to improve effectively on the teaching of the students with diverse abilities and different instructions for teaching and learning.

To overcome these challenges a variety of teaching and learning strategies have been advocated for use in mathematics classrooms moving away from the teacher-centered approach to more students-centered ones, and the use of group learning is one of such potential strategies/arrangements. In a research study conducted by Gravemeijer (1991), the use of technology (concrete materials) in schools equalized learning opportunities for all students. In addition he found that student's motivation was heightened by the use of constructive learning and teaching approach with concrete materials, when those resources were used during classroom instruction.

Many mathematical research works revealed the importance of concept formation as a powerful tool for promoting teaching and learning of mathematics. As such, isolating relationship in the teaching and learning of mathematical concepts should give way to practical activities that promote and facilitate easy learning. It could therefore be seen that any current reform made in the field of mathematics education is deeply rooted in finding ways of empowering students to learn to do mathematics in a more simple and practical way (Thompson,1992)

As stated earlier, students' understanding of algebraic expressions serves as the basis for learning other kinds of equations such as word problem, linear, quadratic and simultaneous equations. Therefore the teaching of simple algebraic expressions must be handled with care. Algebra as a topic is more concerned with the study of processes and basic structures than with particular answer to problems. It is in this light that the researcher has decided to make relentless effort to identify the problem faced by students in solving word problem on linear equations in one variable and use using constructive Model approach to teach the students to overcome their problem. The teachers then proved their claim by showing me some examination papers and exercise books of some of their students. About 70% of the questions involving translating word problem into algebraic equation in one variable were wrongly answered by the students.

1.3 Statement of the Problem

Algebra is a powerful problem-solving tool (Nickson, 2000), therefore understanding of algebra is central to students' ability to do mathematics. 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 concepts and thinking skills.

Students in Vocational Institutes in Ghana are required to take the same curriculum in mathematics as their counter parts at the SHS. These students are usually served in inclusive settings, where they often struggle with word problems on linear equations in one variable. Most of them do have some type of language deficiency in reading and writing. For these students, algebraic word problems on linear equations in one variable are particular difficult because the students may have trouble understanding and properly using the information given.

Although limited research and literature are available these days on teaching word problems for students with difficulties, recognized methods –constructivist approach- can help make the word problems experience more enjoyable for them and for other students in the class. (Maccini, McNaughton & Ruhl, 2000)

Dealing with such students Maccini, McNaughton & Ruhl (2000) advocate step-by-step prompts for word problem solving. According to them, prompts can remind students of questions that need to be answered, help them correct errors, and reinforce success

1. 4 Purpose of the Study

The purpose of this study was to use constructive teaching and learning approach to enhance Form 2 students of Navrongo Community Development Vocational Institute in the Upper East of Ghana to improve their understanding to translate word problem into algebraic linear equation in one variable. The use of constructive approach to teach the underlying principles of translating word problem into linear equation in one variable will link concrete representations of mathematical ideas to abstract symbolic representation to enhance conceptual understanding (Capps & Pickreign, 1998)

1.5 Objectives of the Study

This study needed to enhance Form 2 students of Navrongo Community Development Vocational Institute in the Upper East of Ghana to improve their understanding to translate word problems into algebraic linear equation in one variable and to find the solution sets. Therefore the objectives of this research study were to:

1. Identify difficulties of CDVTI Form 2 students in translating word problems into algebraic linear equation in one variable and finding the solution sets
2. Find the effect of using constructivist approach of teaching/learning with CDVTI Form 2 students in translating word problems into algebraic linear equation in one variable. and finding the solution sets

1.6 Research Questions

The inability of most students in Senior High School Level and Community Development Vocational Training Institutes to translate word problems into linear equations in one variable and find their solutions has called for this research work. The research questions guiding the study therefore are:

1. What difficulties do Navrongo CDVTI form 2 students face in solving word problems involving linear equations in one variable?
2. To what extent is the use of constructivist approach of teaching and learning enhance Form 2 students of Navrongo CDVTI ability to translate word problems into algebraic linear equations in one variable and find the solutions?

1.7 Significance of the Study

The results of this study would help to sharpen most 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 also deepen students' understanding of modeling word problems into linear algebraic equations in one variable in the field of mathematics education, and better equip those who plan curriculum and teach students to meet the needs of Senior High/Vocational School Mathematics students. Moreover, the study would serve as a reference material at libraries to mathematics educators and to the general public. Finally, the study would serve as a guide and add new knowledge to what mathematics teachers already have..

1.8 Delimitation

It would have been proper to cover the entire Senior High /Vocational Schools in Ghana but due to the organization of lessons and in view of constraints such as time and finance, the study was restricted to only form 2 students of Navrongo CDVTI. Currently, there are quite a few researches which aim at promoting teacher professional development for increased teaching effectiveness and student learning on word problems involving linear equations in one variable. However the researcher looked at only one of them- constructivism teaching approach which has been used successfully in both the sciences and the social sciences in Ghana and other countries.

1.9 Limitations

There were several limitations in this study. The first limitation to the study was that one student dropped out due to mobility status. In addition, the amount of time for the study (6 weeks) was a limited factor. The class generally includes thirty (35) students which made teaching to be difficult especially using the constructivist approach of teaching. The results of the study were constrained in terms of generability due to the small sample size. The caliber of students admitted by the school students had weak background in Mathematics and English which in turn had influence on the study.

1.10 Operational Definitions of Terms in Context.

1. Constructivism Teaching and learning Approach:- Constructivism is a specific learning theory in which students learn based upon experimentation, observation, and speculation about their own experiences (Matthews, 2003).
2. Traditional Teaching Method**:-** A method where the educator follows a textbook page by page, addresses the students while standing at the front of the room, writes notes on the board for students to copy and/or practice, asks students questions about class work, and waits for students to finish their work
3. Small Group Instruction**:-**A conductive learning environment where a small group of students were given clear and explicit instructional objectives to increase understanding and course content. Students were able to discuss and express questions and concerns on lesson taught.
4. Form 2**:-**A second year class in the formal school system, in secondary education in Ghana.
5. Vocational Education**:-**Education based on occupation or employment which prepares people for specific trades, crafts and career at various levels

1.11 List of Acronyms Used

The following abbreviations were used in the study:

MOET --- Ministry of Education and Training

INSET --- In-service Education and Training

NCTM --- National Council of Teachers of Mathematics

GES --- Ghana Education Service

SSSCE --- Senior Secondary School Certificate Examinations

WAECE--- West Africa Examination Council Certificate Examination

NVTI --- National Vocational Training Institute.

1.11 Organization of the Study.

This research work attempts to provide hands-on activity that can aid mathematics teachers as well as any other state holders deliver with ease the teaching and learning of translating word problem into algebraic linear equation in one variable at basic as well as second cycle level of education in Ghana. The study is therefore organized in to five chapters.

The first chapter is devoted to the background of the study and the statement of the problem. the purpose of the study, research questions, limitations and delimitations. and the significant of the study are included. Also included here are operational definitions of term, and acronyms.

The second chapter addresses review of related literature which involves the systematic identification, location and analysis of documents containing information related to the research problem that has been written by scholars, educators and experts in the field of study. It also points out research strategies and the specific procedures and measuring instruments.

The third chapter focuses on the methodology of the study. Areas covered here include the research design, the identification of the population, the sample and the sampling procedure, instrumentation, data collection and intervention.

The fourth chapter talked on data analysis and discussion of the findings. The chapter also presents the results of the qualitative and quantitative analysis of the data collected for the study.

The last chapter being chapter five is the summary of the study. The areas covered include the summary of findings based on the analysis of the data collected, the conclusion drawn from the findings and recommendations made. Finally, suggestions which focus on the improvement in the teaching of linear equation in one variable at the basic and second cycle schools are addressed

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Undertaking research without consulting other books, magazines, newspapers and journals in which the topic has been dealt with makes the work more difficult. To overcome these difficulties this chapter discussed prior research with regard to views expressed by various researchers who worked on algebra for that matter translating of word problems into linear equation in one variable and finding their solutions. .

2.1 Theoretical Framework

The study was based on the constructivist theory of teaching and learning. Constructivism is a theory based on how people can learn on their own with little guidance (United States of America Educational Broadcasting Corporation, 2004).. It says that, people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. For instance, when we encounter something new, we have to reconcile it with our previous ideas and experience, maybe changing what we believe, or maybe discarding the new information as irrelevant. From constructivist point of view, we are active creators of our own knowledge.

As a philosophy of learning, constructivism can be traced at least to the eighteenth century and the work of Giambattista, (from 1668 to 1744) an Italian political philosopher, rhetorician, historian, and jurist, held the view that humans can only clearly understand what they have themselves constructed. John Dewey (1859-1952) was an American psychologist, philosopher, educator, social critic and political activist who says, education depends on action. Knowledge and ideas emerged only form a situation in which learners had to draw them out of experiences that had meaning and importance to them. These situations had to occur in a social context, such as a classroom, where students joined in manipulating materials and, thus, create a community of learners who built their knowledge together.

The constructivist approach to mathematics instruction views learning as an active process. Cobb (1988) suggested that constructivism challenges the assumption that meanings reside in words, actions, and objects independently of an interpreter. Teachers and students are viewed as active meaning-makers who continually give contextually based meanings to each other's words and actions as they interact.

According to Von Glaserfeld (1989, p. 162) constructivism is a theory of knowledge with roots in philosophy, psychology, and cybernetics. It asserts two main principles whose application has far-reaching consequences for the study of cognitive development and learning as well as for the practice of teaching, psychotherapy, and interpersonal management in general. The two principles are: (a) knowledge is not passively received but actively built up by the cognizing subject; and (b) the function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality.

Unfortunately, few studies had examined the impact of the constructivist approaches to teaching and learning in Vocational Institutions in Ghana, nor have they compared constructivist approaches with methods Vocational Institutions in Ghana currently use to address student performance needs at that level.

Constructivist teaching/learning gives preeminent value to the development of students' personal mathematical ideas. Traditional teaching/learning, on the other hand, values only established mathematical techniques and concepts. For example, even though many teachers consistently use concrete materials to introduce ideas, they use them only for an introduction; the goal is to get to the abstract, symbolic, established mathematics. Inadvertently, students' intuitive thinking about what is meaningful to them is devalued. They come to feel that their intuitive ideas and methods are not related to real mathematics. In contrast, in constructivist teaching/learning, students are encouraged to use their own methods for solving problems. They are not asked to adopt someone else's thinking but encouraged to refine their own. Although the teacher presents tasks that promote the invention or adoption of more sophisticated techniques, all methods are valued and supported. Through interaction with mathematical tasks and other students, the student's own intuitive mathematical thinking gradually becomes more abstract and powerful.

Because the role of the constructivist teacher is to guide and support students' invention of viable mathematical ideas rather than transmit "correct" adult ways of doing mathematics, some see the constructivist approach as inefficient, free-for-all discovery. In fact, even in its least directive form, the guidance of the teacher is the feature that distinguishes constructivism from unguided discovery. The constructivist teacher, by offering appropriate tasks and opportunities for dialogue, guides the focus of students' attention, thus unobtrusively directing their learning (Bruner, 1986).

2.2 Brief History about Algebra

One of the national objectives of education is to prepare the child for life after school and it is only the teaching/learning of mathematics that can prepare the child adequately to fit into the society. A good foundation in algebra is very essential for the success of the child in life. It is an indisputable fact that translating word problem into linear equation in one variable cannot exist without algebra. Therefore, there is the need to find out the historical background about algebra as we deal with linear equation.

The study of algebra dates back to the Babylonians of 2000 B.C. These were the works of Hindus and Greeks which the Babylonians normally preserved. These works were preserved only because Moslem scholars made translations of them. It was later found out that the Arabs took the works of the Greeks and Hindus and greatly expanded them. (Katz V J. Katz,& Baeton B 2007),

It is also believed that, the word ‘algebra’ comes from the title of the work *Hisab al-jabr w'al muquabalah,* a ninth century treatise by the Arab astronomer and mathematician called Muhammed Ibn Musa alkhowarizmi (Charles 1994). The title translates as “the science of reunion and reduction” or more generally “the science of transposition and cancellation”. In the title of Alkhowarizmi’s book, ja*br* (restoration) refers to transposing negative quantities across the equal sign in solving equations. This explains the fact that in our educational curriculum restoration and reduction is done in solving linear equations Furthermore, from the Latin version of Alkhowarizmi’s text, “*al-jabr*” became the broad term covering the arts of equation solving. His book had a tremendous influence in Western Europe; as his name is remembered today in the word ‘algorithm’ (Charles, 1994).

Another historical fact about algebra is that, the English mathematician Robert Recorde (1510-1558) was the first person to use the modern symbolism for the equal sign in an algebra book. He used the pair of parallel line segments ‘=’, meaning “*lbicuase noe 2 thynges can be moare equale”* (Stanley et al, 1988). This equal sign is widely use today in system of equations. Laud (1995) also defined algebra as a short hand of arithmetic where letters and symbols represent numbers. He enumerated some examples of algebraic expressing as; 3x; 6y; x + y; 2n -5m, 13p + 3q - 8w. Hence algebra as a topic in mathematics seems odd and abstract to most students as they consider it as x's and y's. This may answer the question why students perform poorly in this area of mathematics.

According to Sowell (1989) algebra is a system consisting of a set together with operations that follows certain properties. He described the techniques used in solving equations .and finally pointed it out that, even after more than thousand years, solving equations and simplifying expressions continue to be the primary topics taught in an algebra course. This means the importance role algebra plays in mathematics cannot be over emphasized. In view of this, Demana et al (2011) identify properties of algebra as:

1. Commutative; Addition: $u + v = v + u$, Multiplication: $uv = vu$
2. Associative; Addition: $(u + v) + w = u + (v + w)$, Multiplication: $(uv)\,w = u\,(vw)$
3. Identity; Addition: $u + 0 = u$, Identity Multiplication: $u\,1 = u$
4. Inverse; Addition: $u + (-u) = 0$ Inverse Multiplication: $u * \frac{1}{u} = 1$
5. Distributive; Multiplication Over Addition: $u(v + w) = uv + uw$, Left Hand

   $(u + v)w = uw + vw$, Right Hand

   Distributive Multiplication Over Subtraction: $u(v – w) = uv – uw$,

   $(u – v)w = uw – vw$ where u, v and w are real numbers, variables or algebraic expressions.

2.3 The Conceptual Definition of Linear Equation

An equation is a statement of equality between two expressions. A solution of an equation in 'x' is a value of 'x' for which the equation is true. To solve an equation in 'x' means to find all values of 'x' for which the equation is true, that is to find all solutions of the equation. Supporting this definition, Calvin (1990) defined equation as a statement of equality of mathematical expressions. He said, it is a sentence in which the verb is *equal*s (=).to link the two algebraic expressions. Also, Prosser and Trigwell (1999) states that linear equation is an algebraic statement in first degree that contains the equality sign '='and is made up of three basic parts; the equal sign '=', the expression to the left of the equal sign and the expression to the right of the equal sign.

Linear equation in one variable on the one hand has been defined as an equation that can be written in the form "ax + b = c" where 'a', 'b' and 'c' are real numbers and 'a' ≠ 0 (Singletary, 1995). Other researchers such as Dugopolski (2002) supported this definition and explained that, a linear equation in one variable,'x', is a first–degree equation since the variables, have the highest exponent of one. Further, Singletary (1995) asserted that, a linear equation in one variable is a first degree equation that can be written in the form 'ax = b', or 'ax + b = c' where 'a', c and 'b' are real numbers and 'a' ≠ 0.

On her part, Laud (1995) defined linear equation as a statement where one algebraic expression in first degree equals another. She advances that the equality of an equation is maintained if;

- The same number is added to both sides of an equation.
- The same number is subtracted from both sides of the equation.
- Both sides are multiplied by the same number.
- Both sides are divided by the same number. For example, if 4a = b then 4a / y = b /y
- Two different symbols are both equal to the same symbol then they are equal to each other.

For example, if y = x and y = z then x = z.

Supporting Laud‘s point, McBride & Silverman (1997) also found equation and its related terms to be connected. To him an equation is an equality in which unknown(s) may have only a particular value(s). It is a conditional equality which can be solved to get value.

These representations of linear equation in one variable as shown by the named researchers above, confirm the view of other recognized authorities (Streter, Hutchison and Hoelzle 2001) that, a linear equation in one variable contains only one unknown quantity in the mathematical statement. The process of solving such an equation is therefore to find the value of the unknown quantity that makes the mathematical statement true.

Before a child can solve a linear equation correctly he needs to form the concept of equation. The formation of those mathematical concepts depends on the intellectual development of the child, the extent of the child's experiences with a variety of situations that embody the concepts as well as the nature and the conditions of the mind. Supporting this, Nabie (2009) states that, any situation that can affect a child's intellectual development, his/ her state of mind as well as the quality of what is encountered within the environment has the potential to influence the mathematical concept formation process. He further states that to provide for effective teaching and learning of mathematics, mathematics teachers and curriculum developers need good knowledge of the psychological factors, concepts, principles, and processes, which operate to stimulate learning and those that interfere with the process. He concludes by saying that the teacher needs to know how best children can be helped to understand mathematical ideas, the best way of presenting concepts, principles and their applications to children so that the child can understand and use them profitably.

One interesting thing about linear equation is that in adding or subtracting the same number to or from both sides of it, a second equation which is equivalent to the first one is obtained (Martin, 1994). Also if we either multiply or divide both sides of linear equation by the same non-zero number, we obtained a second linear equation which is equivalent to the first one. Underlying the rules for solving equations are four axioms of equality. Amissah (1998) identify these axioms to be reflective, symmetric, transitive and substitutive. He states that for all real numbers a, b and c:

- Reflective Axiom; means a = b
- Symmetric Axiom; means if a = b, then b = a
- Transitive Axiom; means if a = b, and b = c, then a = c
- Substitution Axiom; means if a = b, then a may replace b in any statement without affecting the truth or falsity of the statement.

2.4 Students' Difficulties in Solving Linear Equation Involving Word Problem

Understanding of linear equations and algebraic relationships is the basic to preparing students for success in higher algebraic concepts. It is believed that students need to develop representational techniques for a profound understanding of, and fluency with linear equations. (Silver, 2000) Therefore it is essential to understand students' facility with translating verbal representation of linear equations into mathematical symbolic forms and finding their resultant solutions.

Word problem solving approach is considered as very vital in the teaching of algebraic concepts. Therefore one cannot talk about linear equation without mentioning word problem. In this approach, a problem is posed to learners and through the solution of such a problem they begin to form various algebraic concepts which are inherent in the problem.

Frobisher (1990) indicates that not every question posed in classroom is mathematics problem. The commonly accepted view of a mathematical problem is the “word problem”. He therefore defined word problem as a task presented in words with a question posed to define a goal the solver is expected to attain in carrying out the task. On his part, Cooney et al. (1983) defines the act of solving word problem as a process of accepting a challenge and striving hard to resolve it. Students find word problem in linear equation difficult to solve. Portal and Sampson (2001) state that students find it difficult to solve word problems because they are not sure and cannot decide on what operation to use. They further argued that although mathematics is the most indispensable tool, many students try to learn it without much success because they manipulate word problem according to memorized rules with little or no meaning. Also many students resort to guessing or using other inappropriate strategies as they attempt to solve word problems (Dickson, 1989) This points out that students find it difficult to solve a world problem when they are not introduced to the skills and concepts and when they are confronted with the problem for the first time.

Nabie (2009) on his part put the blame on teachers who hate mathematics. He states that teachers who like mathematics and know the importance of mathematics in life will convey the same message to the children and strive to expose them to avenues that will generate their interest in the subject. He said the reverse is true for the teachers who hate the subject. Thus, students’ poor word problem solving skills is due to some classroom teachers using basic mathematics rules instrumentally.

Many authors and researchers assert also that in school, teaching word problem is one task that causes difficulties to teachers and students.

The researcher also observed that students' difficulties in solving word problem can be attributed to poor reading skills and lack of skills to perform arithmetic operations. This is because the language used by the teachers is important if they are to make positive impact on their learners. Agreeing on this point, Williams (1986) states that mathematics languages should be carefully and accurately used from the beginning. He further observed that mathematics vocabulary needs to be taught and should be taught in the context of practical experience.

A major goal of problem-solving instruction is to enable children to develop and apply strategies to solve problems. Finding solution to the above problems, Vlassis (2002) states the following algebraic strategies to be used:

1. Read the problem carefully - several times if necessary, that is until you understand the problem, know what is to be found, and know what is given.
2. Let one of the unknown quantities be represented by variable, say x, and try to represent all others unknown quantities interns of x.
3. If appropriate, draw figures or diagrams and label known and unknown parts.
4. Look for formulas connecting the known quantities to the unknown quantities.
5. Form an equation relating the known quantities to the unknown quantities.
6. Solve the equation and work answers to all questions asked in the problem.
7. Check and interpret all solutions in terms of the original problem.

Supporting these techniques, Eshun (2000) also indicates in his study the following strategies in problem solving:

- Drawing a diagram
- Forming an equation
- Making a table

- Acting out the story.

All these strategies or techniques would not work effectively if there is lack of good classroom atmosphere.

2.5 Sub-Concepts in Understanding Linear Equations

Pre-requisite knowledge required for learner to understands linear equations comprises of the following:

1. Number sense and operations;
2. Properties of operations;
3. Concept of a variable;
4. Algebraic terms and expressions-(manipulation of algebraic expressions);
5. Identifying and expressing relationships.
6. Proper interpretation of concept of equation/equality;
7. Ability to read and interpret the symbolic form of an equation; and
8. Ability to identify appropriate strategies for solving the equations.
9. Ability to formulate equations from context problems

2.5.1 Number sense and Operations

According to the Curriculum and Evaluation Standards of the NCTM (2000), understanding of the basic operations; addition, subtraction, multiplication and division is central to knowing mathematics. Understanding operations here refers to ability to recognize conditions in real life where the operations would be useful, awareness of the properties of the operations (including the order in which operations should be performed), the ability to identify relationships among operations and having an insight into the effects of the operations on numbers. When students have good operation sense, they are able to apply operations meaningfully and flexibly, and can make thoughtful decisions about reasonableness of their results. In order for them to be able to solve linear equations, students need to have developed number sense for whole number, fractions, decimals, integers, and rational numbers. French (2002 pg 24) also affirms that emphasizing mental calculation at earlier stages of mathematics learning can enhance these prerequisite skills. Students with good number sense do well understand number meanings and do develops multiple relationships among numbers. They are able to recognize the relative magnitudes of numbers; they know the relative effect of operating on numbers and are able to develop referents for measures of common objects and situations in their environments (NCTM 2000). Ability to use multiple representations of numbers is a very important skill in solving mathematical problems. Good operation sense and number sense together would enable pupils to judge reasonableness of their solutions.

2.5.2 The Concept of a Variable.

In introducing algebra, first pupils encounter the concept of a variable, then algebraic terms and expressions, after which equations would follow. This sequence is based on the fact that equations involve expressions, while expressions in turn involve variables. Understanding of the concept of a variable is fundamental to the study of algebra. According to Van de Walle (2004:474), "a variable is a symbol that can stand for any one of a set of numbers or other objects." In some cases the referent set may have only one value, while it may have an infinite number of values in others, and the variable represents each one of them. Pupils need to develop a clear concept of a variable, that is, an understanding of how the values of an unknown change. A variable provides an algebraic tool for expressing generalizations. Unlike constants which can be defined in numerous ways, variables cannot be defined in terms of cardinal or ordinal values but can only be defined by number system reference (e.g. $a = b + c$) or by expression reference

$$(e.g,\ v = \frac{s}{t})$$

Research studies indicate that students experience a lot of difficulties in dealing with letters, in algebra. From the study conducted by Kuchemann (1981:104), six stages through which students progress in acquiring a mental model of a variable are identified. These are as follows:

1 *Letter evaluated*. In this case students avoid operating on a specific unknown and as such simply assign a numerical value to the unknown from the outset. The pupil may recall any number or recall the number fact about the expressed relationship.

2 *Letter not used*. Here a pupil may just ignore the existence of the letter, or at best acknowledge it, but does not give it meaning. For example, If $a + b = 5$, $a + b + 2 =$? and the pupil gives *7* as an answer.

3 *Letter used as an object*. In this case the child regards the letter as shorthand for an object in its own right. For example, '*3b*' as '*3* balls'. At this level pupils are able to regard expressions like $5 + 2a$, $p + 1$ as meaningful.

4 *Letter used as a specific unknown*. The learner here regards the letter as a specific but unknown number, and can operate on it directly.

5 *Letter as a generalized number*. The letter is here regarded as representing, or at least as being able to take several values rather than just one value.

6 *Letter used as a variable*. This is the final stage where the pupil sees the letter as representing a range of unspecified values and understands that a relationship exists

between two such sets of values. It was found in that study that a greater number of the student treated the letters as specific unknowns than as generalized numbers; despite the classroom experiences they had in representing number patterns as generalized statements. The majority either treated the letters as objects or ignored them. It is important that instruction is geared towards helping student construct a clear concept of a variable. Students need to have experiences with the different meanings and uses of variables so that they can become comfortable in dealing with them in different contexts. Activities that offer student opportunity to explore and investigate patterns, and require them to make verbal formulations of rules that describe the observed patterns and finally generalize situations can play a significant role in the development of the concept of a variable. While English and Warren (1998: 168-169) support this idea, they have however realized that "students find it easier to verbalize a generalization than to express it symbolically". It is clear therefore that a clear understanding of variable is essential as variables provide the algebraic tool for expressing generalizations.

2.5.3 Algebraic Terms and Expressions

Mathematical knowledge is communicated through the symbolic mathematical language. This language uses numbers, letters and other conventional symbols. Austin and Howson (1979) assert that mathematical symbolism in its now internationally accepted form, is shorthand, the bulk of which has been devised by speakers of a few related languages. The use of this symbolism can accordingly cause considerable difficulties to those whose mother tongue has different structures. The use of this formal mathematical language requires the pupil to have a clear understanding of the relevant mathematical concept in order that she/he can translate into the correct symbolic notation, manipulate the symbols and then be able to translate back into meaningful concepts (Austin & Howson 1979).

Use of brackets in mathematics is also one of the complications in interpreting mathematical expressions or statements, as this structure is not present in ordinary language. Earlier research provides evidence that simplification of algebraic expressions creates serious difficulties for many pupils (Linchevski & Herscovics 1996). Students experience serious problems in grouping or combining like terms. Whereas in arithmetic, operations yield other numbers, in algebra operations may yield algebraic terms and/or expressions. For example,

Arithmetic	Algebra
$2 \times 4 = 8\ (8\ is\ a\ new\ \ number)$	$2 \times a = 2a\ (\ a, term)$
$3 + 4 = 9$	$a + b\ (expression)$
$\frac{12}{6} = 2$	$\frac{a}{b}\ b \neq 0\ (a\ term)$

$1 \times 2 + 4\ \ , can\ be\ simplified\ to\ numeric\ term\ while\ \ 3(x + y)\ can\ only\ be\ 3x + 3y$

When given a problem whose final answer is, say, $2x + 3$, some student would go further to give $5x$ as their answer. This results from the fact that to these students $2x + 3$ is not acceptable as the solution; to them a solution should always be a single term. It is clear from this that pupils need to be helped to appreciate the dual nature of expressions. They should be able to see expressions as a process and as a product. Expressions encapsulate a process as instructions to calculate a numerical value, but they are also a product as objects which can be manipulated in their own right (French 2002 pg 24). As French puts it "failure to appreciate this dual nature of expressions is a major barrier to success in algebra" (French 2002 pg 24). Tall and Thomas cited in French (2002 pg 15) and Nickson (2000 pg 142) identified four obstacles frequently met by pupils in making sense of algebraic expressions. These are:

- The parsing obstacle;
- The expected answer obstacle;
- The lack of closure obstacle; and
- The process-product obstacle.

To some pupils, the Plus (+) sign signals that they have to do some calculation; they expect to produce an answer. This is what is referred to as the expected answer obstacle. The way we read from left to right is also noted to influence pupils to interpret for example $3 + 2x$ as saying 'add 3 and 2 and then multiply by x.' This obstacle is what is termed the parsing obstacle. This obstacle also leads pupils into reading "*ab* as *a* and *b*" and thereby end up thinking that it is the same as $a + b$. When pupils show discomfort when they have to accept, say, $2x + 3$ as a final answer after some algebraic manipulations is said to be due to the 'lack of closure' obstacle. To the pupils this is an incomplete answer. The process-product obstacle refers to pupils' failure to appreciate the dual nature of algebraic expressions i.e expressions can indicate an instruction and at the same time they can represent the result of the operations (French 2002:15-16).

From the study that Bishop & Stump, (2000), conducted, many pre-service teachers lacked full understanding of what algebra was and could not explain the kind of activities which may characterize a classroom that promotes algebraic reasoning. It is worth noting that when teachers' knowledge about the role of letters in mathematics is rich, it is very likely that the necessary understandings will be passed over to their pupils. As (Bishop & Stump, 2000 pg 108). puts it ‘‘teacher with a rich understanding of connections between mathematical ideas is more likely to reveal and represent them, at the same time, a teacher who lacks them is unlikely to promote deep insight in his or her students’’.

2.5.4 Manipulation of Algebraic Expressions and Equations

The above-mentioned problems with algebraic terms and expressions lead to further problems that are usually seen when pupils solve equations. Pupils who have insufficient conceptual knowledge about terms and expressions experience serious problems when they have to read and interpret the symbolic form of equations. Pupils are usually not able to make sense of the algebraic equations, as they do not really understand the structure of the relations in the equation (Kieran, 1992 pg 397).

Kieran identified some complexities in the use of the word structure in the context of algebraic equations.. According to Kieran (1992), surface structure, refers to simply the arrangement of different terms and operations that go to make up an algebraic (or arithmetic) expression or equation.. As Nickson (2000 pg 112) puts it, ‘‘Systemic structure refers to the properties of operations within an algebraic expression and the relationships between the terms of the expression that come from within the mathematical system’’. For example, rewriting $2 + 5(x + 2)$ as $5(x + 2) + 2$ using the commutative law or as $5x + 12$ using the distributive law and addition. There is also the notion of the *structure of an equation*, which incorporates the systemic structure and the relationship of equality (Nickson, 2000:112).

Solution of linear equations involves both procedural and structural operations. Procedural operations refer to the arithmetic operations carried out on numbers to yield numbers, while structural operations refer to a set of operations carried out on algebraic expressions. For example, substituting p and q in to the algebraic expression p + q with real numbers to obtain 13 is a procedural operation while simplifying an expression such as 5p + q – 2p to yield an equivalent expression 3p + q is a structural operation.(Kieran 1992:392).

Algebraic manipulations include processes such as simplifying, expanding brackets, collecting like terms, factorizing, etc. In solving linear equations these processes are performed when transforming the original equation to its simpler equivalent forms. Earlier research studies e.g. Kieran (1992), and the experience of the researcher as a mathematics teacher, reveal that most pupils do actually encounter difficulties when they are confronted with solving equations involving negative numbers. This is usually evident where brackets are involved, particularly when the brackets follow the minus sign. Other cases include where the like terms are collected and there is a gap in between them, with a minus sign before the other terms. Nickson (2000:120) indicates that these result from a static view of the use of brackets and jumping off with the posterior operation by pupils. According to Nickson, pupils at this level could not realize that "926 – 167 - 167 was the same as 926 - (167 +167) as only two of the 27 pupils thought this was the case. "The jumping off with the posterior operation" refers to cases where pupils, in an attempt to collect like terms where the distance between the terms is involved, they tend to focus on the operation sign that follows the term. For example x + 7 – 2x – 3 may be simplified to 3x – 4. Mastery of skills and knowledge required for correct manipulation of algebraic expressions plays a very significant role in pupils' ability to solve linear equations correctly. French (2002: 24) affirms that understanding and fluency in performing operations with negative numbers is an essential pre-requisite for learning algebra successfully. He notes, "a proper understanding of algebraic processes is inevitably very dependent on a corresponding understanding and facility with arithmetical operations"(French(2002: 47).

2.5.5 The Concept of Equation / Equality

Equations are mathematical statements that indicate equality between two expressions. Many pupils at the elementary level and junior secondary level fail to interpret the equal sign as a symbol denoting the relation between two equal quantities. To them the sign is interpreted as a command to carry out a calculation. Experience in classroom teaching has it that in solving for the unknown in an equation of the form $7 + 3 = x + 9$

Pupils would respond as follows: $7 + 3 = 10 + 9 = 19$.

Usiskin et al (2003: 137) further illustrate this situation by indicating that when pupils are asked to find out what number would make the statement 7 +__ = 10 + 5 true, many would give the answer as 3, seeing 10 as the result after addition, ignoring the 5 on the right. This kind of response also indicates that to pupils the equality has a from left to right. In their workings, particularly those that involve extended computations; learners would calculate, for example, 13 + 45 + 7 as 13 + 45 = 58 + 7 = 65. This clearly indicates that pupils interpret the equal sign as the command to carry out the calculation; it does not represent the relation between the left hand side and the right hand side of the equation. The above-indicated problem suggests that teachers should emphasize the meaning of the equality and the role of the equal sign in an equation to the pupils. It is very important that learners are helped to develop proper interpretation of the equal sign as this understanding is essential in algebraic manipulations.

2.5.6 Formulating Equations From Context Problems

Mathematics is taught in schools to develop in the pupils, knowledge and skills that they require in solving problems they may encounter in their daily life. It has however been realized that when confronted with realistic mathematical problems, pupils often find it very hard to formulate the given problem situation into the symbolic mathematical language. This is mainly due to lack of correct interpretation of the question, which involves identification of variables and relationships that exist between those variables.

As mentioned earlier, mathematics is sometimes considered a language, due to its strong lingual base, often spoken in symbolic notations. Mathematical terms are well defined and symbols are used to express the mathematical relationships in shorthand. From previous studies, it has been realized that, when solving algebraic word problems pupils experience serious difficulties when interpreting a problem and translating it into the symbolic mathematical language.

MacGregor (1991: 25) indicates that several researchers have confirmed that the sequential left to right translation from ordinary language to mathematical symbolism is a common procedure taught to pupils. The common error associated with this approach is the 'reversal error'. The *student-professor* problem is the well-known example that illustrates this. The problem requires students to write an equation for this statement: "At this university there are six times as many students as professors" using S for the number of students and P for the number of professors (MacGregor 1991:19).From research reports, some responses to the *student-professor* problem were $6S = P$ which is actually wrong. Although this question was asked to university students, their wrong response is a result of their inherent misconceptions from early years in algebra learning. Kieran (1992:403) reckons "some semantic knowledge is often required to formulate these equations; but solvers only typically use nothing more than syntactic rules." As English and Halford (1995) put it "students rely on direct syntactic approach to solving these problems, that is, they use a phrase-by- phrase translation of the problem into variables and equations" (English & Halford 1995:241). Berger and Wilde (1987:23) also affirm "algebra word problems have been a source of consternation to generations of students." Even for those pupils who are most able in solving linear equations, the moment these equations are cloaked in a verbal cover story (Berge &Wilde 1987:123), they also struggle to solve such problems. From experiences that one has gathered as a mathematics teacher, it has become very clear that in order for pupils to become successful problem solvers, they need to be taught problem solving as a skill.

According to Constructivism effective learning occurs when pupils are actively involved in the process, therefore exposing learners to solving many real life mathematical problems is very advantageous in developing their problem solving skills.

2.6 Modeling Equations From Verbal Representations

Mathematics is a language for communication and a tool for new discovery. Like any language, it has grammatical rules and syntax structure that can be difficult for students to master (Esty, 1992). Students must have skills in reading comprehension and reasoning before an algebraic expression or equation can be derived. The use of language in classrooms is critical in developing these skills with Senior High students. Before students learn to represent algebraic situations symbolically, they should have opportunities to discuss them in easily understood, everyday language, thus developing their conceptual understanding (Kieran & Chalouh, 1993).

According to Rosnick (1981), Students' greatest difficulties in algebra are modeling equations from problem situations. Translating from verbal relational statements to symbolic equations, or from English to mathematics, causes students of all ages a great deal of confusion. Like the solving of equations, modeling equations from word problems can be taught with a procedural or conceptual emphasis.

Lodholz (1990) observed that writing equation from word problem is often a skill taught in contrived situations or isolation. Mathematical word problems that require students to write an expression that represents "5 more than 3 times a number;" when taught apart from opportunities for application, can cause students difficulty when interpreting meaningful sentence later. This gives students a procedural method for doing what, by nature, should be conceptual. Students may translate English sentences to mathematical expressions, simply moving from left to right. "Three less than a number" is interpreted by many students as "3-x" since the words "less than" (which means to subtract, they have always been told) follow the 3. Teachers must be aware of these misconceptions and address them in instruction (Lodholz, 1990).

Writing equations from word problems is a difficult skill for students, whether caused by cognitive misconceptions or literal translation. Students' inclination to translate directly from English sentences to algebraic expressions may be augmented by the procedural method many teachers use when addressing this topics in class. It is not uncommon for teachers to encourage students to look for "key words" in word problems that signify a particular operation (Kroesbergen et al., 2004). According to Wagner and Parker (1993), though looking for key words can be a useful problem-solving heuristic, it may encourage over-reliance on a direct, rather than analytical, mode for translating word problems into equations.

2.7 The Constructivist Classroom

A constructivist teacher and a constructivist classroom exhibit a number of discernable qualities markedly different from a traditional or direct instruction classroom. A constructivist teacher is able to flexibly and creatively incorporate ongoing experiences in the classroom into the negotiation and construction of lessons with small groups and individuals. The environment is democratic, the activities are interactive and student centered, and the students are empowered by a teacher who operates as a facilitator/consultant.

Constructivist classrooms are structured so that learners are immersed in experiences within which they may engage in meaning-making inquiry, action, imagination, invention, interaction, hypothesizing and personal reflection. Teachers need to recognize how people use their own experiences, prior knowledge and perceptions, as well as their physical and interpersonal environments to construct knowledge and meaning. The goal is to produce a democratic classroom environment that provides meaningful learning experiences for autonomous learners. This perspective of learning presents an alternative view of what is regarded as knowledge, suggesting that there may be many ways of interpreting or understanding the world. No longer is the teacher seen as an expert, who knows the answers to the questions she or he has constructed, while the students are asked to identify their teacher's constructions rather than to construct their own meanings. In a constructivist classroom, students are encouraged to use prior experiences to help them form and reform interpretations. This may be illustrated by reference to a personal response approach to literature, using a constructivist strategy first articulated by Rosenblatt in 1978. Rosenblatt (1978) argues for a personal and constructive response to literature whereby students' own experiences and perceptions are brought to the reading task so that in transacting with that text, the realities and interpretations which the students construct are their own. A reader response approach to literature rejects the idea that all students should necessarily come to the same interpretation of a selection of literature, that single interpretation being the teacher's or someone else's. A reader response approach allows students to explore variant interpretations, the teacher's own interpretation being only one possible interpretation in the classroom.

In a traditional classroom, an invisible and imposing, at times, impenetrable, barrier between student and teacher exists through power and practice. In a constructivist classroom, by contrast, the teacher and the student share responsibility and decision making and demonstrate mutual respect. The democratic and interactive process of a constructivist classroom allows students to be active and autonomous learners. Using constructivist strategies, teachers are more effective. They are able to promote communication and create flexibility so that the needs of all students can be met. The learning relationship in a constructivist classroom is mutually beneficial to both students and teachers.

2.8. Constructivist View of Teaching Mathematics and Classroom Practice

Having began as a theory of learning; constructivism has progressively expanded its dominion, becoming a theory of teaching, a theory of education, a theory of the origin of ideas, and a theory of both personal knowledge and scientific knowledge. Constructivism is undoubtedly a major theoretical influence in mathematics education because it arguably fits in with, and supports, a range of programmes in mathematics education (Confrey, 1990; Bentley, 1998).

Taylor (1996), have discerned three 'constructivist theories': epistemological, psychological and pedagogical. Constructivism as an epistemological theory is grounded in the claim that all knowledge is self constructed, and does not mirror an objective reality; constructivism as a psychological theory of learning builds on the notion that acquiring knowledge asks for active construction by the learner. According to this pedagogy, the role of the teacher is to help the students elaborate and expand their own constructions (Cobb, 1988).

A number of influential inquiries into the teaching of mathematics (Ernest, 1996; NCTM, 2000) have propounded humanized and anti-absolutist (if not wholeheartedly fallibilist) views of mathematics, which arguably supports the investigational approach to the teaching of mathematics. Constructivism as a theory of teaching and learning mathematics can influence a type of pedagogy, which can lead to better understanding of mathematics and better communication of mathematics ideas by students (Schifter & Fosnot, 1992; Raymond, 1993; Jaworski, 1994). Simon and Schifter (1991) studied the effects of constructivist oriented in-service programme for teachers on their students' learning of mathematics. They found that, along with the transformations in the nature and quality of mathematics activity in the classroom, the students' belief about learning mathematics changed and their attitude towards mathematics improved.

The construction of knowledge in the classroom goes beyond the interaction between teacher and student to the wider interaction between students themselves in the social and cultural environment and beyond. It seems crucial for mathematics teachers to be aware of how mathematics learning might be linked to language, social interaction and cultural context. (Jaworski, 1994, p.28). In the constructivist classroom, teachers and pupils are viewed as active meaning makers who continually give contextually based meanings to each others' words and action as they interact (Flecher, 2000).

2.8.1. Cooperative Learning

Some recent definitions of cooperative learning include:

An activity involving a small group of learners who work together as a team to solve a problem, complete a task, or accomplish a common goal (Artzt & Newman, 1990).

A task for group discussion and resolution (if possible), requiring face-to-face interaction, and atmosphere of cooperation and mutual helpfulness, and individual accountability (Davidson, 1990). The instructional use of small group so that students work together to maximize their own and each other's learning (Johnson, Johnson & Smith, 1991).

By encouraging a state of cooperative learning and classroom discussion focused on student-to-students exchange, students will be encourage to construct and evaluate their own and their classmates' knowledge and reasoning and will becoming better problem solvers (Karen, 2006).

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Overview

When one embarks on research work, a sequence of events take place; the situation to be investigated is fully defined, samples are chosen from an appropriate population using an established procedure, samples are analyzed and conclusions are drawn (Jone, 1999).

Chapter 3 therefore, deals with the method use in conducting the study. It covers the research design, population and sampling procedure, instrumentation, pretest, interview, post-test, data analysis procedure and intervention.

3.2 Research Design

The model for this study is action research, since it seeks to find solution to students' inability to solve word problems on linear equations in one variable effectively. Mills (2004) defined action research as any systematic inquiry conducted by teachers, administrators, counselors, or others with a vested interest in the teaching and learning process, for the purpose of gathering data about how their particular schools operates or how they teach, and how students learn so as to improve teaching/learning.

Furthermore, action research is preferred in this context because it deals with a small scale intervention which is appropriate to one classroom situation in which the researcher carried out the study. As a teacher in the field, one aspect of the design involved a series of interviews conducted on some randomly selected students who did not do well in the pre-test of the sampled class. The students were interviewed on their level of understanding of the manipulative materials used to present mathematical concepts.

The researcher used qualitative data to get better insights on students' mathematical thoughts and understanding. The qualitative aspects of this research allowed the researcher to see and interpret things in their natural settings, attempting to make sense of it. Qualitative data are important because they provided important viewpoints, and explanations to students' problem-solving abilities. In addition, the researcher used quantitative data to establish if any teaching method/strategies affected students' problem-solving abilities in translating word problem into linear equation with one variable. Quantitative researched used numbers to quantify the cause-effect relationship (Mills, 2004). The use of quantitative data was important because it allowed the researcher to see analysis and effective display of both numeric and textual data. Trustworthiness and creditability were obtained by the use of multiple data sources:

3.3 Population and Sampling Procedure.

The research was conducted at Community Development Vocational Training Institute-Navrongo . It is in Kasen-Nankana Municipality of Upper East region in Ghana. The Municipal is bounded in the east by Bolgathanga, Upper East Regional capital , West by Paga , North Sandima . The strategic location of Navrongo has made the school enroll students from many ethnic backgrounds in Ghana. The school runs three academic programmes, namely Secretariat , Fasion ,and Catering. The institution is a second cycle school according to the school standards in Ghana and is basically mixed-day and private under Department of local government consisting of 108 students. Out of that 11(10%) are boys and 97 (90%) are girls.

The targeted population of this study consists of all Form 2(two) students with a total population of 35 since they were those who demonstrated behaviours and strategies that were particularly illuminating. The students do offer the secretariat, fashion, and catering programs with an average age of 16 years. The research did not cover students from other Senior High/Vocational Schools. However, since they are following the same programmes it is likely that such difficulties in solving word problem on linear equation in one variable may prevail in those schools as well.

3.4 Instrument

The main source of collecting data for the study was unstructured interviews, achievement test and classroom, observations. There was pre-test and post-test. The pre-test, post-test as well as interview were the methods used to gather information on the students' possible cause of poor performance in solving word problem involving linear equation in one variable. The pre-test and the post-test were task given to students to carry out in order to know their level of performance. These tests also served as bases for evaluating the students.

3.4.1 The Interviewing Processes

The nature of the interviews used in mixed research is in a range or continuum. Participant observers tend to favour the use of in-depth unstructured interview instruments, which are open-ended. These only outline topic to be discussed with participants. Maykut and Morehoue (1994) explain that "with one's focus of inquiry clearly in mind, the researcher tactfully asks and actively listens in order to understand what is important to know about the [students] in that setting'' (p.81). There are no pre-determined questions and respondents are given the freedom of response. The researcher asks questions pertinent to the study as opportunity arises, then listens closely to participant's responses for clues as to what question to ask next, or whether it is necessary to probe for additional information.

The students were interviewed to get an sight into their word problem solving strategies and how they used these strategies in solving word problem involving linear equations in one variable tasks. This occupied a major part of the study and was mainly to gather descriptive data in the participants own words so that insights could be developed on the study. During the interviewing process, students who were not comfortable with the activities were excused. Comparability was achieved by asking interviewees to respond to the same tasks and perform the same activities. The tasks given to the participants involved: were based on:

1. Translating word problem involving variable of linear equation in one variable into mathematical languages.
2. Students' interest in word problem involving linear equations in one variable
3. Students' confidence in solving word problem involving linear equations in one variable.

4. Importance of word problem involving linear equation in one variable to students. and
5. Strategies used by students in solving word problems involving linear equation in one variable

3.4.2 Pre-Test

A pre-test on algebraic word problem was given to the target group to find out their strength and weaknesses. The pre-test was made up of ten (10) items (see Appendix A1). The first six items were based on simple algebraic word problems and students were asked to translate them into algebraic linear expressions/equations. For the last four items on the pre-test, the students to translate the word problems on involving linear equation in one variable into algebraic form and solve the resultant algebraic linear equations in one variable.

3.4.3 Administering the Pre-Test

The pre-test items were given to students during a normal class teaching periods and the researcher asked the students to respond to the questions individually.

Each student was given a printed question paper and answer sheets. The duration of the pre-test was thirty (30) minutes. Responds to the items of students for the pre-test were marked using a marking scheme (See Appendix A2). The researcher examined the task given to the students for common errors and weaknesses, and also critically examined the wrong responds given by students' to find out possible causes of errors in students thinking..

3.4.4 Post-Test

After the intervention, a post-test was conducted to find out the effect of the intervention activities on students in modeling algebraic word problems into linear expressions/equations. The post-test was not exactly the same as the pre-test, with the reason that if the intervention has been effective then the students should be able to answer the items. The post- test consisted of ten (10) items and the duration of the test was forty-five (45) minutes. (See Appendix B1). Answers of the students to the post-test questions were marked using a marking scheme I prepared. (See Appendix B2).

3.5 Validity and Reliability

The researcher in order to ascertain the content validity and reliability of the instrument, some lecturers including the supervisor of the Department were consulted to review the test item, they evaluated whether the items were relevant to the research questions. Their suggestions helped to establish the face and content validity of the items. Hopkins (2000), expresses precision as validity and reliability. He explains that validity represents how well a variable measures what it is supposed to measure and reliability as how consistent the measure is on a retest. The items were then piloted.

3.6 Intervention

This section discusses intervention used to remedy the difficulties of CDVTI- Navrongo Form two (2) face in solving linear equation in one variable.

3.6.1 Constructive Teaching and Learning Strategies During Intervention

Constructive learning approach was used as teaching approach where students were grouped principally according to mixed ability- high and low achievers- each group was made up of five (5) students. The intention of having students with mixed ability was to encourage them to challenge each other's thinking and skills since the challenge presented by different thinkers leads to higher group and individual achievement, higher- quality reasoning strategies, and solutions to problems (Johnson & Johnson, 2009). In addition, students working in the various groups tended to be more intrinsically motivated, intellectually curious, caring of others and psychologically healthy. That is not to say that competition and individual work should not be valued and encouraged. For example, competition is appropriate when there can be only one winner, as in a sporting event, and individualistic effort is appropriate when the goal is personally beneficial and has no influence on the goals of others (Slavin, 1995). Moreover, the researcher effectively used teacher- lead made groups;– instead of the traditional choose your own groups. Students were also made to rotate group roles depending on the activity. Potential group roles and their functions includes:

1. Leader – the leader is responsible for keeping the group assigned tasks The leader also makes sure that all members of the group have equal opportunity to participate , learn and have respect of their team members. The leader make sure that all of the group members have mastered the learning points of a group exercise.
2. Secretary -he/she picks and maintains the group files and folders on daily basis and keep and keep records of all group activities including the material contributed by each group member. The recorder writes out the solutions to the problems for the group to use as notes or to submit to the instructor.
3. Monitor – the monitor is responsible for making sure that the group's work areas is left the way it was found and acts as a time keeper for timed activities
4. Wildcard: the wildcard acts as an assistant to the group leader and assumes the role of any member that may be missing.(Refer to Appendix C For Activities)

3.6.2 Problem Faced during Intervention Process

The major problem that I encountered during the intervention process was that some of the students did not take part in the discussion because they were sacked for non-payment of school fees. Also, initially, the researcher did not have the full cooperation of the students as the whole process was not explained to them. Finally, the time spent in applying the intervention was not enough as the breaking down of the question items used during the intervention involve a lot of time to discuss.

3.7 Data Analysis Procedure

Data were analysed using mixed method (qualitative and quantitative).Quantitative analyse is based on the research questions formulated for this study. According to Cooper and Schindler (2006), quantitative research attempts precise measurement of something and it determines facts and figures. Quantitative analysis is used to figure out exactly what happened, or how often things happened. Quantitative analysis collects data that is factual and can be measured and considered statistically Cooper & Schindler (2006). Frequency tables with percentage of students performance in word problem were constructed for the various responses of the students, and to the various questions covered in the pre-test and the post-test. For further confirmation on quantitative methodology, the data collected was analyzed using t-test comparison.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.0 Introduction

In Chapter 5, the pre-test and post-test scores of students were analyzed to find the conceptual understanding of students in translating word problem into algebraic linear equation in one variable. The analysis of the data is divided in to two parts. The first part deals with Descriptive Statistics analysis and the second part deals with inferential analysis. The sequence of the presentation and the discussion of the results obtained were discussed in accordance with the research questions formulated for the study.

4.1 Analysis of Pre-test Scores of Students

Students were first given a pre-test and then exposed to a series of an instructional teaching after which they were given a post-test. The pre-test were conducted based on the students' previous knowledge on the mathematical concepts they have learnt. Students were asked to use any method of their choice to solve the questions. The marks obtained out of 100 by the students in the pre-test are shown in Table 4.1 below.

Table 4.1 Pre-test Scores of Students

24	35	48	28	32	18	35
18	31	11	28	38	35	8
38	31	22	40	13	35	38
51	8	21	28	28	32	21
58	8	35	48	31	12	9

From the over all pre-test score of students as shown in Table 4.1 above, only two (2) of the students representing 5.75% scored above 50 marks or above, while 94.25 fell below the 50 mark.

After marking students' test items, the researcher examines the items one by one based on the two (2) objectives of the pre-test, mainly the ability to translate mathematical word problem into algebraic linear expressions/equations and the ability to solve resultant algebraic linear equations. The results of the analysis of pre-test scores are as shown Table 4.2 below:

Table 4.2 Sample size, Success and Failure Rates on Pre-test Items of Students

n	No. of success Item 1 -6	%	No. of success Item 7 -10	%	Total Success	%	Total Failure	%
35	8	22.86	2	5.71	10	28.57	25	71.43

From Table 4.2, the number of students who answered items 1 to 6 which was based on the ability to translate mathematical word problem into algebraic linear expressions/equations correctly was 8 representing 22.86.6%, while 27 of the students representing 77.8% had the items wrong. The researcher observed that only 10 students representing 28.57% out of the sample size of 35 were able to solve the items correctly and 25 representing 77.8% had the items wrong.

Item 1 from the pre-test required the students to write an algebraic expression representing two times a number plus 5times the same number. The correct response is, $2x + 5x$ (if we let x be the number). The students responses were $2(x + 5x)$ and the majority wrote $2x$ +5y as the answer. Most of the students wrote the expression in two variables instead of writing it in one variable.

Item 2 from the pre-test required that the student add $6 \; and \; \frac{x}{10}$ Most tudents' responses for items 2 were; $\frac{6+x}{10} \; and \; \frac{6x}{10}$ instead of $6 + \frac{x}{10}$**.** Most of the students' interpreted 'sum' to mean product and also some divided the sum of 6 and x by 10. For item 3, the students were asked to subtract 20 from 4 times any variable say, x. The students misunderstood this to mean subtracting 4 times a number from 20 and wrote $4x – 20$, instead of $20 - 4x$**.** For item 4, 10 less than a number means subtraction 10 from any variable say x. But most of the students use the operation sign '<' to get $10 < x$ and some of the students also subtract 10 from the variable to get $10 –x$, instead of $x – 10$. Also a student wrote $10x$ as the correct answer.

Item 5 from the pre-test required the students to write an algebraic linear equation representing the situations. "Ama has some trading cards. Aku has 3times as many trading cards as Ama. They have 36 trading cards in all." Only one student was able to write the correct answer, that is $x + 3x = 36$. The Students likely saw the phrase "3 times" in the problem and thought to translate that as

3x. The “36 trading cards in all” indicated to students that they should finish their algebraic linear equation $3x = 36$ instead of $x + 3x = 6$. The majority of the students made this mistake.

Items 6 required the students to write an expression that could be used to represent the number of rows, if there were n girls all together and each row had 6 girls. The most popular answer given by the students was 6n. Many of the students chose multiplication as the necessary operation, when the situations actually called for the division of the total n by 6, the number of girls in each row

From the result of the pre-test, the researcher observed that, the general performance of the students on modelling algebraic linear expressions/equations was very poor Only 2 of the students had items 7 – 10 though most of them attempted the items.

4.2 Analysis of Post-test Scores of Students

The post-test was administered after students were introduced to the intervention with regard to the of using constructive teaching and learning approach to enhance their ability to translate word problems into algebraic linear equation in one variable and find the solution sets of the resultant equations. The post-test questions were similar to the pre-test questions and this assisted the researcher to assess the effectiveness of the intervention. The researcher examined the students' responses to the items one after the other in order to obtain sufficient information about students' thinking process to each of the items. The marks obtained out of 100 by the students after the post-test were as shown in Table 4.3.

Table 4.3 Post-test Scores of the Students

49	79	52	84	46	49	86

29	52	86	36	76	89	81
56	59	42	35	49	58	84
36	32	54	83	47	52	85
49	79	43	38	59	61	97

Table 4.3 shows the post-test scores of the 35 respondents who took part in the study. From the table, twenty one (21) respondents representing 60% had marks of 50 or more while 14 representing 40% of the respondents had below 50 marks. This shows an improvement over the pre-test.

After marking the post-test scripts, the researcher examined the questions based on the 2 objectives (translating word problem, and solving algebraic linear equation in one variable) of the test. The results obtained are as shown in Table 4.4 below:

Table 4.4 Sample size, Success and Failure Rates on Post-test Items of Students

n	No. of success Item 1 - 6	%	No. of success Item 7 - 10	%	Total Success	%	Total Failure	%
35	23	65.71	10	28.57	33	94.29	2	5.71

From Table 4.4, the number of students who answered items 1 to 10 which was based on the concept of translating word problem into algebraic linear equation and finding the solution sets were 33 representing 94.29% out of the 35 respondents. .Only two (2) students representing

5.71% failed to answer all the items.. Most of the students were able to answer the questions well though they were not able to score full marks. During the intervention stage they were introduced to varieties of questions using the constructive teaching and learning approach. This assisted the students to apply the concept correctly. The students could interpret words like "sum" to mean "add", "difference" to mean "subtract", "quotient" to mean "divide" and "product" to mean "multiply" after the intervention .The two respondents who were not able to solve the items correctly found it difficult moving away from the arithmetic approach to the algebraic approach thus were still using the traditional approach.. They also had few errors in the use of the operational signs and in calculation

There were some respondents rewriting and crossing out their solution sets. This showed that they were able to reject an initial model or solution method that was not useful and therefore had to think through the item again.

The intervention process has helped the students to understand the concepts and did not rely on memorized procedures to solve algebraic linear equations. This shows a remarkable improvement with Form 2 students of NCVTI on solving word problems involving linear equations in one variable.

4.3 Mean and Standard Deviation of Pre-test and Post-test Scores of Students

The students mean and standard deviation for the scores of the pre-test and post test are shown in Table 4.5 below.

Table 4.5 Mean and Standard Deviation of Students' Scores Mean

	Mean	N	Std. Deviation	Std. Error Mean
PRE TEST SCORES OF STUDENTS	28.4571	35	12.89173	2.17910
POST TEST SCORES OF STUDENTS	59.7714	35	19.55698	3.30573

Comparing the means of the Pre-test and Post-test, in Table 4.5, it is observed that the mean for the pre-test is 28.46 while that of the post-test is 59.77. at P=00, which is less than 0.05..This is in line with the finding of Awante and Amppiah (2004)

4.4 Discussion of Findings

To answer the two research questions, researcher used the analysis of the results from the pre-test and the post-test

Research Question 1**:** What difficulties do Navrongo CDVTI Form 2 students face in solving word problems involving linear equations in one variable?

A common finding from the analysis of the pre-test is that many of the Form 2 students of NCVTI lack procedural flexibility; are not sure and cannot decide on what operation to use. They only depend on algorithms which they know by rote thus have difficulties. They find it difficult to understand the text of the problem. These influence the strategies they use, and the justification they give for their solutions when faced with translation of word problems into algebraic equations. This is in line with Portal's (2001) finding when he states that students find it difficult to solve word problem often because they are not sure and cannot decide on what operation to use. He further argued that although mathematics is the most indispensable tool, many students try to learn it without much success because they manipulate word problem according to memorized rules with little or no meaning. Also many students resort to guessing or using other inappropriate strategies as they attempt to solve word problems Teachers should remember that students' selection of a solution strategy depend extensively on the strategies employed by their teachers to solve word problems on linear equations in one variable in their lessons. This also supports Nabie (2009) finding that students' poor word problem solving skills is due to some classroom teachers using basic mathematics rules instrumentally.

Research Question 2. To what extent is the use of constructivist approach of teaching and learning enhance Form 2 students of Navrongo CDVTI ability to translate word problems into algebraic linear equations in one variable and find the solutions?

In Table 4.5 the results of the pre-test and posttest were compared. The posttest had a mean score of 59.71 with a standard deviation of 19.56 as against that of the pre-test scores with a mean of 28.46 and a standard deviation of 12.89. This shows a significant improvement in students' performance on the posttest. The researcher can conclude that finding solutions to word problems on linear equation in one variable at Navrongo CDVTI came about as a result of the use of the Constructive Teaching and Learning Approach.

Another finding, is that students discovered during the intervention that there are often several correct ways of finding a solution to a problem. This finding also is in line with that of Kieran and Chalouh (1993) who hold the view that teachers who employ Constructive Teaching and Learning Approach usually outperform those who do not use them, because when students are given the opportunity to express algebraic situations in easily understood language, as a means of developing conceptual understanding of a problem before representing them symbolically.

The results showed that Form 2 students of Navrongo CDVTI main difficulties were mostly as a result from their inability in representation and understanding of word problems, making a plan and defining related vocabularies. Other difficulties were text difficulties, unfamiliar context in problems and using inappropriate strategies.

CHAPTER 5

SUMMARY CONCLUSION AND RECOMMENDATION

5.0 Introduction

This chapter is the final chapter of the research study and contains the summary of the research findings, conclusion as well as recommendations and suggestions for further research work.

5.1 General Over view of the Study.

The purpose of this research was to use Constructive Teaching and Learning Approach to improve the performance of students in translating word problem into linear equation in one variable and finding the solution of the resultant algebraic equation. The research is an action research and the design used were unstructured interview, pre-test, and post test

The researcher identified the problem of the students during the course of teaching them. In an attempt to solve the problem, pre-test consisting of 10 questions based on translating word problem into algebraic linear equation were given to a sample of 35 the students of Navrongo CDVTI. The following research questions assisted the researcher:

1. What difficulties do Navrongo CDVTI form 2 students face in solving word problems involving linear equations in one variable?
2. To what extent is the use of constructivist approach of teaching and learning enhance Form 2 students of Navrongo CDVTI ability to translate word problems into algebraic linear equations in one variable and find the solutions?

Constructive Teaching and Learning Approach was the main interaction instrument because the researcher wanted to assist students to use it to solve linear equations. This is because most of the students saw the presentation as strange as they were not taught with the Constructive Teaching and Learning Approach. The pre-test and the post-test were analyzed using descriptive and inferential statistics. Even though the intervention was effective in improving student's performance in translating word problem into linear equation in one variable yet not all the students were able to solve problems using Constructive Teaching and Learning Approach

5.2 Summary and Conclusion of Findings

The topic translating word problem into Linear equation in one variable sounded familiar to most students though they still have difficulties in it. The statistical difference showed that the intervention tools of Constructive Teaching and Learning Approach used improved student's algebraic knowledge under the study. This indicated that teachers have been teaching the translating of word problem into linear equation in one variable without the use of the Constructive Teaching and Learning Approach. They use direct method (traditional method). This makes students not to interact with each other during the lesson. They were not also allowed to work in groups neither they were made to criticize their own classmates work. The research revealed that students did not know that they could learn better from their classmates until the intervention stage. The intervention let students develop more positive attitude towards word problems and mathematics as a whole

Word problem solving is one of the important elements of mathematical problem solving which incorporate real life problems and applications. But from the study on word problem solving of linear equation in one variable, some students Navrongo CDVTI are faced with difficult items including: not being able to adequately understand define the word problems: not having sufficient experience in word problem solving: not knowing which problem need to use addition or subtraction operation; and finally lack of motivation, and reluctance of some of the students to give the problem a start.

Finally the vital role of algebra for that matter translating word problem into linear equation cannot be over stated since it covers most of the topics in mathematics and other subjects.

5.3 Recommendation

Based on the findings of this study, the researcher would like to make the following recommendations as essential for consideration:

1. Teachers try as much as possible to employ the use of the Constructive Teaching and Learning Approach as part of their instructional strategies in their planning and delivering of lessons.
2. Teachers should help improve the mathematical language of students by given them much task on translation of word problems into algebraic equations
3. Teachers must make students see difficult words in the text from other angles until meaning is clear.

4. Regular in-service training workshop on word problems solving should also be organized on regular basis.
5. Students should be made to solve a lot of problems practically in class. using different strategies.(cooperative and discovery)
6. Finally, appropriate courses need to be introduced in the Colleges of Education for the training of teachers in the skills of designing, developing and applying the Constructive Teaching and Learning Approach as well as other concrete materials in teaching translating of word problem into linear equations in one variable at the basic level of education.

5.5 Suggestion for Future Research

This study was carried out with 35 Form 2 students of Navrongo CDVTI and as such the result cannot be generalized for the whole country Ghana. It should therefore be replicated in other Vocational Training Institutes in Ghana.

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APPENDIX A1

Name………………………………………………………..…… Class……………

PRE-TEST QUESTIONS

Time: 30mins.

Answer all the questions

1. Two times a number plus 5times the same number.
2. The sum of six and a number divided by 10.
3. 20 decreased by four times a number.
4. 10 less than a number.
5. Ama has some trading cards. Aku has 3times as many trading cards as Ama. They have 36 trading cards in all. Write an equation to represent their trading cards.
6. There are m girls scouts marching in a parade. There are 6 girls in each row. Write an expression to find out how many rows of the girls scouts are marching in the parade?

7. Find the value of x in the equation 43 = x - 28

8. Find the value of x that make the equation 19 = 3 + 4x true.

9. Solve the equation 4x = (35 – x)

10. Find the value of x in the equation $\frac{2}{3}x - 21 = \frac{1}{5}x$

APPENDIX A2

PRE-TEST MARKING SCHEME

1. Let x be the number, ____$B_{1/2}$ ⇒ 2x + 5x___$A_{1/2}$

2. Let x be the number, ____$B_{1/2}$ ⇒ 6 + $\frac{x}{10}$ ___$A_{1/2}$

3. Let y be the number,____$B_{1/2}$ ⇒ $20 - 4y$ ___$A_{1/2}$

4. Let z be the number, ___$B_{1/2}$ ⇒ $z - 10$____A

5. x + 3x = 36__$A_{1/2}$

6. ⇒ $\frac{m}{6}$__$A_{1/2}$

7. 43 = x – 28____A

⇒ 43 + 28 = x – 28 + 28 (Add 28 to both sides)

⇒ 61 = x

∴ $x = 61$___$A_{1/2}$

8. 19 = 3 + 4x___$A_{1/2}$

$\Rightarrow 19 - 3 = 3 - 3 + 4x$ (Subtract 3 from both sides)

$\Rightarrow 16 = 4x$

$\Rightarrow \frac{16}{4} = \frac{4x}{4}$ (Divide both sides by 4)

$\Rightarrow 4 = x$

$\therefore x = 4$_____$A_{1/2}$

9. $4x = 3(35 - x)$___$A_{1/2}$

$\Rightarrow 4x = 105 - 3x$ (Expand to remove the bracket)

$\Rightarrow 4x + 3x = 105$ (Group like terns)

$\Rightarrow 7x \quad = 105$

$\Rightarrow \frac{7x}{7} \quad = \frac{105}{7}$ (Divide both sides by 7)

$\Rightarrow x \quad = 7$

$\therefore x \quad = 7$____$A_{1/2}$

10. $\frac{2}{3}x - 21 = \frac{1}{5}x$____$A_{1/2}$

$\Rightarrow 15 \times \frac{2}{3}x - 21 \times 15 = 15 \times \frac{1}{5}x$ (Multiply through by 15 i.e. LCM)___$M_{1/2}$

$\Rightarrow 10x - 315 = 3x$___$A_{1/2}$

$\Rightarrow 10x - 3x \quad = 315$ (Group like terms)

$\Rightarrow 7x \quad = 315$

$\Rightarrow \frac{7x}{7} \quad = \frac{315}{7}$ (Divide both sides by 7)

$\Rightarrow x \quad = 45$

$\therefore x \quad = 45$____$A_{1/2}$

APPENDIX B1

Name………………………………………………………. Class…………………

POST-TEST QUESTIONS

Time: 45mins.

Answer all the questions.

1. Four times a number is three times the difference between thirty-five and the number. Find the number.
2. Eight less than five times a number is four more than eight times the number. Find the number.
3. The difference between six times a number and four times the number is negative fourteen. Find the number.
4. Twice the difference between a number and twenty-five is three times the number. Find the number.
5. Five times a number less than 12 is 48. Find the number.
6. Twice the sum of a certain number and 26 is 72. Find the number.

7. Three times the sum of 8 and an unknown number is equal to twice the sum of the unknown number and 7. Find the number.
8. When twice the sum of five and an unknown number is subtracted from eight times the unknown, the result is equal to four times the sum of eight and twice the unknown number. Find the unknown number.
9. The sum of three numbers is 81. The second number is twice the first, and the third number is six more than the second. Find the numbers.
10. When 21 is taken from two-third of a certain number, the result is one-fifth that number. Find the number.

APPENDIX B2

POST-TEST MARKING SCHEME

Let x be the number.

1. $\Rightarrow 4x = 3(35 - x)$____A1/2

$\Rightarrow 4x = 105 - 3x$ (Expand to remove the bracket)

$\Rightarrow 4x + 3x = 105$ (Group like terns)

$\Rightarrow 7x = 105$

$\Rightarrow \frac{7x}{7} = \frac{105}{7}$ (Divide both sides by 7)

$\Rightarrow x = 15$

$\therefore x = 15$ ____A1/2

2. $\Rightarrow 5x - 8 = 8x - 4$ ____A1/2

$\Rightarrow 5x - 8x = -4 + 8$ (Group like terms)

$\Rightarrow -3x = 4$

$\Rightarrow \frac{-3x}{-3} = \frac{4}{-3}$ (Divide both sides by -3)

$\Rightarrow x \quad = -\frac{4}{3}$

$\therefore x \quad = -\frac{4}{3}$____A1/2

Therefore the number is – 4

3. $\Rightarrow 6x - 4x = -14$____A1/2

$\Rightarrow 2x \quad = -14$

$\Rightarrow \frac{2x}{2} \quad = \frac{-14}{2}$ (Divide both sides by 2)

$\Rightarrow x \quad = -7$

$\therefore x \quad = -7$_ ___A1/2 . Therefore the number is – 7

4. $\Rightarrow 2(x - 25) = 3x$ ____A1/2

$\Rightarrow 2x - 50 \quad = 3x$ (Expand to remove the bracket)

$\Rightarrow 2x + 3x \quad = 50$ (Group like terms)

$\Rightarrow -x \quad = 50$

$\Rightarrow \frac{-x}{-1} \quad = \frac{50}{-1}$ (Divide both sides by -1)

$\Rightarrow x \quad = -50$

$\therefore x \quad = -50$____A1/2

5. $\Rightarrow 12 - 5x = 48$____A1/2

$\Rightarrow 12 - 12 - 5x = 48 - 12$ (Subtract 12 from both sides)

$\Rightarrow -5x \quad = 36$

$\Rightarrow \frac{-5x}{-5} \quad = \frac{36}{-5}$ (Divide both sides by -5)

$\Rightarrow x \quad = -\frac{36}{5}$ Or $-7\frac{1}{5}$____A1/2

6. $\Rightarrow 2(x + 26) = 72$ ____A1/2

$\Rightarrow 2x + 52 \quad = 72$ (Expand to remove the bracket)

$\Rightarrow 2x + 52 - 52 = 72 - 52$ (Subtract 52 from both sides)

$\Rightarrow 2x \quad = 20$

$\Rightarrow \frac{2x}{2} = \frac{20}{2}$ (Divide both sides by 2)

$\therefore x \quad = 10$_____A1/2

7. $\Rightarrow 3(8 + x) = 2(x + 7)$____A1/2

$\Rightarrow 24 + 3x \ = 2x + 14$ (Expand to remove the brackets)

$\Rightarrow 3x - 2x = 14 - 24$ (Group like terms)

$\Rightarrow x \quad = -10$_____A1/2

Therefore the number is – 10

8. $\Rightarrow 8x - 2(5 + x) = 4(8 + 2x)$____A1/2

$\Rightarrow 8x - 10 - 2x \ = 32 + 8x$ (Expand to remove the brackets)

$\Rightarrow 8x - 2x - 8x \ = 32 + 10$ (Group like terms)

$\Rightarrow -2x \quad = 42$

$\Rightarrow \frac{-2x}{-2} = \frac{42}{-2}$ (Divide both sides by -2)

$\therefore x \quad = -21$_____A1/2

9. Let the first number be x, the second number be $2x$ and the third number be $2x + 6$

$\Rightarrow x + 2x + 2x + 6 = 81$____A1/2

$\Rightarrow 5x + 6 - 6 \quad = 81 - 6$ (Subtract 6 from both sides)

$\Rightarrow 5x \quad = 75$

$\Rightarrow \frac{5x}{5} \quad = \frac{75}{5}$ (Divide both sides by 5)

$\therefore x \quad = 15$____A1/2

Therefore the first number is 15, the second is 30 and the third number is 36

10. $\Rightarrow \frac{2}{3}x - 21 = \frac{1}{5}x$ _____A1/2

$\Rightarrow 15 \times \frac{2}{3}x - 21 \times 15 = 15 \times \frac{1}{5}x$ (Multiply through by 15)

$\Rightarrow 10x - 315 = 3x$

$\Rightarrow 10x - 3x = 315$ (Group like terms)

$\Rightarrow 7x = 315$

$\Rightarrow \frac{7x}{7} = \frac{315}{7}$ (Divide both sides by 7)

$\therefore x = 45$____A1/2

Therefore the number is 45.

APPENDIX C

Activity 1

In the first two weeks, l guided the students through how an English sentence can be translated into mathematical statements. I explained to the students that, there are often conditions necessary for writing algebraic expressions/equations. Examples can be seen below:

The sum of a number and five.

Sum means "add"

Answer: $x + 5$

The difference between a number and four

Difference means "subtract"

Answer: $x - 4$

The quotient of 5 and a number.

Quotient means "divide"

Answer: $\frac{5}{x}$

The product of nine and a number.

Product means "multiply"

Answer: $9x$

Activity 2

From the second week onward, I took the students through the following problems.

Activity two was done to teach the students how to translate words into numbers, variables, and operations using constructivist approach of teaching.

In this activity, I guided the students to write an algebraic linear expression for each problem. I then explained each term in the questions to the students after observing their answers.

1. Write each phrase as an algebraic expression:

A. the quotient of a number and 4

I realized that most of the students were able to write the correct answer. However, some still wrote $\frac{4}{n}$ as the answer instead of $\frac{n}{4}$

I then explained;

Let n be the number,

I asked the students: what is the meaning of the word "quotient**"** in the question.

Students' respond**:** Quotient means "divide"

Now write the expression for the phrase **"**the quotient of a number and 4**"**

Students' respond: $\frac{n}{4}$

B. *w* increased by 5

For this particular question, all the students had the correct answer.

Students' respond: $w + 5$

C. the difference of 3 times a number and 7

In this question also, most of the students found it very difficult to write the correct expression. Some wrote $7\text{-}3x$, while others wrote $3(x\text{-}7)$ instead of $3x - 7$.

I then explained: The difference of 3 times a number and 7

I asked the students: what is the meaning of the word "difference" in the question.

Students' respond: Difference means "subtract"

I then asked the students to write an expression for the phrase, **"**3times a number**"** given that x is the number.

Students' respond**:** $3x$ as the answer.

Now, I asked the students to write an algebraic expression for the phrase "the difference of $3x$ and 7."

Students' respond: $3x – 7$

D. the quotient of 4 and a number, increased by 10

I have observed here that, the explanation given in the previous questions helped the majority of the students to successfully write the correct expression for this question. However, I guided those who were not able to write the correct expression to do so.

I asked: write an expression for the phrase, "the quotient of 4 and a number", given that n is the number.

Students' respond: $\frac{4}{n}$

I asked: write an algebraic expression for the phrase, "$\frac{4}{n}$ increase by 10"

Students' respond: $\frac{4}{n}+10$

E. w increased by 5

Students' respond: w + 5

F. a number decreased by 10

Students' respond: Let y be the number,

Answer: $y - 10$

G. r plus 20

Students' respond: r + 20

H. the product of a number and 5

Students' respond: 5*m*

I. 4 times the difference of *y* and 8

The students find it very difficult to write the correct expression.

The different answers given were; 4y – 8, 8 -4 y and 4(8-y). Only 5 of the students were able to write the correct expression.

I asked: write expression for the phrase "the difference of y and 8", and enclose the answer in brackets.

Students' respond: $(y - 8)$

I asked: write expression for the phrase "4 times the difference of $(y - 8)$".

Students' respond: $4(y - 8)$.

After activity two, I realized that some of the students are still having problem in modeling mathematical word problems, hence, I decided to carry out the third activity.

Activity 3

In this activity, I made the students to work in groups of four to help each other solve the prepared questions. Activity three was done to let the students cooperatively help each other, Since the constructivist approach of teaching typically makes extensive use of cooperative learning, on the theory that students will more easily discover and comprehend difficult concepts if they can talk with each other about the problems.

Write each phrase as an algebraic expression:

A number minus 20.

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

5 less than the product of nine and a number.

One-tenth of a number

The sum of 5 and one-fifth of a number.

During the cause of solving the questions, I went round helping groups that were having difficulties with the questions using 'scaffolding' or assisted learning instructional model.

Students' responds to these questions are shown below:

Let x be the number,

$x - 20$

Let y be the number,

y+ 9y

Let x be the number,

$9x - 5$

Let n be the number,

$\frac{1}{10}n$

Let x be the number,

$5 + \frac{1}{5}x$

Activity 4

Before the post- test, I guided the students through the following intervention process. In activity four I guided the students to model algebraic linear equations; and also, how to solve the equations after modeling using constructivist approach of teaching. After giving the students the steps involve in modeling word problems into algebraic linear questions, I then practiced some questions with the students by asking series of questions.

Read the problem carefully and figure out what it is asking you to find.

Usually, but not always, you can find this information at the end of the problem.

Assign a variable to the quantity you are trying to find.

Most people choose to use x, but feel free to use any variable you like. For example, if you are being asked to find a number, some students like to use the variable n. It is your choice.

Write down what the variable represents.

Re-read the problem and write an equation for the quantities given in the problem.

Solve the equation.

Check your solution.

When 6 is added to four times a number, the result is 50. Find the number.

Me**:** What are we trying to find?

Students' respond: A number.

Me**:** Assign a variable for the number.

Students' respond: Let's call it *n*.

Me**:** Write down what the variable represents.

Students' respond: Let *n* = a number

Me**:** Write an equation.

I explained: We are told 6 is added to 4 times a number. Since n represents the number, four times the number would be 4*n*. If 6 is added to that, we get $6+4n$. We know that, the answer is 50, so now we have an equation $6+4n=50$

Me**:** Solve the equation.

Students' respond:

6+4n =50

6 – 6 +4n = 50- 6 (subtract 6 from both sides)

4n = 44

$\frac{4n}{4} = \frac{44}{4}$ – (divide both sides by 4)

n = 11

Me: Answer the question in the problem

Therefore, the number is 11.

Me**:** Check the answer.

Students' respond: 6 + 4(11) = 6 + 44 = 50

The sum of a number and 9 is multiplied by -2 and the answer is -8. Find the number.

Me**:** What are we trying to find?

Students' respond: A number.

Me**:** Assign a variable for the number.

Students' respond: Let's call it *n*.

Me**:** Write down what the variable represents.

Students' respond: Let *n* = a number

Me**:** Write an equation.

Students' respond: $-2(n+9) = -8$

Me**:** Solve the equation.

Students' respond:

$$-2(n+9) = -8$$
$$-2n - 18 = -8$$
$$-2n = 10$$
$$n = -5$$

Me**:** Answer the question in the problem

Students' respond: The number we are looking for is -5.

Me**:** Check the answer

Students' respond: $-2(n+9) = -2(-5+9) = -2(4) = -8$

In an algebra test, the highest grade was 42 points higher than the lowest grade. The sum of the two grades was 138. Find the lowest grade.

Me**:** What are we trying to find?

Students' respond: The lowest grade on an algebra test.

Me**:** Assign a variable for the lowest test grade.

Students' respond: Let's call it *l*.

Me**:** Write down what the variable represents.

Students' respond: Let *l* = the lowest grade

Me**:** Write an equation.

Students' respond: $(l+42)+(l) = 138$

Me**:** Solve the equation.

Students' respond:

$(l+42)+(l) = 138$
$2l + 42 = 138$
$2l = 96$
$l = 48$

Me**:** Answer the question in the problem

The lowest grade on the algebra test was 48.

Me**:** Check the answer.

Students' respond: $(48+42)+(48) = 90+48 = 138$

The length of a rectangular map is 15 inches and the perimeter is 50 inches. Find the width.

Me**:** What are we trying to find?

Students' respond: The width of a rectangle.

Me**:** Assign a variable for the width.

Students' respond: Let's call it *w*.

Me**:** Write down what the variable represents.

Students' respond: Let w = the width of a rectangle

Me**:** Write an equation.

Perimeter = width + length + width + length.

Since length is 15 inches, width is *w*, and perimeter is 50, we get

Students' respond: $P = w + l + w + l$ or $P = 2w + 2l$

50 w +15 + w + 15 0r 50 = 2w + 30

Me**:** Solve the equation.

Students' respond:

$P = w + l + w + l$
$50 = w + 15 + w + 15$
$50 = 2w + 30$
$20 = 2w$
$10 = w$

Me**:** Answer the question in the problem.

Students' respond: The width of the rectangle is 10 inches.

Me: Check the answer.

Students' respond: $10 + 15 + 10 + 15 = 50$