
*Advances in Research*
*5(1): 1-12, 2015, Article no.AIR.13932*
*ISSN: 2348-0394*

**SCIENCEDOMAIN** *international*
www.sciencedomain.org

# The Constructivist Approach of Solving Word Problems Involving Algebraic Linear Equations: The Case Study of Mansoman Senior High School, Amansie West District of Ghana

**Emmanuel Appoh Andam[1], Christopher Adjei Okpoti[1], William Obeng–Denteh[2*] and Evans Atteh[1]**

*[1]Department of Mathematics Education, University of Education, Winneba, Ghana.*
*[2]Department of Mathematics, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/AIR/2015/13932
Editor(s):
(1) Yang-Hui He, Merton College, University of Oxford, UK and Reader in Mathematics, City University, London, UK.
(2) Ali Said Mohamed Al-Issa, College of Law, Sultan Qaboos University, Sultanate of Oman.
Reviewers:
(1) Anonymous, Turkey.
(2) Garba Sahabi Adamu, Department of Mathematics, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria.
(3) Anonymous, Iran.
(4) Ömer Beyhan, NE. University, A.K. Education Faculty, Curriculum Development & Teaching Branch Meram, Konya, Turkey.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1154&id=31&aid=9375

***Original Research Article***

***Received 10th September 2014***
***Accepted 17th November 2014***
***Published 23rd May 2015***

## ABSTRACT

This paper is an action research which involves a sample of forty (40) second year students of Mansoman Senior High School. The study was aimed at using the constructivist approach to enhance students' competence in solving word problems involving algebraic linear equations. Prior to the study, it was observed that the students were not able to understand and solve word problems under algebraic linear equations. The constructivist approach of teaching and learning was employed as the intervention strategy and was carried in a series of activities. The pre – test and post – test scores obtained by the students were analyzed quantitatively based on the research questions that preceded the study. Comparatively, the results obtained from the pre – test and post – test showed a significant improvement on the students' ability to translate word

**Corresponding author: E-mail: obengdentehw@yahoo.com;*

problems into algebraic linear equations and solve the equations as well. It was then concluded from the findings that the constructivist approach of teaching and learning employed during the intervention processes improved the students' academic achievements. The constructivist approach of teaching promoted students participation in the teaching and learning process and environment, and it must be encouraged by all.

*Keywords: Constructivism; word problems; algebraic linear equation; mathematics education; problem solving skills.*

## 1. INTRODUCTION

Mathematics is a fundamental human activity which cuts across everything all over the world. This human activity is demonstrated right from childhood. Identifying these fundamental activities, mathematics educators are to provide experience that will continue to foster students' understanding and appreciation of mathematics to improve on their performance.

According to [1], the fundamental objective of mathematics education is to enable children understand, reason and communicate mathematically and solve problems in their everyday life. 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 [2].

Algebra, according to [3] is conceived as a branch of mathematics that deals with symbolizing and generalizing numerical relationships and mathematics structures, and with operating within those structures. In addition to this, [4] noted that, algebraic reasoning involves representing, generalizing, and formalizing patterns and regularity in all aspects of mathematics.

It has been a traditional phenomenon that, students only begin learning algebra when they enter senior high school. [5] noted in their research that learners at this level experience serious problems in understanding pre-algebraic concepts and that the teaching of algebra learning should not wait high school freshmen [6]. [7] are of the view that, solution of linear equations poses a lot of problems to pupils at this level. The main problem here seems to be that, most pupils tend to use algorithms associated with transformations of equations to simpler equivalent forms incorrectly.

Teaching should allow students to wonder why things are, to inquire, to search for solution and to resolve incongruities. The constructivist theory of learning, indicates that effective learning can only take place when pupils are given chance to grapple with problems, reflect on their solution procedures and then check the reasonableness of their results.

Constructivism carries a major influence in contemporary science and mathematics education. Remarkably, one of the most important implications of constructivism challenges the processes by which individual students actively construct their own knowledge. For example, [8] suggested that, more attention has to be given to the interpersonal or social aspects of learning, i.e., to what appear to be at least, temporary states of inter subjectivity.

Word problems are often used to refer to any mathematical exercise where significant background information on the problem is presented as text rather than in mathematical notation [9]. As word problems often involve a narrative of some sort, they are occasionally also referred to as story problems and may vary in the amount of language used [10].

Mathematical word problems, or story problems, have long been a familiar feature of school mathematics. For many students, the transformation of word problems into arithmetic or algebra causes great difficulty, and a number of studies have addressed the linguistic and mathematical sources of that difficulty from a psychological point of view [11].

Constructivism is a theory that explains how knowledge is constructed in the human being when information comes into contact with existing knowledge that had been developed by experiences. Constructivists believe that knowledge should not be just deposited into the learner's minds; instead it should be constructed by the learners through active involvement in the learning process. According to [12],

constructivism is not a method but it is a theory of knowledge and learning that should inform practice but not prescribe practice.

When teachers believe that learners are empty vessels to be filled with the information from the authority, then teacher domination will always exist in the teaching and learning environment.

The domination of the teacher is referred to as the 'banking concept' of education [13], where the teacher is seen as the only source of information. It is important that teachers should actively involve learners in their teaching to enable the students to construct knowledge. Mathematics by nature is a subject that requires learners to be fully engaged in order for learning to take place.

The purpose of this paper to use the constructivist approach to enhance and improve student's competence and understanding in solving word problems under algebraic linear equations. The paper will explore the extent to which learners, when given the opportunity, how best they can construct their own knowledge in mathematics.

### 1.1 Statement of the Problem

The mathematics syllabus in Ghana recommends the use of mathematics in our daily life by recognizing and applying appropriate mathematical problem solving strategies [14]. Students are expected to learn mathematics concepts while acquiring processed skills, positive attitudes and values and problem solving skills. A variety of teaching strategies have been advocated for use in the mathematics classroom, ranging from teacher – centered approach to more students – centered ones.

Algebra, according to [15], is a powerful problem – solving tool and therefore, the understanding of algebra is central to students' ability to do mathematics. However, studies have shown that students are not able to solve mathematical word problems [16,17]. 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. Such skills can be promoted at all school levels through the constructivist approach.

Thus, this study was aimed at using the constructivist approach to enhance students' competence in solving word problems involving linear equations. According to [18], learning to comprehend sufficiently well to interpret meanings embedded in the context of a word problem is now a mathematical problem solving prerequisite. The authors believe that students can develop firm conceptual basis of translating word problems into mathematical statements if they are provided with this framework, where they can easily make references. Moreover, effective use of constructivist approach of learning will promote cooperative learning among students, students' confidence and enhance their effective mathematical confidence in the classroom as a whole.

### 1.2 Research Questions

The research questions for this paper are as follows:

1. What difficulties do students encounter in understanding and translating word problems into algebraic linear equations?
2. To what extent will the use of the constructivist approach of teaching and learning help students improve their competence in solving the algebraic word problems under algebraic linear equations?

## 2. REVIEW OF RELATED LITERATURE

### 2.1 Constructivism

The constructivist approach of teaching and learning has been broadly addressed in a number of researches in mathematics education [19,20]. According to this theory, students do not just passively receive information but constantly create new knowledge based on prior knowledge in conjunction with new experiences. As opposed to the traditional approaches where students learn by copying "word for word", what teachers say, constructivism has shifted to a more radical conception of teaching and learning whereby the learners' fresh ideas are brought to class, acknowledged, and enhanced through a variety of teaching and learning techniques that actively engage them.

A number of studies have shown the effectiveness of the constructivist approach in teaching and learning in contrast to the traditional drilling and reciting approach [20,21].

In the study to find out the constructivist approach in solving word problems, [22] found out that, constructivism is a view of learning in which learners use their experience to create understanding rather than having understanding delivered to them in already organized forms.

Further research study such as that of Fosnot [23] suggests that a constructivist approach to learning builds on the natural innate capabilities of the learner. Again, [24] posit that learning is constructed when students' generate their own knowledge through active participation. This suggests that students can be provided with opportunities to examine information and to make sense of it. From this perspective, the learner is viewed as actively constructing understanding through the use of authentic resources and social interaction [22]. There were studies that described constructivism as a process in which the learner explores and develop meanings [22] and also described the interchange between the learner and his environment [25].

It is the authors' belief that these are feasible guidelines to be implemented among students to assess whether constructivist activities will improve performance and enhance students' problem solving skills in relation to word problems.

## 3. RESEARCH DESIGN

[26] defined a research design is a plan, recipe or blueprint for the investigation and thus offers a clear description of how the research is going to be conducted. The ultimate aim for a good research is to provide a credible answer to the research questions [27].

The research design model for this paper is an action research and it seeks to address the different research questions in the study. Action research, as being described by [28], is a process by which practitioners attempt to study their problems scientifically in order to guide, correct and evaluate their decision and actions. It involves the application of appropriate intervention strategies aimed at finding solutions to problem(s) identified in teaching-learning situation in order to bring about a change.

The authors adopted action research as a preferred research design for this study because it deals with small scale intervention which is appropriate for a one classroom situation in the context of which the study was carried out.

The pre – test and post methods were used in conducting the research and it involved different set of questions on algebraic word problems (see Appendices A & B). They were designed for easy collection, interpretation, analysis and organisation of the data collected. The pre – test and the post – tests task were given to students to carry out in order to know their level of performance. It also served as the basis for evaluating and assessing the students.

The pre – test and post – tests were administered to the students to find out their strength and weaknesses and to find out how far the intervention activities will help them improve their performance respectively. Both the pre - test and post – test involved ten (10) questions which were marked over fifty (50) marks and was conducted in a normal class teaching period of forty – five (45) minutes, but had different set of similar questions. Students were asked to solve the questions individually without any consultation from friends and reference from any textbooks in both tests.

### 3.1 Population and Sampling

To address the objective of the paper, Mansoman Senior High School, Manso Atwere was selected. The school is located in the Amansie West District of Ashanti Region of Ghana.

The school runs three academic programs, namely, General Arts, General Science and Business Studies. The population of the school is five hundred and sixty – six (566) students. The school is a mixed institution with three hundred and fifty – two (352) males and two hundred and fourteen (214) females. Two hundred and ninety five (295) are in the second year whiles the rest are in the first year. At the time of the research, the third year batch of candidate for the 2014 West Africa Senior School Certificate Examination (WASSCE) had sat for the exam and had completed and left the school. The research was conducted with a random sample of forty (40) second year students of which twenty – four (24) were males and the remaining sixteen (16) were females.

### 3.2 Intervention Activities

Due to the non-performance of the students in the Pre – test (see Table 1), the challenges they encountered when translating the word problems into linear equations had to be addressed. The authors outlined series of list of instructions for

the intervention. The activities were therefore put in place and implemented based on the outcome of the pre – test, which revealed that most of the students had problems in the area of understanding the algebraic word problems and hence translating them into linear equations. They instructions for the activities were as follows:

1. Read the problem thoroughly to understand what you are solving for. List all the unknowns in the problem, and assign a variable for each unknown. If there are two unknowns, you need two variables, such as x and y, for example. If there are three unknowns, you need three variables, such as x, y and z. The number of unknowns in the word problem also indicates the number of equations required. It may help to name the variables so they reflect the unknowns that you are solving for. For example, if you are solving a problem dealing with an unknown number of apples and pears, use "a" as the variable for apples, and use "p" as the variable for pears.
2. Translate the problem into a system of equations using key terms to describe the mathematical operations required. Terms such as ‘increased by’, ‘total of’, ‘more than’, ‘combined together’, ‘sum’, ‘added to’, etc. signal operations that involve ADDITION. Phrases such as ‘decreased by’, ‘difference between’, ‘less than’, ‘fewer than’, ‘reduced by’, ‘difference of’, etc. means the operations involve SUBTRACTION. Words and phrases such as ‘of’, ‘product of’, ‘times’, ‘multiplied by’, etc. indicate operations that require MULTIPLICATION. Terms such as ‘per’, ‘out of’, ‘ratio of’, ‘quotient of’, ‘percent’, etc. indicate operations that require DIVISION. When words like ‘is’ or ‘will be’ are featured in a word problem, this indicates the total amount of the unknown expressions must be EQUAL.
3. Solve the equations using graphical, substitution or elimination methods.
4. Check the proposed solution by plugging the answers into each equation. If both sides of each equation are equal, you have the solution. If one side of the equation is not equal to the other, check your work and revise your solution to the problem.

## 4. DATA ANALYSIS AND RESULTS

The results of the study obtained by the students were analyzed and discussed in relation to the objectives of this paper. The pre – test (see Appendix A) was aimed at finding out the students’ level of understanding on translating word problems into algebraic linear equations and how to solve the modeled equations as well. A total of ten (10) questions which were marked out of fifty (50) and was conducted for the forty (40) students and was administered in a normal class lesson period of 45 minutes. Table 1 shows a frequency distribution in percentages of the scores obtained by the students in the pre – test.

After administering the pre – test, the authors observed a generally low performance of the students in terms of modeling algebraic linear equations out of word problems, which was below the average score. The indication was that, students were not able to interpret words like sum, difference, product of, less than, quotient, etc.

To address these challenges of the students, a series of intervention activities using the constructivist approach of teaching and learning were organized by the authors for the students and a post – test was administered to them. This was aimed at ascertaining whether the intervention had gone down well with the students.

The post – test, involving ten (10) questions (see Appendix B), required the students to model word problems into algebraic linear equations and solves the equations. It was also administered in a normal class lesson period of 45 minutes and was marked out of fifty (50). Table 2 is the frequency distribution in percentages of the marks obtained by the students in the post – test.

**Table 1. Frequency distribution of pre-test scores in percentages**

| Score | Frequency | Percentage (%) |
|---|---|---|
| 1 – 10 | 14 | 35 |
| 11 – 20 | 20 | 50 |
| 21 – 30 | 4 | 10 |
| 31 – 40 | 2 | 5 |
| 41 – 50 | 0 | 0 |
| Total | 40 | 100 |

**Table 2. Frequency distribution of post – test scores in percentages**

| Score | Frequency | Percentage (%) |
|---|---|---|
| 1 – 10 | 0 | 0 |
| 11 – 20 | 8 | 20 |
| 21 – 30 | 10 | 25 |
| 31 – 40 | 16 | 40 |
| 41 – 50 | 6 | 15 |
| Total | 40 | 100 |

The post – test scores indicated a change in the performance of the students as compared to that of the pre –test scores. The authors attributed the improvement in the students' performance to change in the teaching strategy. With the introduction of the constructivist approach, the students' were exposed to numerous activities during the intervention processes.

The authors undertook inferential analysis of the pre – test and post – test, and the data used for this analysis were the scores obtained by the students in both tests. Statistical Package for Social Scientist (SPSS) was employed by the authors to obtain the results of the analysis.

Results from Table 3 indicate that, the mean value of the pre – test scores and the post – test scores were 13.82 and 31.43 respectively. The standard deviation of the pre – test scores was also 7.042 whiles that of the post – test was 8.769.

Comparatively, a conclusion can be drawn from the mean score values of both the pre – test scores and the post – test scores. The mean scores showed a significant improvement in students' performance in solving algebraic word problems. The intervention process using the constructivist approach of teaching and learning has helped the students in translating algebraic word problems into algebraic linear equations and solving the equations as well.

## 4.1 Testing of Hypothesis

According to [29], hypothesis concerns comparing means of two small dependent samples, when the same respondent or person is measured under the two conditions or when matched paired are measured under the same condition. In this research study, we compare the mean value of the pre –test and the post – test. The means of the dependent samples, pre – test and post – test, are given in Table 4 below. The P – value for the statistical test for the hypothesis was set at $P < 0.05$.

### 4.1.1 Null hypothesis, $H_0$

There is no significant difference in the mean scores of the pre – test and the post – test of the students at $\alpha = 0.05$ level of significance ($P < 0.05$).

$$H_0 : \mu_1 = \mu_2$$

### 4.1.2 Alternate Hypothesis, $H_\alpha$

There is significant difference in the mean scores of the pre – test and the post – test of the students at $\alpha = 0.05$ level of significance ($P < 0.05$).

$$H_\alpha : \mu_1 \neq \mu_2$$

## 4.2 Decision

The result from the statistical test for the hypothesis from Table 4 yielded a value for $P = 0.000$, which indicated that the difference in the means was significant. The test statistic was set at $P < 0.05$ and since P is less than 0.05 (level of significance), we reject the Null Hypothesis and accordingly accept the Alternate Hypothesis.

**Table 3. Descriptive statistics of pre – test and post – test scores**

| | N | N | Std. deviation | Std. error mean |
|---|---|---|---|---|
| Pretest | 40 | 13.82 | 7.042 | 1.113 |
| Posttest | 40 | 31.22 | 8.769 | 1.387 |

**Table 4. Paired sampled test for pre-test and post-test scores**

| | N | Mean | Std. deviation | Std. error mean | Lower | Upper | t | df | p - value |
|---|---|---|---|---|---|---|---|---|---|
| Pretest - Posttest | 40 | -17.400 | 14.983 | 2.369 | -22.192 | -12.608 | -7.345 | 39 | 0.000 |

We therefore conclude that there is a significant difference between the pre – test scores and that of the post – test which is in favour of the post – test. And this is attributed to the intervention processes the researcher took the students through.

## 5. DISCUSSIONS

The success of the students on the post – test demonstrated much on what was suggested in the literature. This was as a result of the authors continuous encouraging of different kinds of mathematical communication and comprehensions as well as cooperative learning among the students during the intervention activities. Results obtained from the post – test is in line with the research study by [30] that, students should be given the opportunity to express algebraic situations in an easily understandable language, as a means of developing conceptual understanding of a problem before representing them symbolically.

Considering the scores obtained by the students in the pre – test and post – test, as shown in Tables 1 and Table 2 respectively, it can be deduced that the performance of the students before the intervention was very low. The respective frequency distribution tables of the pre – test and post – test (see Tables 1 and Table 2) clearly showed the difference in the scores obtained by the students. In the pre – test (see Table 1) for instance, thirty - four (34) out the forty (40) students scored less than half of the 50 marks for the test, which represented 85% of the total number of students. This low performance by the students in the pre – test was due to the teaching strategy used in teaching the students and it took the lecture form of teaching. With this teaching strategy, the students did not have the chance of using their experience to create their own understanding, since lessons were delivered to them in an organized form previously. The students were used to only memorizing and imitating teachers and this did not give the students sufficient wisdom to survive independently, applying to word problems as well as real world situations.

As a result of this, students were not able to understand and translate the algebraic word problems into algebraic linear equations and solving the equations as well. The students also lacked cooperative learning and hence the average students could not help their low performing colleagues. The students could not analyze simple mathematical word problems and interpret key words, such as ‘sum’ to mean ‘add’, ‘difference’ to mean ‘subtract’, ‘product’ to mean ‘multiply’ and ‘quotient’ to mean ‘divide’.

Results from the post – test scores by the students, as shown in Table 2, clearly indicated that the students performed much better as compared to the pre – test. This suggests that they had improved upon their ability to model algebraic linear equations out of algebraic word problems and solving the equations as well. From the frequency distribution of the post – test scores (Table 2), out the forty (40) students who took part in the test, thirty – two (32) of them obtained more than half of the total mark of 50 for the test, representing 80% of the total students number. The results indicated an upwards trend in the post – test scores, which showed that the intervention activities were effective in assisting the students overcome their problems and helping them in their learning.

The improvement in the performance of the students, which was evident in the post – test scores they obtained, was not by chance, but through the constructivist teaching strategy that the authors employed during the intervention activities. With the constructivist approach, the authors designed a well – planned intervention activity in the lessons with the students. The constructivist approach of teaching enabled the students to participate actively in the lessons and also encouraged cooperative learning among the students. And in effect, each student in the group was not only responsible for learning what was being taught alone, but also helped their colleagues who were still having problems and thus created a good learning atmosphere.

In the event of all these, the authors found out that the students were motivated and also inspired by the way the lessons were taught. The constructivist approach of teaching used in this research study enabled the students to comprehend the conceptual knowledge and the procedural understanding of mathematical word problems which the students were able to translate and solve them successfully. The constructivist approach of teaching and learning had a positive effect of the performance of the students in algebra and for that reason, mathematics as a whole.

### 5.1 Revisiting the Research Questions

From the intervention activities initiated by the authors with the forty (40) second year students of Mansoman Senior High School, as well as the

findings in the data analysis, the research questions were revisited and analyzed. The findings from the research study were related to the research questions and assessed whether they had undoubtedly answered the research questions.

The first research question, which read: What difficulties do students encounter in understanding and translating word problems into algebraic linear equations?

The findings in the paper showed that the students were not able to read and understand the word problems. They could not analyze and interpret the key words involved as well as translating them into mathematical statements and equations and solving the equations as well. This was evident in the scores they obtained in the pre – test. The pre – test was basically aimed at finding out the students' level of understanding and translating word problems into linear equations. The results from Table 1 showed that 85% of the students scored less than half of the 50 marks for the test. The observation was that the students were not able to interpret words like sum, more than, difference, less than, product, quotient, etc.

For example, students encountered problems with words like 'sum', 'added to', 'increase by', 'more than' meaning 'ADDITION', whiles 'decrease by', 'difference between', 'difference of', 'less than' also meant 'SUBTRACTION'. In addition to this, words such as 'product of', 'times', 'multiplied by' mean 'MULTIPLICATION' and words such as 'out of', 'quotient of', 'per', 'ratio of' also mean 'DIVISION' were a problem to the students.

The second research question read: To what extent will the use of the constructivist approach of teaching and learning help students improve their competence in solving the algebraic word problems under algebraic linear equations?

With this question, the authors observed that students who previously employed the guess and check method of solving algebraic linear equations were discouraged and refrained from such methods. The observations made it clear that students have putting a stop their usual memorizing and imitating (chew and pour) method of solving linear equations as well. The constructivist approach of teaching through the interventional processes has helped the students to now understand the concepts of solving algebraic linear equations and not relying on the memorized procedures to solve the equations. With the constructivist approach of teaching and learning, the students can have the chance of using their own experience to create their understanding rather than being delivered to them in an already organized form.

## 6. CONCLUSION

Mathematics has been an intimidating subject for many people, particularly in the area of algebraic word problems. Translating word problems from English to mathematical equations/expressions has been a prevalent stumbling block for many students and even teachers as well. However, once the equation is constructed, solving for the answer is relatively straightforward.

The main intervention for this study was the constructivist approach of teaching and learning. The statistical analysis showed that the intervention activities has helped improve students' competence in solving algebraic word problems. This indicated that teachers have been teaching the solving of algebraic word problems in an organized form rather than allowing the students to create their own understanding themselves. [31] ascertained that "teachers who have been habituated to teaching by telling and directing student's work must shift from seeing themselves as central in producing learning to seeing the student as central". This makes students not to interact with each other during lessons. They were not also allowed to work in groups through cooperative learning, neither were they made to criticize the work of their colleagues and help them overcome their challenges.

The research revealed that, until the intervention stage, students did not know that they could learn better from their colleagues. The intervention led to students developing a more positive attitude towards mathematics in general. In spite of all these from the findings of this study, regardless of the challenges associated, the constructivist approach of teaching and learning promoted students' active participation in the teaching and learning process and environment and improved their performance in solving algebraic word problems.

## ACKNOWLEDGEMENT

The authors acknowledge with appreciation the assistance offered by the second year students

of Mansoman Senior High School, selected for the research. The authors are grateful to the entire staff as well. They also express their gratitude to unknown reviewers for their useful comments.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Nabie JM. Fundamentals of the psychology of learning mathematics. 2nd Edition. Akonta Publications. Mallam, Accra. 2004.
2. Sherrod SE, Dwyer J, Narayan R. Developing science and mathematics integrated activities for middle school students. International Journal of Mathematical Education in Science and Technology; 2009.
3. Kieran C. The learning and teaching of school Algebra. Grouws, D.A; 1992.
4. Van De Walle JA. Elementary and middle school mathematics: Teaching developmentally. New York: (5th edition). Pearson Education Inc.; 2004.
5. Linchevski L, Herscovicks N. Crossing the cognitive gap between arithmetic and algebra: Operating on the unknown in the context of equations. Education Studies in Mathematics. 1996;30:39-65.
6. MacGregor ME. Reading and writing in mathematics. Bickmore-Brand, J. (Ed). Language in Mathematics, Australia: Australian Reading Association Inc. 1991.
7. Usiskin Z, Pereessini A, Marchisoto EA, Stanley D. Mathematics for high school teachers: An advanced perspective. New Jersey: Prentice Hall, Pearson Education, Inc.; 2003.
8. Cobb P, Wood T, Yackel E. A constructivist approach to second grade mathematics. In E. von Glasersfeld (ed.), Radical Constructivism in Mathematics Education. 1991;57-176. Dordrecht: Kluwer.
9. Verschaffel L, Greer B, De Corte E. Making sense of word problems. Lisse, Netherlands: Swets & Zeitlinger. 2000.
10. Moyer JC, Moyer MB, Sowder L, Threadgill-Sowder J. Story problem formats: Verbal versus telegraphic. Journal for Research in Mathematics Education. 1984;15(1):64-68.
11. Burton MB. Grammatical translation-inhibitors in two classic word problem sentences. For the Learning of Mathematics. 1991;11(1):43-46.
12. Hausfather S. Where is the content? The role of content in constructivist teacher education. Educational Horizons. 2001; 80(1):15-19.
13. Freire P. Pedagogy of the oppressed, New York: Herder and Herder; 1970.
14. Ministry of Education (MOE).Teaching syllabus for junior high school mathematics. Curriculum Research and Development Division, Accra, Ghana; 2007.
15. Nickson M. Teaching and learning mathematics: A teacher's guide to recent research and Its Application. London: Cassell. 2000.
16. Cook JL. College students and algebra story problems; strategies for identifying relevant information. Reading Psychology. 2006;27:95-125.
17. Thevenot C, Devidal M, Barrouillet P, Fayol M. Why does placing the question before an arithmetic word problem improve performance? A situation. Quarterly Journal of Experimental Psychology. 2007; 60,43-56.
18. Chamot AU, Dale M, O'Malley JM, Spanos GA. Learning and problem-solving strategies of ESL students. Bilingual Research Journal. 1992;17(3):1-34. Retrieved July 2, 2009, from Academic Search Premier Database.
19. Katic EK, Hmelo-Silver CE, Weber KH. Material mediation: Tools and representations supporting collaborative problem-solving discourse. International Journal of Teaching and Learning in Higher Education. 2009;21(1):13-24.
20. Steele DF. A construct! visit approach to mathematics teaching and learning by fourth–grade teachers. Unpublished Ph.D. Dissertation, University of Florida; 1995.
21. Hmelo-Silver CE, Duncan RG, Chinn CA. Scaffolding and achievement in problem based and inquiry learning: A response to Kirscher, Sweller and Clark (2006). Educational Psychologist. 2007;42(2):99-107.

22. Eggen PD, Kauchak DP. Teaching and learning: Research-based methods. (4th Ed.). Allyn and Bacon; 2003.
23. Fosnot CT. Enquiring teachers, enquiring learners: A constructivist approach for teaching. New York: Teachers College Press; 1989.
24. Fosnot CT. Constructivism: Theory, perspectives, and practice. New York: Teachers College Press; 2005.
25. Cobb G. Teaching statistics, in heeding the call for change: Suggestions for curricular action, ed. L. Steen, MAA Notes. 1992;22.
26. De Vos AS. Research at Grass Roots: For the Social Sciences and Human Service Professions. Pretoria: Van Schaik Publishers. 2002;165.
27. MacMillan JH, Schumacher S. Research in education: A conceptual introduction. New York: Longman. 4th Ed. 2001;166.
28. Kannae LA. Research skills capacity building for national teachers' organization, training manual. Pan African Teachers Centre, Lome, Togo; 2004.
29. Asiedu – Addo SK, Awanta EK, Amppiah M. Statistics and probability with computer applications. Accra: City Publishers; 2004.
30. Kieran C, Chalouh L. Pre – algebra: The transition from arithmetic to algebra. Research Ideas for the Classroom: Middle Grades Mathematics. Reston, VA. National Council of Teachers of Mathematics; 1993.
31. De Vries R, Zan B, Hildebrandt C, Edmiaston, R, Sales, C. Developing constructivist early childhood curriculum, New York: Teacher's College Press; 2002.

## APPENDIX A

## PRE – TEST QUESTIONS

**Name: …….** **Class: ……..**

**Attempt all questions** **Time: 45 minutes**

1. The sum of twice a certain number and 26 is 72. Find the number.
2. $\frac{1}{3}$ of a number is added to $\frac{1}{5}$ of the same number, the result is 8. Find the number.
3. Three more than five times a certain number is five less than seven times the same number. Find the number.
4. The difference between five times a number and twelve is 48. Find the number.
5. $\frac{5}{6}$ of a certain number is 4 greater than $\frac{3}{4}$ of that number. Find the number
6. When $\frac{1}{3}$ of a number is added to 8, the result is 18 from $\frac{1}{2}$ of it.
7. A certain number divided by 3 and 3 was added to the results. The final answer is 8. What is the number?
8. Solve the equation $2x - 1\frac{1}{3} = 5x - 6$.
9. Find the value of x in the equation $\frac{2}{3}x - 21 = \frac{1}{5}x$.
10. Find the truth set of $\frac{1}{5}(2+m) = \frac{1}{2}(m-1)$.

## APPENDIX B

## POST – TEST QUESTIONS

**Name: …….** **Class: ……..**

**Attempt all questions** **Time: 45 minutes**

1. When a certain number is subtracted from 10 and the result is multiplied by 2, the final result is 4. Find the number.
2. Eight less than five times a number is four more than eight times the number. Find the number.
3. The product of a number and four is three times the difference between 35 and the number. Find the number.
4. The sum of three consecutive numbers is 27. Find the numbers
5. 68 less than 5 times a number is equal to the number. Find the number.
6. Three times the sum of 8 and a certain number is equal to twice the sum of the number and 7. Find the number
7. When 21 is taken from two – thirds of a certain number, the result is one – fifth of that number. Find the number.
8. If $\frac{3}{4}$ of a number added to $\frac{5}{6}$ gives the same result as subtracting $\frac{7}{8}$ of the number from $20\frac{1}{3}$. Find the 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 twice the sum of five and a certain number is subtracted from eight times the number, the result is equal to four times the sum of eight and twice that number. Find the number.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*http://www.sciencedomain.org/review-history.php?iid=1154&id=31&aid=9375*