# Improving the Performance of Basic School Pupils in Addition and Subtraction of Integers Using Rectangular Cut out Number Line: A Case of a Ghanaian Basic School

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**Abstract**
*This study is set out to investigate into the performance of learners in mathematics, specifically addition and subtraction of integers at Happy Home School at Abuakwa in the Ashanti region of Ghana.*
*The purpose of this study is to find out the factors affecting learners' mathematics, particularly addition and subtraction of integers and how to use rectangular cut out number line to help solve the problem. Purposive sampling technique was used for data collection. Observation, interview and test were the research instruments used for the study.*
*The study revealed that pupils' performance improved drastically after the implementation of the intervention (rectangular cut out number line). The study recommends that teachers or facilitators should use teaching and learning materials in their delivery to aid better understanding since learners learn better through touching and manipulation of objects. In addition, the Ghana Education Service must help improve the use of teaching and learning materials in teaching mathematics at all levels through in-service training programs on how to improve and use teaching and learning materials.*
*Keywords: Intervention, teaching and learning materials, in-service training, improvise, Ghana Education Service (GES).*

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## I. Introduction

### 1.1: Background to the Study

Mathematics is a wide and varied subject but also very interesting. Mathematics is learnt to develop a logical and qualitative thinking. Mathematics is one of the most widely used tools in all daily activities. Mathematics as a subject deal with the way of finding solutions to problems. It uses methods of investigating into concepts which leads to a reliable solution of a problem. The knowledge gained through investigations in mathematics is stored and can be used for further understanding in life.

The Oxford Advanced Learner's Dictionary defines mathematics as science of numbers, quantity and space. Mathematics becomes functional in the lives of children when they have developed basic concepts and computational skills and apply mathematics in their world. However, many children develop negative attitude towards mathematics due to the fact that they have wrong perception of what mathematics is and how important the subject is in our daily lives.

The importance attached to the study of mathematics is paramount to the development of every society. The world has become a global village that both adult and children need to have a little knowledge in mathematics. Learning of mathematics also helps us to learn about money and be able to make simple calculations in buying and selling. That is why mathematics is very vital in our daily lives.

Mathematics is a subject which should be taught using more teaching and learning materials which will enhance better understanding, but it is taught in abstraction by most teachers which bring about poor teaching and learning. Poor understanding and love for mathematics is due to the absence of teaching and learning materials when teaching or learning mathematics.

### 1.2: Purpose of the Study

Difficulties in addition and subtraction of integers were identified when the researchers were teaching basic school pupils of Happy Home School, at Abuakwa in the Ashanti region. The main purpose of the study is to investigate into the performance of pupils in mathematics, specifically addition and subtraction of integers using rectangular cut out number line. The following objectives helped in achieving the main goal of the study:
1. to find out what integers are.
2. to find out the extent to which pupils understand addition and subtraction of integers.

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3. to identify an appropriate instructional resource/material to promote the teaching and learning of addition and subtraction of integers.
4. to test the effectiveness of the rectangular cut out number line in the teaching of addition and subtraction of integers.

**1.3: Research Questions**
In attempting to solve the problem outlined above, answers will be sought to the following questions.
1. What are integers?
2. How do pupils understand addition and subtraction of integers?
3. What type of teaching method can be used to teach the topic, addition and subtraction of integers?
4. What is the effect of using rectangular cut out number line in teaching addition and subtraction of integers?

**1.4: Significance of the Study**
 This part of the study indicates the benefit of the study. The study will help basic school pupils in general and especially pupils of Happy Home School to understand the concept of addition and subtraction of integers through the use of rectangular cut out number line.
 The study will further help mathematics teachers to know the essence of teaching mathematics with teaching and learning materials. It will also enhance the review of activities of the Curriculum Research Development with respect to the teaching of mathematics.
 Finally, it will also serve as a document for further research.

## II. Literature Review
 This section of the study deals with the review of related literature of renowned authors in this area of study. Education functions well on five interactive and supportive pillars. These are; the state, the community, the teacher in the school, the parents and learners. The ultimate aim of education is to develop the individual totally. In order to let the individuals, have positive and acceptable behaviour to improve the society, education in mathematics must be considered on a large scale.
 It is very important to work methodically in the literature review. To make sure that all arrangements are coherent in nature, this review is categorized in this form: the meaning of mathematics, the meaning of integers, and concept of addition and subtraction.

**Meaning of Mathematics**
 According to Scholastic Children's Dictionary (1996), mathematics is "the study of numbers, quantities, shapes, and measurements and how they relate to each other." Think of mathematic as the science of how we use and interrupt the things around us using numbers [1].
 According to Heinemann English dictionary for Ghana, mathematics is the science subject dealing with numbers, size, shape and measurement.
 Also Concise Oxford English Dictionary acknowledges mathematics as the branch of science concerned with numbers, quantity and space either as abstract concepts (pure mathematics) or as applied to physics, engineering and other subjects (applied mathematics).
 Pertaining to the importance of mathematics, Collins English dictionary is of the view that mathematics as a group of related sciences, including algebra, geometry and calculus, concerned with the study of numbers, quantity, shape and space and their interrelationships by using a specialized notation.
 In a study by [2], they compared the learning of mathematics to the learning of Chinese. They said that for children to understand mathematics, they should be allowed to discover their own symbols that make them retain principles and concepts for solving problems.
 Mathematics helps counting. It helps measuring. It helps comparing things. Addition, subtraction, multiplication and divisions are the basic operations of the mathematics, through which we can define and develop many more operations suiting our practical situation.
 Counting could be in different fashions from the primitive man to the present day. Probably it is the basic necessity for the man to understand how many things he possessed. The different system of numbers in different countries itself shows how our elders tried to explore the ways to count.
 Measuring or quantifying is another way of bringing any characteristics under mathematics. Converting characteristics like length, volume, mass, velocity, acceleration are all the ways of understanding in science.
 According to [3], the mathematical skills that a child has to learn are the skills of counting one, two, three and so on. In mathematics, these numbers are counting numbers or natural numbers. Natural numbers can be extended in two ways or directions. One of these is the extension to the negative direction and the other to the positive direction. Mathematics referred to the positive and negative numbers together with zero as integers.

**Meaning of integers**

The classification of numbers starts from natural numbers (counting numbers), whole numbers, integers, rational and irrational numbers and real numbers. This extension came as a result of man's development. The real number is not even the limit, there is still another, the complex numbers. An integer is a set of numbers which consists of a set of positive whole numbers, zero and the set of negative whole numbers.The integers can be shown on a number line that extends endlessly in both directions from zero. Every integer represents a magnitude and direction.

Magnitude is the number of units the integer is away from zero on the number line. Direction can be positive (usually to the right on a number line) or negative (usually to the left on a number line). Positive can be any direction so long as negative is the opposite direction. Here are some examples of magnitude and direction; 3 has magnitude 3 and positive direction and -5 has magnitude 5 and negative direction.

According to [4], integers consist of all the natural numbers, the negatives of the natural numbers and zero. The set {…, -4, -3, -2, -1, 0, 1, 2, 3, 4, …} of all integers is denoted by the symbol Z. Integers are numbers that show direction as well as magnitude [5]. They look like numbers with a "+" or "-" sign. It is seen in the book that when a body moves from one place to another, it needs to be indicated whether it moves backwards or forward. This is where negative sign is introduced and the same applied to magnitude of object. The negative sign in terms of direction tells backward movement while the positive sign mean forward movement. Negative sign in terms of magnitude implies decrease in size and positive here means increase in size.

In the view of [6], the set of counting numbers can also be named as the set of positive integers, P.

$$P = \{1, 2, 3, 4, 5, 6, 7, 8, 9, ….\}$$

For each positive integer located to the right of zero on the number line, there is a corresponding negative integer located at the same distance to the left of zero. These are indicated by using minus signs against the numbers.

The concept of integer is the basis of algebra learning domain in primary school mathematics teaching and it is considered as an important pre-condition for mathematics course. In the past, the concept and operations of integers were taughtthrough algebraic rules, instead of explaining with models. Innovative strategies include various methods and models to help students learn and understand the abstract ideas including integer calculations. The importance of modeling studies is no longer a matter of debate in mathematics teaching. Groupsstudying with mathematical modeling activities have been reported to be more successful in associating mathematics with daily life than those who don't study with these activities [7] as cited in [8].

Learners often view negative numbers as absurd in learner's early conception because they have not developed a way to understand numbers less than zero. Precisely, they often ask why negating a negative number will result in a positive answer. Again, learners often have problems in conceptualizing numbers less than zero, creating negative numbers as mathematical objects and formalizing rules for integer arithmetic [9]. Almost every day, learners have interactions with negative numbers or experienced phenomena that negative numbers can model, for instance the temperature, altitude (above and below sea level), money, and other phenomena [10]. In fact, almost any concept that is quantified and has direction probably has both positive and negative values.

**The Concept of Addition and Subtraction of integers**

According to Longman dictionary of contemporary English, addition is the process of adding numbers or amounts to make a total whereas subtraction is the process of taking a number or amount from a larger number or amount.

Modeling in mathematics education has been a central focus for instructional designers. According to some studies, there are two models for integer instruction, namely counters and number line [9][11][12]. For counters model, it consists of two colour counters, namely one colour for positive counts and another for negative counts. In dealing with this counters model, the learners should also understand that it is always possible to add and to remove from a set any number of pairs consisting of positive and negative counters without changing the value of the set.

The number line is the second model for integers instructions. A study conducted by [12], number line model has the advantage for modeling integer operations. In this number line, arrows can be used to show distance and direction. Considering the two methods mentioned above, very few studies have compared these two models. A study by [12] concluded that, learners who used counters model performed slightly better on addition problems. However, the learners have challenges in subtraction problems, especially ones that deal with different signs. She also emphasized that the number line models have the advantage that supports the understanding of negative numbers. Comparing the studies done on the two models above, this study will use number line as a model to support learners develop the concept of addition and subtraction of integers. There are other models in teaching addition and subtraction of integers which includes the charged particle model and the nomograph model.

## III. Methodology
The research design for this study was based on descriptive survey. The study took place at Happy Home School. The class has a population of forty (40) with one mathematics teacher. Sample of forty (40) learners were chosen using purposive sampling technique. Purposive sampling was used because all the learners had the problem under study. For this study to achieve a good result the researchers approached the mathematics teacher, the headteacher and pupils by way of interview and personal observation.

Children are active constructive learners and with this approach, it calls for child-centered and activity based learning instead of passive learning. Therefore, learners must be actively involved in all activities to enable them come out with their own discoveries. The teacher should not talk much so that the pupil will talk or do more work.

**3.1: The interview between the headteacher and the researcher.**
**Researcher:** Sir, please why do you think Junior High School 1 pupils have difficulties in addition and subtraction of integers?
**Headteacher:** Well, I think in the primary school they were taught how to add and subtract one number from another. For example: $5 + 2 = 7$, $4 - 3 = 1$, etc. but the difficulties came when the positive and negative numbers were mixed together. This is because they were confused about where a positive number cancels the negative number or where two negatives come together because they have just been introduced to integers.
**Researcher:** What do you suggest should be done to solve this problem?
**Headteacher:** I think as they are taught continuously and by doing more work they will be able to understand very well.

**3.2: The interview between the mathematics teacher and the researcher.**
**Researcher:** What do you suggest should be done to solve the problem of addition and subtraction of integers?
**Mathematics teacher:** I teach them by solving the questions on the chalkboard with them.
**Researcher:** By just solving the questions on the chalkboard, do they understanding what you teach them?
**Mathematics teacher:** Some of them understand and others do not.
**Researcher:** So what do you do to those who do not understand?
**Mathematics teacher:** I will try to explain to them and if still they do not understand, I leave them to find out for themselves.

**3.3: The interview between a pupil and the researcher.**
**Researcher:** Where does your mother works?
**Pupil:** She works in the market.
**Researcher:** What does she sell?
**Pupil:** Charcoal
**Researcher:** Who helps you to do your homework?
**Pupil:** At times, my brother who is in Junior High School 3 or I do it myself.
**Researcher:** When do your parents come home?
**Pupil:** My father always come home late and my mother too.
The researcher then tried to find out how best the pupils understand the topic, "addition and subtraction of integers" and this was what happened.
**Researcher:** Let's say I owe 6 Ghana cedis and I also have 2 Ghana cedis. If I add what I owe to what I have, how much will I get?
**Pupils:** Sir, you will get 8 Ghana cedis.
**Researcher:** Why 8 Ghana cedis?
**Pupil:** Sir, you will get 8 Ghana cedis because, one of the positive signs will cancel the negative before the 6, so that you will add 6 to 2 to get 8 Ghana cedis.

**3.4: Intervention stage**
After conducting the interview and observing the pupils, the researchers' intervention was as follows.
Week ending: 7<sup>th</sup> February, 2020.
Lesson: Solving addition and subtraction of integers using rectangular cut-out number line.
Duration: 70 minutes

**Step 1:**

The researchers used the rectangular cut-out number line that have been drawn on cardboard sheet and also some of the cardboards have been shaped like an arrow where positive and negative integers have been written on each of them. In order for pupils to understand the addition and subtraction of integers, the researcher uses the arrow length activity to demonstrate to pupils. He used the number line and arrow lengths to solve question for pupils to see.
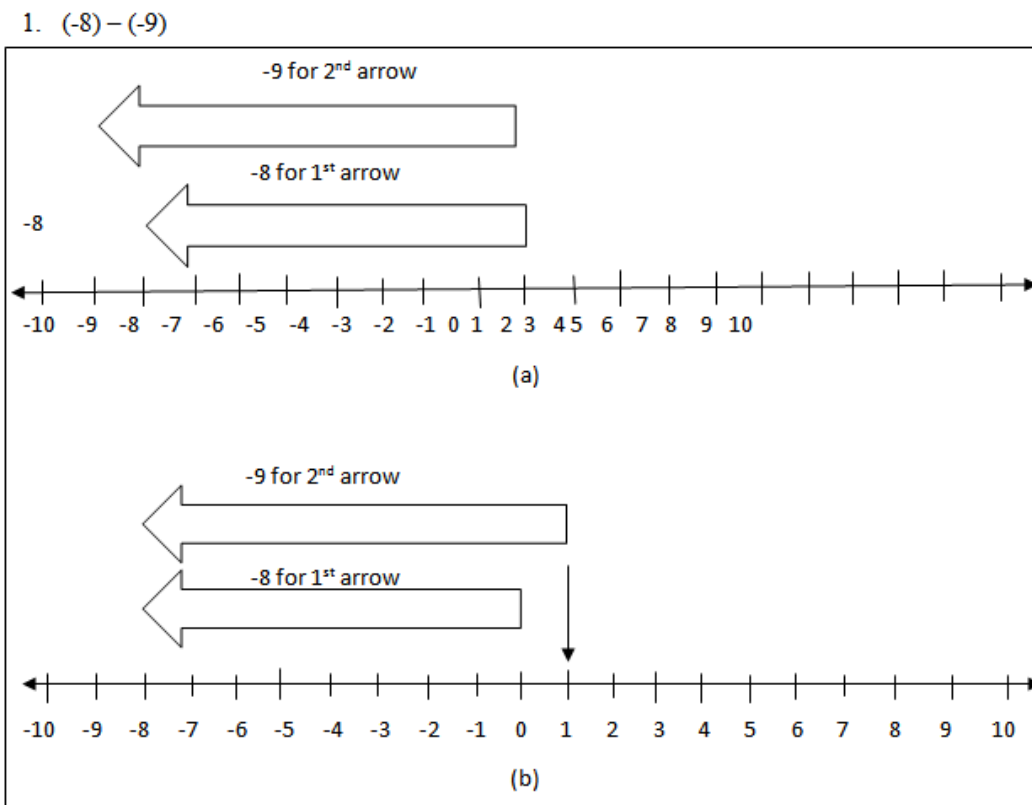
1. $(-8) - (-9)$



**Fig. 1:** Rectangular cut out number line used at step 1

The researchers laid the first arrow (-8) from point 0 to the left on -8. He then puts the second arrow (-9) at the tip of the first arrow and it is also pointed to the left on -8 because -9 is being subtracted from -8 as shown in "a" in figure 1. The answer was deduced from the number line with the second arrow by shifting it to the right hand side of the number line whilst the end tips are aligning equally. Here the end of the second arrow is in line with the number one (1) on the number line as shown in "b" in figure 1.
Therefore $(-8) - (-9) = 1$

**Step 2:**
The researchers also used this activity on positive and negative numbers. For example: $(-7) + 3$
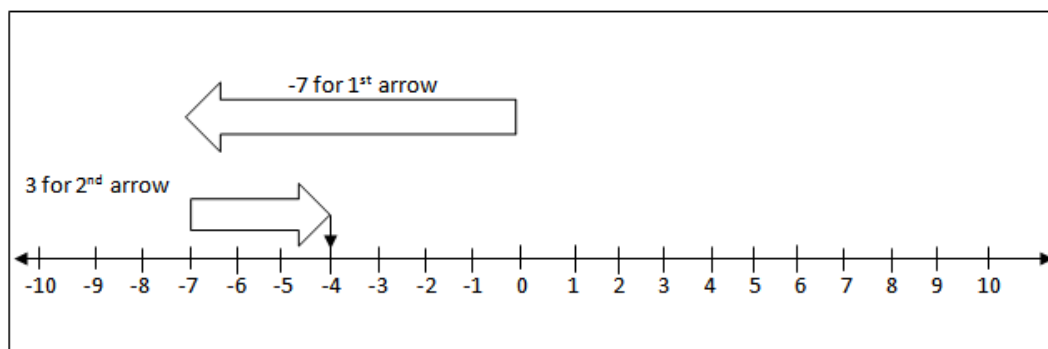


**Fig. 2:** Rectangular cut out number line used at step 2

The first arrow (-7) was laid from point zero (0) to the left on -7. The second arrow which is positive (3) was laid below the first one. It was laid from point (-7) to the right. The tip of the second arrow was (-4) which is the answer. Therefore (-7) + 3 = -4.

The researcher noticed that most of the pupils could solve most of the addition and subtraction of integers. This was because, during the intervention pupils were taken through activities which helped them a lot and after this it was realized that the pupils were performing wonderfully well through the work they did.

## IV. Discussion

After they had been taken through the intervention activities, that is, how to use teaching learning materials to solve questions, they gained more interest in the topic. This was noticed during the follow up activity conducted by the researchers during and after the intervention. Below gives an analysis of pupils' performance before and after the intervention.

**Table 1: Pre – intervention results**

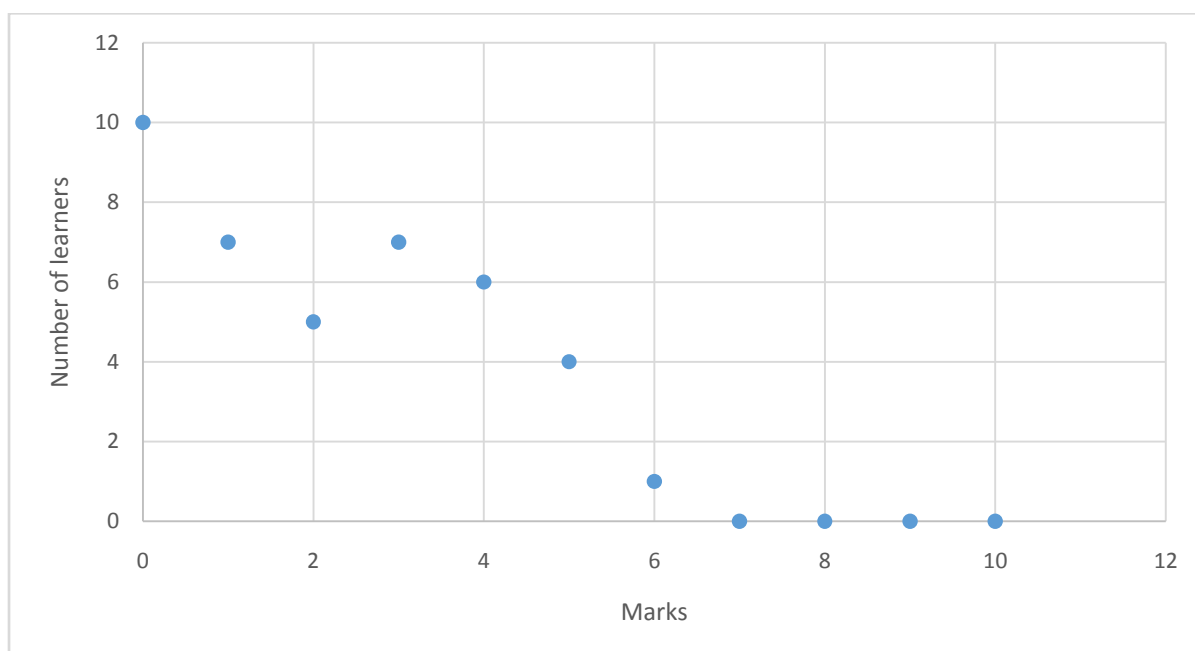| Marks | Number of learners | Percentage (%) |
|-------|--------------------|----------------|
| 0 | 10 | 25.0 |
| 1 | 7 | 17.5 |
| 2 | 5 | 12.5 |
| 3 | 7 | 17.5 |
| 4 | 6 | 15.0 |
| 5 | 4 | 10.0 |
| 6 | 1 | 2.5 |
| 7 | 0 | 0.0 |
| 8 | 0 | 0.0 |
| 9 | 0 | 0.0 |
| 10 | 0 | 0.0 |
| **Total** | **40** | **100** |



**Fig. 3**: Scatter diagram of the pre-intervention results

**Table 2: Post – intervention results**

| Marks | Number of learners | Percentage (%) |
|-------|--------------------|----------------|
| 0 | 0 | 0.00 |
| 1 | 0 | 0.00 |
| 2 | 0 | 0.00 |
| 3 | 2 | 5.00 |
| 4 | 2 | 5.00 |
| 5 | 5 | 12.50 |
| 6 | 7 | 17.50 |
| 7 | 6 | 15.00 |
| 8 | 7 | 17.50 |
| 9 | 6 | 15.00 |
| 10 | 5 | 12.50 |

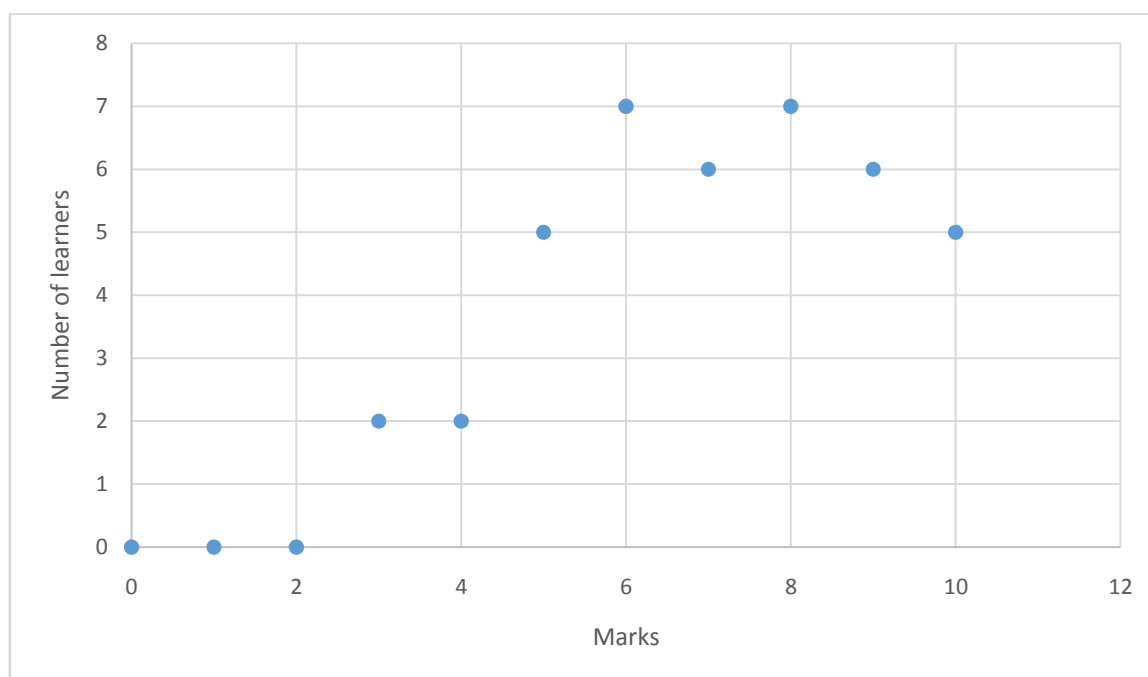| | | |
|---|---|---|
| **Total** | **40** | **100** |



**Fig. 4:** Scatter diagram of the post-intervention results

A critical look at the scatter diagram for pre – intervention results shows that it is skewed towards the right hand side. This shows that learners did not perform well. Whiles the scatter diagram for the post – intervention results was skewed towards the left which indicated an improvement in the performance of learners. This improvement in performance is as a result of the use of rectangular cut out number line in teaching addition and subtraction of integers. A line graph is shown below to give a clearer picture of the pre – intervention results versus post – intervention results.
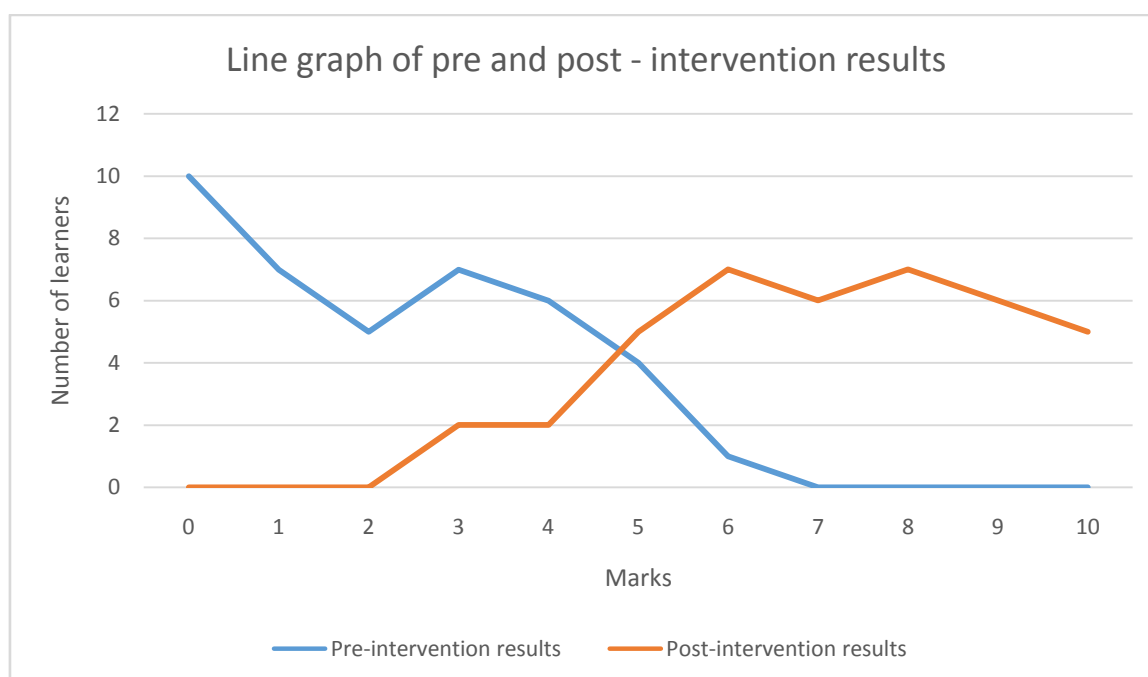


**Fig. 5:** Line graph of pre and post – intervention results

The following were proposed by the researchers for solving addition and subtraction of integers.
Before learners were taken through the activities, the researchers found out that the pupils could solve some simple additions and subtractions but the problem came about when they were introduced to integers. This

is because, the mathematics teacher was teaching in abstraction. He did not use any teaching and learning materials to teach the learners. He was just solving the questions on the chalkboard for them to observe for themselves.

The researchers found out that, this was not helping the learners at all because they did not understand what was being taught as there were no use of teaching and learning materials that would enhance their understanding. This deterred the learners from gaining interest in the topic.

From the research conducted, it was pointed out clearly that in teaching of integers, there should be materials that will enhance learner's co-operation and understanding in the classroom. With the use of teaching and learning materials, learners would be able to understand what is being taught quickly.

This also helped learners to have in-depth knowledge of what an integer really is, because before the researchers introduced the teaching materials, the learners did not really understand the concept of integers. After going through the use of teaching and learning materials with the learners, they understood the topic better. This also indicates that the use of teaching and learning materials in mathematics id very vital.

## V. Conclusion

It is very true from the discussion above that for pupils to be interested and participate in teaching and learning, there should be the use of teaching and learning materials in every mathematics lesson. This brings about good participation and also the subject "mathematics" is made easier for learners. Teachers must also look at the approaches they use in teaching mathematics. They should see to it that learners have acquired the skill of using teaching and learning materials to solve problems.

The study recommends that teachers or facilitators should use teaching and learning materials in their delivery to aid better understanding since learners learn better through touching and manipulation of objects. In addition, the Ghana Education Service must help improve the use of teaching and learning materials in teaching mathematics at all levels through in-service training programs on how to improve and use teaching and learning materials.

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