IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 13, Issue 4 Ser. IV (July. – August. 2023), 37-46
www.iosrjournals.org

Effects Of Algebra Tiles In The Teaching And Learning Of Algebraic Expressions

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ABSTRACT
This study is aimed at using algebra tiles to assist students at the basic level to understand the concept of addition and subtraction of algebraic expressions in East Mamprusi Municipality of the North East Region of Ghana. The study also aims at providing practical ways by which teachers can use them to handle the topic effectively. A good grasp of algebraic expressions will help improve pupils' performance in exponents, polynomials, quadratic equations among others. Action research design was adopted for this study. Two research questions were formulated to guide the study. Achievement pre-test and post-test were developed and administered to the pupils and they were analyzed using simple frequency distribution tables. Percentages and average scores of the students were also calculated. In all, twenty-five (25) pupils were selected from form one junior high school (JHS) using stratified random sampling technique. The results of the study indicated a very significant difference between the pre-test and post-test which implied that the intervention yielded positive results on the pupils in the introduction of addition and subtraction of algebraic expressions. The study recommended among others that teachers should resort to the use of algebra tiles as teaching and learning materials when teaching algebraic expressions. More emphasis must be placed on the use of child centered method of teaching to ensure pupils participation during lesson delivery.

Keywords: *Algebra tiles, algebraic expressions, pre-test, post-test*

Date of Submission: 18-08-2023 Date of Acceptance: 28-08-2023

I. INTRODUCTION

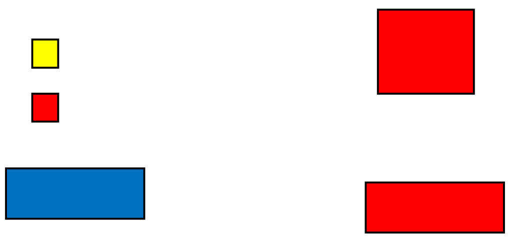
Algebra is a branch of mathematics which deals with the use of letters and symbols to represent numbers. Algebra was invented by Abu Ja`far Muhammad ibn Musa al- Khwarizmi, a mathematician, astronomer, geographer, who was born about 780 in Baghdad. Algebra has many branches such as advanced algebra, abstract algebra, elementary algebra, linear algebra and commutative algebra. Algebra is studied at all levels of the educational ladder in Ghana. Therefore, once you are a student in Ghana you cannot exempt yourself from coming into contact with it, be it at the basic level, secondary or at the tertiary levels. It was included in the 2018 new curriculum in the early grade (KG to Basic 3), Upper grade (Basic 4-6) and Junior High School grade (Basic 7-9). It appears in most of the topics in mathematics such as transformation, vectors, statistics and calculus, algebraic expressions, algebraic equations, binary operations, simultaneous equations etc. Algebraic expressions is an aspect of algebra so when learners clearly understand the concept of algebra, they will not be found wanting in the other topics listed above. An algebraic expression is a mathematical phrase that includes variables, constants, coefficients and algebraic operations. Algebraic expressions do not have equal sign. According to Webster (2006), algebraic expression is a generalization of arithmetic in which letters representing numbers are combined according to the rules of arithmetic. In short, it is a division of mathematics designed to help solve certain types of mathematical problems easier and quicker. Algebraic expression is a collection of letters and symbols combined with at least one of the operators (+, -, ×, ÷). Algebraic expression also describes clear relationships between variables and constants and is considered the language of mathematics. It also describes relationships between people, thoughts, elements and structures.

Form one Junior High School (JHS) students in the East Manprusi Municipality of the North East region of Ghana have some challenges with addition and subtraction of algebraic expressions. Several attempts have been made by mathematics teachers aimed at addressing the challenges faced by the students using different approaches ranging from teaching methods to teaching resources but it appears the problem still persists. This is evident by the results being churned out by the West African Examination Council (WAEC) on yearly basis. We conducted interviews to ascertain whether or not mathematics teachers use algebra tiles in teaching algebraic expressions and it was found out that most teachers did not make use of algebra tiles in their lessons. The study therefore seeks to use algebra tiles to help address the problem. It will also use cooperative learning strategy to help students overcome their learning difficulties. Algebra tiles are mathematical manipulative or teaching and learning materials (TLM) that help students to understand algebraic expressions and the concept of algebra in general. Algebra tiles can be used throughout algebra instruction to teach students the following concepts; adding, subtracting, multiplying and dividing integers, completing the square, factoring, and distributive property can be taught by using algebra tiles (Leitze & Kitt, 2000). These teaching aids are easy to carry about and manipulated by students. Teachers can prepare or purchase ready-made materials from stores or sometimes ask pre-service teachers to prepare them as part of their portfolio building for marks in colleges of education in Ghana. Cass et al. (2003) posit that manipulative can be described as concrete objects that learners can physically assemble or use in a way to denote several mathematical relationships. They also see manipulatives as apparatuses that enable learning of a new mathematical skill a real process. Students are engaged in problem solving as they manipulate objects as they search for a solution. It is always difficult for students to understand concepts when they are presented in abstract form and so the use of hands-on interaction with concrete manipulative allows students of any level to begin instruction on a level playing field. As Smith (2009) posits, “A good manipulative bridges the gap between informal math and formal math. To accomplish this objective, the manipulative must fit the developmental level of the child” (p.20). There are multiple ways to use manipulatives. In the classroom, teachers are using manipulatives in a lesson as they introduce, practice or remediate a mathematical concept (Hidayah et al., 2021). The use of algebra tiles in teaching algebraic expressions makes the lesson practical and real for the students. According to the National Council for Curriculum and Assessment (NaCCA), manipulatives are important tools for teaching and learning of mathematics at all levels of education. The Ministry of Education, Transforming Teacher Education and Learning (T-TEL), and NaCCA have made it clear to all Ghanaian Basic School Teachers that they are required to include manipulative materials in preparing their lesson notes and using them for teaching (Ministry of Education, 2020). The Government of Ghana in its efforts to enhance understanding of concepts in mathematics with the use of manipulative materials secured funding in 2018, through T-TEL Challenge Fund, for Colleges of Education to equip their resource centers with manipulatives, and to enhance teaching and learning in the Colleges of Education in the country.

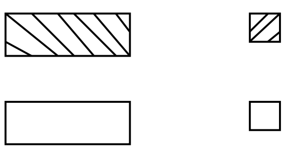
II. LITERATURE REVIEW

W.W. Sawyer developed the idea behind Algebra Tiles in the 1940s. Z.P. Dienes worked with them in the 1960s and Charles Lovitt and colleagues published a manual about them in the 1970s.These algebra tiles can be used to teach a variety of concepts, including counting, area, integers, linear equations, algebraic equations, polynomials etc. They are mathematical manipulatives that allow students to understand ways of algebraic thinking and the concepts of algebra. The introduction of algebra tiles and other manipulatives into mathematics lessons provide mathematics teachers with exciting opportunities to empower students with different learning styles. These tiles have proven to provide concrete models for elementary school, middle school, high school, and college-level introductory algebra students. Algebra tiles are used to build concrete area representations of abstract algebraic concepts. The concrete representations help students become comfortable with using symbols to represent algebraic concepts. Algebra tiles are typically used to explore integers, algebraic expressions, equations, factoring, and expanding. Again, algebra tiles allow students to model algebra problems and help them visualize numbers and variables in a given algebraic expression. Algebra tiles can also be used to solve simple and complex problems. Algebra tiles allow both an algebraic and geometric approach to algebraic concepts. They give students another way to solve algebraic problems other than abstract manipulation (Kitt et al, 2000). The National Council of Teachers of Mathematics (NCTM) recommends a decreased emphasis on the memorization of the rules of algebra and the symbol manipulation of algebra in their Curriculum and Evaluation Standards for mathematics. Larbi and Okyere (2014, 2016) examined the efficacy of using algebra tiles manipulatives in junior high school students with a sample of 56 students from two schools purposely selected and divided into experimental and the control group. The experimental group was taught using algebra tiles whilst the control group was taught using the traditional approach over a period of four weeks. The results indicate that the experimental group out-performed their counterparts in the control group significantly and also improved students thinking process as they solved problems in algebra. Similarly, Saraswati et al.’ (2016) study entitled “supporting students’ understanding of linear equations with one variable using algebra tiles” investigated one variable using algebra tiles combined with balancing method, which consists of three phases, namely preliminary design, teaching experiment and retrospective analysis. Padmore (2017) examines the use of manipulative materials in teaching Mathematics among Junior High School Teachers in the Wa Municipality of Ghana with a sample of 94 teachers and 10 head teachers. His conclusions on the benefits of manipulative use were as follows; (1) manipulative materials improve pupils understanding and help them to construct their own knowledge of the subject easily (2) it saves a lot of time and allows teachers to cover more topics easily, motivates pupils and helps bring on board their needs to be met (3) help pupils not to shy away from mathematics but are able to relate the real-world situation to mathematical symbolism. (4) Allowing pupils to work cooperatively in solving problems, mathematics ideas and concepts and (5) make mathematics fun and easy for teachers to introduce concepts. Also, his study results on challenges of manipulative use as; (1) inadequate supply of manipulative materials to teachers (2) lack of continuous professional training on manipulative use (3) inadequate user guide for teachers on the use of manipulative materials (4) High cost in preparing and purchasing manipulative materials. (5) too much workload on teachers and (6) large class size affects the use of manipulative materials in teaching mathematics.

In mathematics teaching, students should be encouraged to learn by doing and to have experience with mathematical manipulatives that help development of cognitive, affective and psychomotor domains (Okpube, 2016). Manipulatives also generate motivation for students to engage in learning process and enable students to understand and visualize concepts more clearly (Bruins, 2014). Therefore, teachers should begin mathematics lessons with concrete manipulatives, and then pass to the representational models such as pictures, diagrams, and figures. Using manipulatives can be useful for all students with different learning styles. Cooper (2012) stated that manipulatives are beneficial even for students who are proficient in symbolic procedures because they enhance students' conceptual understanding by providing a different perspective for mathematics. Furthermore, manipulatives are effective tools for kinesthetic learners at the elementary and secondary levels because they learn better when they touch or are physically involved in what they are studying (Corrales, 2008; Gage, 1995). Manipulatives provide numerous benefits for students. However, there are several issues that need attention while using manipulatives in the mathematics classes. First, there are certain difficulties related to using manipulatives in the classroom. Students can use manipulatives to play games rather than complete their assignments. Moreover, distributing and collecting manipulatives result in considerable loss of time. For these reasons, before implementing manipulatives in the classroom, the teacher should consider the amount of time and be aware of the possibility that students can use manipulatives as toys (Magruder, 2012). Piaget (1952) believed that due to the fact that students cannot understand abstract mathematics only with the explanations and instructions, they should have experiences with models and materials. Similarly, according to Bruner (1960), students' early experiences and interactions with concrete objects provide a basis for their future abstract learning. Using manipulatives helps students make a transition between concrete and symbolic representations of the concepts (Fennema, 1972). One of the materials that can be used in algebra teaching process is algebra tiles. "Algebra tiles usually come with a small square, an oblong-rectangular strip, and a larger square. The tiles are purposely designed so that the side length of the larger square is not an integral multiple of the side length of the smaller square" (Chappell & Strutchens, 2001, p. 20). They can be used to model several mathematical processes in algebra concepts and help students visualize and conceptually understand these processes (Brahier, 2016). By using algebra tiles, students can explore algebraic expressions in a visual and hands-on way. Thus, students can learn the rules of algebra from their own experiences (Okpube, 2016). Furthermore, using algebra tiles helps students avoid making mistakes and eliminate students' confusion between expressions such as "2x" and "2+x" (Picciotto & Wah, 1993) and they provide better understanding of zero principles (Sibbald, 2009). Students can create varied pairs of zero while simplifying algebraic expressions and generate different expressions without changing their values (Chappell & Strutchens, 2001). Students generally tend to use symbols such as "x" and "y" to represent variables because of the common usage of these symbols and forget that different symbols can also be used. Algebra tiles enable students to understand the arbitrary nature of the variable concept. On the other hand, algebra tiles have some limitations. Polynomials beyond first and second degree cannot be modelled with algebra tiles (Smith, 2017). Besides, modelling complicated examples with algebra tiles is difficult. Therefore, rules to complicate examples can be extended by using the symbolic form. Algebra tiles cannot represent fractions. For this reason, it is difficult to represent division equations by using algebra tiles (Magruder, 2012 as cited by Salifu, 2022). Furthermore, in modelling algebraic expressions with algebra tiles, one color of the rectangle algebra tile represents –x but area cannot have a negative value in reality. Hence, this can lead students to a misconception (İşleyen, 2012). Algebra tiles usually consist of x sets and y sets. Different pieces are used to model 1, x, x^2, y, y^2 , and xy. Sets consist of two different colors to represent both positive and negative terms. There are different models of algebra tiles that are used depending on the concept to be learned and its requirements. One can use colored tiles without numbers written on them but must explain what each tile represents as in this study. Examples of such tiles include



Also shaded and unshaded tiles could also be used as shown below



The unshaded tiles represent positive numbers and variables while shaded tiles represent negative numbers and variables.

As stated earlier, algebra tiles are a concrete, visual, area-based model which naturally link students' previous understandings to algebraic representations, forging the links of factors and the distributive property from number and applying them to algebra. Since students already know that the sum of a number and its opposite is zero, it becomes easier for them to add a positive tile and a negative tile to form the zero pair. For example positive three (+3) and negative tree (-3) tiles when added together equal zero. Allowing students to perform these activities help them in gaining confidence in their abilities to find solutions to mathematical problems using methods that they come up with themselves without relying on the directions of the teacher. This is in line with the Chinese adage which states 'I hear and I forget, I see and I remember, I do and I understand'

Kog and Baser (2012) study revealed that visualization approach not only affected the students' attitudes towards mathematics but also affects their mathematics achievement positively. The purpose of the study was to examine the effects of visualization approach on the 8^{th} grade students in a pretest-posttest experimental. The experimental group was taught with the help of visualization approach using algebra tiles, computer-assisted visual materials, concept cartoons, metaphors, and activity sheets while the control group took traditional instruction approach as cited by Salifu (2022). Also, Gurbuz and Toprak (2014) concluded that activity-based instruction was more effective than regular instruction when 58 7^{th} grade students were used as the sample when the students wrote both pre and post-test. The experimental group used activity-based instruction using balance, counters and algebra tiles as the manipulatives while control group had regular. The purpose of their study was to design, implement and evaluate activities that enable 7^{th} grade students to make transition from arithmetic to algebra. It is very clear from the foregoing that algebra tiles can actually help improve the performance of students since it helps to minimize common mistakes.

III. THEORETICAL FRAMEWORK

This study is based on the constructivist learning theory which traces its origin from the cognitive scientists like Jean Piaget, John Dewey, Jerome Brunner among others. Constructivism is a learning theory that emphasizes the active role of learners in building their own understanding. This means that learners do not passively receive information or knowledge but rather actively participate in the teaching and learning process by reflecting on their experiences, create mental representations and incorporating new knowledge into their schemas (Saul Mcleod, 2023)

Constructivism is "an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner" (Elliott et al, 2000, p.256). This means ideas cannot and should not be transmitted to passive learners; they are not tabula rasa. Every learner is unique and rich with ideas that should be used to construct new concepts and procedures. Constructivism's central idea is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning. This prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences (Philips, 1995).

Knowledge is socially constructed. Learning is a social activity – it is something we do together, in interaction with each other, rather than an abstract concept (Dewey, 1938). Learning is a social interaction between and among students as well as facilitated socially between teacher and learners. Environment plays a crucial role in the teaching and learning process. For example, Vygotsky (1978) believed that community plays a central role in the process of "making meaning." For Vygotsky, the environment in which children grow up will influence how they think and what they think about. Thus, all teaching and learning is a matter of sharing and negotiating socially constituted knowledge.

Knowledge and understanding are unique for each student. Students have different network of ideas that the individual integrates with the new knowledge when faced with a task. Each individual learner has a distinctive point of view, based on existing knowledge and values. This means that same lesson, teaching or activity may result in different learning by each pupil, as their subjective interpretation differ. Teachers should not treat all students as the same.

The constructivist theory posits that knowledge can only exist within the human mind, and that it does not have to match any real-world reality (Driscoll, 2000). Learners will be constantly trying to develop their own individual mental model of the real world from their perceptions of that world. As they perceive each new experience, learners will continually update their own mental models to reflect the new information, and will, therefore, construct their own interpretation of reality. Reflective thinking is a very important ingredient for effective learning. Students must be mentally engaged, encouraged to find the relevant previous ideas and use them to develop new ideas and solutions to new problems. This promotes relational learning. This will make learners critical thinkers and problem solvers which will help the children to earn their living and to make them self-sufficient

In constructivist approach, learning is interactive and student-centered activity. The emphasis is on learning rather than teaching. The students' task is to learn and the teacher's task is to pose worthwhile math tasks and create an enabling environment for exploration and sense making. The source of mathematical truth is formed in the reasoning carried out by the class. It is therefore important that mathematics teachers who are teaching at the basic level are required to use any concrete manipulative that will help learners relate mathematics to the real-life situations and give pupils appropriate hands-on activities that will discourage rote-learning, authoritative teaching and memorizing facts, theorems and formulas.

Statement of the problem

The problem was encountered in a mathematics lesson in form one (1) when pre-service teacher was teaching the topic "addition and subtraction of algebraic expressions". The pre-service teacher observed that learners' participation was poor and though only a few questions were asked, few of the pupils were able to answer the questions correctly. The test items were repeated at a different day but the feedback remained the same. Generally, the performance of students in mathematics at the basic education certificate examination in East Mamprusi Municipality in the North East Region of Ghana is very poor. Anytime the students sit for any external examinations the results are not always encouraging. This is because the students find it difficult understanding basic concepts of which addition and subtraction of algebraic expressions is key. This is supported by the results being churned out by WAEC on yearly basis. This prompted the study on the topic to find out what could be done to assist JHS students to improve upon addition and subtractions of algebraic expressions. There is no known research that sort to help students overcome their difficulties of understanding algebraic expressions at the basic level within the Municipality using algebra tiles. Therefore the study seeks to use algebra tiles to help JHS students to understand addition and subtraction of algebraic expressions

Purpose of the study

The purpose of the study was to help junior high school students to overcome their difficulties in addition and subtraction of algebraic expressions. This study looks at how algebraic tiles could be used to help them solve their challenges. Also, the study is to help children enrich their knowledge on the concept of algebra in mathematics which they will continue to encounter in their further studies in mathematics.

Objectives of the study

1. Use cooperative learning strategy to assist junior high pupils in the Municipality to overcome their difficulty in addition and subtraction of algebraic expressions
2. Use algebra tiles to assist junior high pupils to develop positive attitudes towards mathematics in general and addition and subtraction of algebraic expressions in particular

Research Questions

1. How will the use of cooperative learning strategy assist JHS pupils overcome their difficulty in addition and subtraction of algebraic expressions?
2. How will the use of algebra tiles assist JHS pupils to develop positive attitudes towards addition and subtraction of algebraic expressions?

IV. Methodology

Design

The research design used in this study was an action research. Action research is chosen because it helps the teacher to understand what is in a teaching and learning situation. Action research is an interactive inquiry process that balances problem-solving actions implemented in a collaborative context with data-driven collaborative analysis or research to understand underlying causes enabling future predictions about personal and organizational change, Reason, Peter, Bradbury, Hilary, eds. (2001). The basic aim of action research is to improve practice rather than to produce knowledge. Action research helps the teacher in his lesson delivery. It also enables both the teacher/researcher and learners to develop appropriate intervention strategies aimed at finding solutions to learning problems.

Again, action research differs from other forms of research because it focuses on improving practice as opposed to developing theoretical understandings. The study intends to help junior high school pupils to grab the concept of how to add and subtract algebraic expressions using the algebra tiles. However, action research consumes time because it takes one problem at a time and it's limited to the classroom teaching and learning situation.

Population, sample and sampling procedure

The population for this study was form one Junior High school students in the East Mamprusi Municipality of North East Region of Ghana. The sample for the study was twenty-five students comprising ten (10) males and fifteen (15) females. Sampling was done to avoid bias in the selection process and to help the researcher to work with a reasonable size. The probability sampling technique used was the stratified random sampling. This is a technique in which the varied accessible population is divided into a mutually exclusive group called strata and random samples are then taken from each stratum as sample, Popoola (2011). In this study, the stratums were males, females, above average and below average. Specific number of 'yes' or 'no' were written on pieces of papers for them to pick and the sample was gotten from that.

Research Instruments

The main instrument used in this study was achievement test on addition and subtraction of algebraic expressions. Both pre-test and post-test were in a form of essay type questions administered to the students to measure their competencies in addition and subtraction of algebraic expressions. Pre-test was dispensed to the pupils before the intervention activity as a diagnostic test while post-test too was administered to them after the intervention activity to determine the effectiveness of the intervention. Test enables the teacher to know what pupils have learnt and where they have difficulties. It also helps the teacher to know his or her teaching effectiveness.

Data collection procedure

The methods of obtaining or collecting data about the group of pupils was based on three critical areas, the pre intervention phase, the intervention phase and post intervention phase

Pre-Intervention

The pre-intervention is the procedure that was adopted in trying to define the problem before the actual intervention. Here, the researcher used observation, interviews and test to diagnose the problem. We tried to find out the causes of pupil's inability to add and subtract algebraic expressions using observation as the first tool. We observed different lessons on different topics on the same subject (mathematics) and realized that teachers do not use concrete teaching and learning materials in teaching. It was also observed that learners were not motivated enough to learn and participate especially during mathematics lessons. Learners did not also ask relevant questions during lesson delivery. Test which was the main instrument was then used to ascertain the veracity or otherwise of the problem. A pre-test was administrated to the pupils to find out the extent of the problem. The questions were written on the chalkboard for pupils to answer with a given time, the test was marked out of ten (10) and the results revealed poor performance of pupils.

Intervention

Intervention is a deliberate process by which change is introduced into pupils' thoughts, feeling and behaviors. It took the researcher about one week to complete this part of the work in sessions.

Activity 1 (70) minutes

We first introduced learners to the concept of algebra and what algebraic expressions are. Pupils were also guided to distinguish between algebraic expressions and algebraic equations with the latter having an equal sign

Learners were then put into five (5) groups with each group having five members. Key notice was given to ability and sex while grouping them. Different cardboards made of the colors red, yellow, green, blue and white were given to learners to be used as the tiles. We then gave them specific measurements to cut the materials into different shapes representing algebra tiles. The following were the tiles made from the cardboards from each group

Here learners were introduced to the idea of using algebraic tiles in solving a wide range of mathematical problems such as integers, linear equations and inequalities, expansion and factorization and to the main topic algebraic expressions. Learners were taken through what each and every tile they made was going to represent in our discussions as shown below;

- +1 : small yellow square tile
- -1: small red square tile
- +X: rectangular blue tile
- -X: rectangular red tile
- +Y: rectangular green tile
- -Y: rectangular white tile
- $+X^2$: big blue square tile
- $-X^2$: big red square tile

- $+Y^2$: big green square tile
- $-Y^2$: big white square tile

Learners were guided on how to represent an algebraic term with the use of tiles as shown below

Each group was then given specific terms to represent using the tiles, after which selected members from each group presented their work for the whole class discussions.

Learners were then engaged to establish some guidelines with respect to addition and subtraction of algebraic expressions using algebra tiles.

- Terms of the same kind can be brought together to give one outcome. That is if two terms are found in different sides of an algebraic expressions, they are brought together to give one answer. For example, if 2x and 3x are found in different areas, they are brought together to give the result 5x. In using the tiles, tiles of the same kind will also be brought together likewise those of different kind cannot be brought together.
- Learners were also guided to discover the concept of zero pairs when using algebra tiles. That is, a positive tile combining with a negative tile to give zero as shown below in the following combinations.
  (i) 3 and -3 :   (ii) $2x^2$ and $-2x^2$:   (iii) 3y and -3y:
  .

Each group were then asked to write their own five zero pairs and demonstrate the combinations using the tiles.

V. Results and Discussions

The tables below give a detailed analysis of the data collected on the students through the use of test as the research instruments. It also deals with the statistical representation of data collected on them.

Table 1: pre-test Results

Marks	Frequency	Percentage (%)
0 – 2	18	72
3 – 5	5	20
6 – 7	2	8
8 – 10	0	0
Total	*25*	*100*

From the pre-test results shown above, it was observed that eighteen (18) pupils out of the twenty-five (25) representing seventy-two percent (72%) scored marks between zero (0) to two (2) which is very poor. Again, five (5) pupils representing twenty percent (20%) had the marks between three(3) to five (5) out of a possible ten. Also, two (2) pupils were able to get the scores six (6) to seven (7) out of ten representing eight percent (8%). And finally, no student was able to score eight (8), nine (9) and ten (10) out of ten (10) representing zero percent (0%).

A careful look at the pre-test results indicated clearly that, the pupils had challenges with addition and subtraction of algebraic expressions. We further calculated the average score of the students in the pre-test. The results are shown below in table 2.

Table 2: Average score of pre-test results

Marks	*Class Midpoint (X)*	*Frequency (F)*	*FX*
0 – 2	1	18	18
3 – 5	4	5	20
6 – 7	6.5	2	13
8 – 10	9	0	0
Total		*$\sum f = 25$*	*$\sum fx = 51$*

Calculating the mean or average score,

$$\pi = \frac{\sum fx}{\sum f} = \frac{51}{25}$$

$\pi = 2.04$

Hence the mean or average score is 2.04

KEY

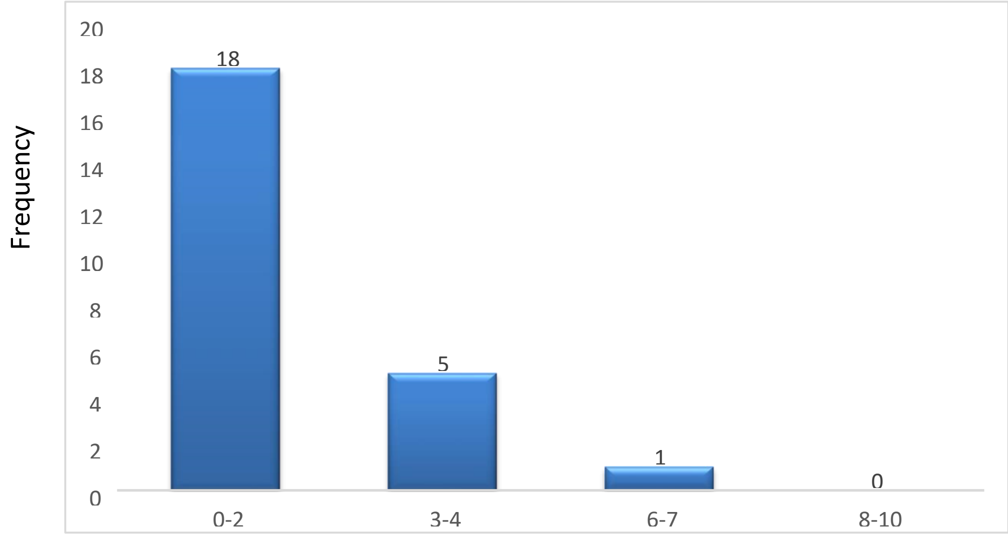
π =Mean

X=class midpoint

F= Frequency

∑ = Summation

From the above calculations, it was observed that pupils performed poorly in the pre-test as the average score of learners in the pre-test (2.04) was far below the average score of the test (5) and this called for an intervention to curb the situation. A pictorial representation was done using a bar graph as shown below.



Marks

Figure 1: Bar chart depicting Pre-test results

From the above awful performance by pupils, we decided to put in several intervention strategies to help pupils overcome their difficulty. After the intervention activities, a post-test was conducted to examine the impact of the interventions. The results of which are represented in table 3 as shown below.

Table 3: Post-test results

Marks	Frequency	Percentage (%)
0 -2	1	4
3 – 5	2	8
6 – 7	3	12
8 – 10	19	76
Total	25	100

From the table above it could be observed that after the intervention activities, one (1) student had the scores between zero (0) to two (2) representing four percent (4%). Also, two (2) pupils representing eight percent (8%) had the scores between three(3) to five (5) respectively. Again, three (3) students had the marks between six (6) to seven (7) representing twelve percent (12%). And finally, a huge nineteen (19) of the students representing seventy-six percent (76%) scored the marks between eight (8) to ten (10) from the post-test indicating a massive improvement by pupils in addition and subtraction of algebraic expressions.

We also represented the above performance on another table in order to calculate for the mean or average mark of the pupils in the post-test as shown below.

Table 4: Average of post-test results

Marks	Class Midpoint (X)	Frequency (F)	FX
0 – 2	1	1	1
3 – 5	4	2	8
6 – 7	6.5	3	19.5
8 – 10	9	19	171

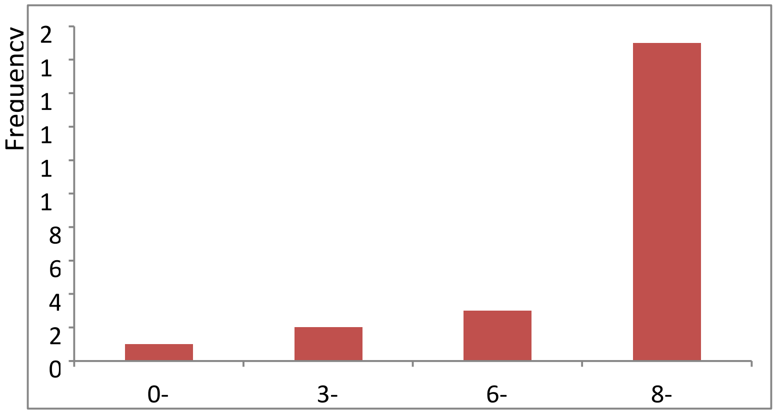
Total	25	199.5

$$\pi = \frac{\sum fx}{\sum f} = \frac{199.5}{25}$$
$=7.98$

Hence the mean or average score is 7.98

From the above calculations, it was observed that pupils performed very well in the post-test as compared to their scores in the pre-test as the average score of learners in the post-test (7.98) was far above the average score of the test (5) and this showed a massive improvement of pupils in addition and subtraction of algebraic expressions.

This information was again represented in a bar chart to give a clearer picture of the improvement as shown below.

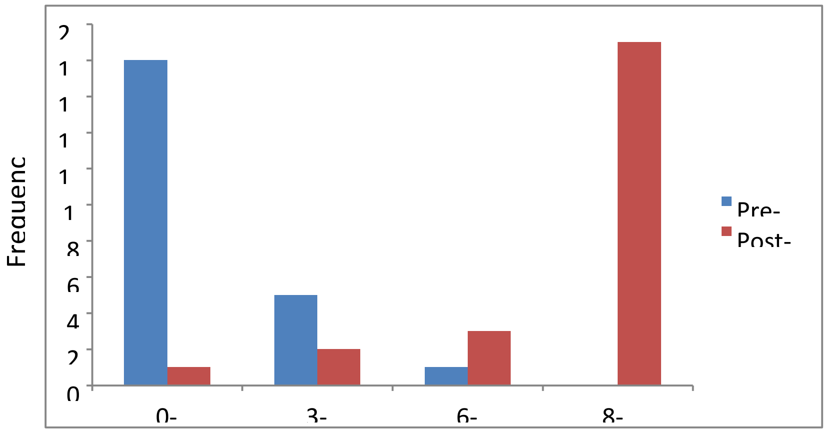


Marks

Figure 2: Bar chart depicting Post-test results

Table 5: Comparison of Pre-test and Post-test results

Marks	Pre-test Frequency	Post-test Frequency
0 – 2	18	1
3 – 5	5	2
6 – 7	2	3
8 – 10	0	19
Total	25	25



Marks

Figure 3: Column Graph showing pre-test and post-test comparison

VI. Conclusion

. The mode of intervention through the use of relevant teaching and learning aids with the appropriate methods and strategies gave the reality of experience that stimulated self-activity on the part of learners. The output of the intervention could be observed by pupils' good performance in the post-test. Pupils learn and understand concepts and skills through the use and interaction with concrete and semi-concrete materials. Pupils also learn well by seeing and touching things for themselves. Teachers should therefore always present lessons in an activity oriented form.

Pupils should also involve themselves in the teaching and learning processes in order to gain maximum benefit from it. The teaching and learning aids must be used wisely not losing sight of individual differences.

To end this, it is proper that lessons must be introduced well with practical activities, illustrations and clear pictorial charts which make learning easier. As teachers, we must enjoy the lesson ourselves before we can convince others.

VII. Recommendations

Based on the findings of the study, the researcher came out with the following recommendations to be considered by the authorities and all those who matter in the field of education in the municipality.

Ghana Education Service (G.E.S.) should support the various schools with teaching and learning materials or manipulative materials such as algebra tiles etc and make them readily available to both teachers and learners at the basic levels. Where they are not available, teachers should be motivated to improvise TLMs for effective lesson delivery.

Secondly, lack of knowledge of the use of algebra tiles could be solved through workshops organized by G.E.S for mathematics teachers to learn more about the use of manipulatives in the classroom

Moreover, emphasis must be placed on the use of child-centered methods and strategies of teaching and learning to ensure full participation and understanding by pupils during lesson delivery.

Also, in-service training should be organized periodically especially for mathematics teachers to be abreast with the new methods, strategies and techniques of teaching various aspects of the subject.

VIII. Limitation

The limitation the researcher encountered during the course of the study was the sample size of twenty five (25) students. The sample size was too small for the municipality and therefore larger sample size may have yielded or produced different results for the study.

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