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Cooperative Learning with Manipulatives and Students' Performance in Mathematics Problem Solving

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Abstract
The use of manipulatives in teaching mathematics has been identified to have a significant improvement on students' understanding of mathematical concepts as well as their interest in their studies and subsequently their performance. Studies have examined the impact of this method on students' performance in mathematics in general little data is available on how cooperative learning with manipulatives learning affects learners' performance in mathematics problem-solving skills. Hence this study was to assess the effect of cooperative learning (CPL) with manipulatives on students' performance in mathematics problem-solving skills. The study employed a quasi-experimental research design. A multistage sampling procedure was employed to select eighty Junior High School students from a public school in Asikuma Odoben Brakwa District in the Central Region of Ghana. Mathematics Non-Routine Achievement Test (MNRAT) and an interview guide were used to gather primary data from the participants. Descriptive statistics and an independent t-test at $P \leq 0.05$ level of significance were used to analyzed the data gathered from the field. The findings of the study indicated that students taught cooperatively with or without manipulatives outperformed students taught utilizing the lecture technique with or without manipulatives and no discernible differences were found between males and females in their performance (with and without the use of manipulatives). The study therefore recommends that, the use of cooperative teaching and learning strategies integrated with manipulatives should be encouraged and adopted in schools by educational bodies, mathematics educators and teachers through workshops, seminars, in-service training and conferences on the importance and how to employ cooperative teaching and learning strategies with manipulatives to enhance Junior High School learners' social and interactive participation, critical thinking, logical reasoning, effective communication and problem-solving skills in mathematics
Keywords: Cooperative teaching and learning strategy, manipulatives, lecture method, mathematics problem-solving skills, students' performance in mathematics
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1.0. Introduction

The improvement of pupils' critical thinking, problem-solving abilities, and general cognitive capacities depends heavily on mathematics education. Effective school instruction and knowledge acquisition can be considered one of the best methods for empowering and ensuring a country's progress. A country's educational system can undoubtedly be of high quality if effective teaching and learning are implemented. The purposes, objectives, and goals that are included in the country's curriculum are coined in the developmental plans of a village, town, city, state, country, and the globe at large (Mullis, Martin & Foy, 2011; Mullis & Martin, 2015). A good mathematics education gives a base for grasping the world, the ability to think mathematically, admiration for mathematics' beauty and power, and a sense of enjoyment and wonder about the subject. Mathematics is used in various professions and for numerous hobbies these days. The drop in accomplishment in maths, on the other hand, is worrying. Students' negative attitude toward mathematics, such as considering mathematics to be a difficult and boring subject, fear of mathematics, insufficient qualified teachers, inadequate teaching and learning materials, and ineffective pedagogies in teaching mathematical concepts and skills are some of the reasons for the fall in mathematics achievement in schools (Mullis & Martin, 2015). Duncker (1945), poised that, a problem develops when a living organism has a goal but does not know how to achieve it. In any case, whenever one is confronted with a problem for which there are no specific procedures to follow to get a good solution, he must devise an accurate plan by combining ideas from various concepts and skills in his schemas to generate a unique and appropriate solution to the problem that did not exist previously. One way to think of Problem-solving (PS) is

that it describes cognitive processes used to attain a goal when the problem solver has no known solution techniques. Numerous instructional strategies and tools have been used as educators work to improve math learning outcomes and experiences.

According to available literature, ineffective teaching and learning methods such as the lecture method, rote learning, and a lack of critical thinking approaches to learning contribute significantly to students' lack of interest and poor performance in mathematics. The Ghanaian government and other mathematics education stakeholders, have made significant efforts to address the country's mathematics education difficulties. However, it appears that the continued employment of ineffective teaching and learning methods continues to nibble at the untold efforts made by all education stakeholders. Greater efforts are therefore needed to improve educational quality because pupils' performance in mathematics and science courses has not yet met the requisite levels. This was partly due to the fact that professionals in the teaching fraternity continued to adopt lecture approaches that make learners passive in class.

Despite these efforts, there is still much to be done to boost the classroom-level learning. Learning styles and tactics must be understood in order to educate or develop children's potential in various ways based on their talents, learning traits, and requirements (Chan, 2001). These efforts, as well as multiple curriculum revisions across a wide range of junior high school topics, have failed to produce significant improvements in students' academic achievement in mathematics. Findings from several research works indicate that, students' mathematics proficiency at all levels is still deteriorating on a regular basis. In the Ghanaian context, many international and national evaluation outcomes might be used as evidence. For example, the International Association for the Evaluation of Educational Achievement (IEA) reports of the Trends in International Mathematics and Science Study (TIMSS) for Ghana's grade eight students' mathematics performance suggested that Ghana was: second from the bottom with an average scale score of 309, far below TIMSS's average scale score of 500.

Furthermore, according to the West African Examinations Council (WAEC, 2017-2020; Summary & Entries, 2006), students' performance in mathematics is very poor at the High School levels in Ghana, particularly at examination items involving word problems, non-routine situations, and algebraic expressions.

Poor performance in the academics of students in the Asikuma Odoben Brakwa (AOB) district especially in mathematics is due to several factors including; truancy, absenteeism, peer group influence, lateness to school on the part of students; ineffective teaching methodologies, inadequate teaching and learning materials, non-availability of libraries in schools, failure by parents in providing their children with their basic needs for school as well as teachers' regular lateness and absence from school (Tinagyei, 2017; Baidoo-Anu, 2017).

Cooperative learning is one method that encourages students to participate actively in group projects and discussions with their peers. Additionally, the use of manipulatives tangible items that students can physically manipulate as an important pedagogical tool in mathematics instruction has garnered attention. Cooperative learning is made even more effective by the use of manipulatives. With the help of manipulatives, students can study abstract concepts in a real and visual way. Manipulatives give mathematical concepts concrete representations. They help pupils get a greater comprehension of mathematical concepts by acting as a link between the concrete and abstract worlds. Students can experiment, draw connections, and find patterns by manipulating actual objects, which can result in more fulfilling learning opportunities.

People of AOB can best be described as 'a cooperative community who believes in the sense of 'we feeling' and peruses the success of 'we all' and not 'I alone'. In view of the nature and culture of the people of Asikuma Odoben Brakwa district, this research seeks to employ cooperative teaching and learning (CPL) strategy to improve junior high school students' performance in mathematics problem-solving skills

1.1. Statement of the Problem

Low students' mathematics achievement is a cause of alarm globally. TIMSS (2011, 2015 & 2019) report, gives clear evidence that students' achievement in mathematics has not been good enough in many countries worldwide of which Ghana is not an exception (Anamuah-Mensah & Mereku, 2006; Grades, 2007; IEA, 2015; Learn; Martin & Foy, 2003; Mccrone, Sullivan, Gonzales & Schneider, 2007; Mullis & Martin, 2015; Ly, Phauk & Chea, 2022; LaRoche, Joncas & Foy, 2019; Mullis, Martin, Foy & Hooper, 2015 & 2019).

Generally, as stated earlier, mathematics achievements of Ghanaian students is very low and keeps falling drastically yearly. This abysmal performance is a cause of alarm to many stakeholders, educators and the country at large.

However, despite the government's efforts in various revisions of the curriculum, mathematics has not taken a new look in terms of its presentation and performance standards. This is evident in the consistent fallen standards of mathematics performance among students of basic and secondary levels of which students of AOB are of no exception.

Reports from the School & Circuit-based Mathematics Performance Monitoring Peer-Review Committee (SC-MPM-PRC, 2017 – 2021) and that of the AOB District Mathematics Achievement Board (D-MAB, 2017 -

2021) stated that; 'AOB district JHS and SHS students' performance in mathematics generally and specifically in non-routine mathematics word problems is very poor, keeps declining, alarming and needs to be addressed with immediate effects. This poor performance in mathematics is also revealed by the district report (2017-2020) of students' performance which indicates that on average 55.99% of the total number of Jamra Methodist Basic School students who sit for the Basic Education Certificate Examination (BECE) conducted by the West African Examinations Council (WAEC) fail in the mathematics paper yearly.

According to the Chief Examiner's Reports, Ghana has been experiencing abysmal student mathematics achievements for the most recent decades across the basic levels through to the senior high level, especially about items that are framed in a non-routine way. The report suggests students should be engaged in the solution of more than one-step non-routine problems, and helped to know, understand and apply mathematical concepts through learner-centred teaching and learning approaches such as cooperative learning approaches to appreciate the relevance of mathematic real-life situations. (WAEC 2017, 2018, 2019 & 2020; Summary & Entries, 2006). Moreover, findings from various tertiary institutions in Ghana are not quite different as low performance of students in mathematics and mathematics related courses is concerned.

The consistent poor performance of students in mathematics at the Basic School level leaves one in doubt about the effectiveness of the teaching method popularly used by mathematics teachers for teaching the subject. A series of observations made during mathematics lessons taught by some of the mathematics teachers of Jamra Methodist Basic School revealed that students' participation in the lessons were not encouraging.

The lecture method of instruction is used mainly in most of the courses taught at all levels, notably among JHS and SHS levels of Ghana's system of education. In many cases, this results in one-way communication from the teacher to the students, with little or no interaction and participation from the students. The traditional talk-and-chalk approach to teaching and learning results in chewing, pouring, passing, and forgetting of the contents studied, resulting in fact and concept memorization without application. There is the need to find out the effectiveness of other teaching methods, relative to the traditional lecture method.

Carpenter (1990), argues that in order to gain mathematical knowledge, learners must be engaged in the solving of multi-step and non-routine tasks. In the primary, junior high, and senior high school levels of Ghana's mathematics curriculum, students are taught how to apply their knowledge, how to strengthen their analytical thinking skills, how to generate ideas, and how to deal with mathematical difficulties on a daily basis. As a result, in order to cultivate good research and problem-solving skills, mathematics is a core component of the Ghanaian education system (MOE, 2007; 2010; 2012). Mathematical processes and chances for pupils to investigate mathematical concepts should be included in all lesson plans, especially for beginning and middle school teachers (MOE, 2007; 2010; 2012).

When students are provided with a classroom environment where they are able to explain, demonstrate, practice, relate, compare, associate, and cooperate with one another, as well as clarify their ideas in a safe environment, they will have a greater chance of adapting to and thus benefiting from their new knowledge. It is not the job of mathematics teachers to dispense rules, definitions, and procedures to be memorized by students; rather, it is their responsibility to inspire, sustain, and engage students as active participants to change their behaviour in logical reasoning in order to find answers to mathematics problems with clear, detailed and acceptable explanations of how solutions were arrived at. According to the findings of various studies conducted by various researchers, the use of the CPL strategy improves students' performance by increasing practice and retention of information when compared to the traditional lecture teaching strategy. (An et al., 2002; Huang et al., 2012; Kathleen & Berg, 1993; Ling et al., 2016; Nievecela & Ortega, 2019; Robinson, 1991; Shaaban & Ghaith, 2005; Slavin & Cooper, 1999).

The use of pedagogies such as lecture, demonstration, individualized discovery, and inquiry to improve students' performance in PS has been shown in recent studies. However, few studies have been conducted in Ghana, particularly in the Asikuma Odoben Brakwa District (AOB), to achieve similar results using CPL at the basic level. In the light of the foregoing, it is necessary to investigate the efficacy of alternative teaching methods in comparison to the traditional lecture method.

Previous studies have shown that manipulatives and cooperative learning have a positive effect on students' mathematical achievement. The combined benefits of these two instructional strategies on students' problem-solving skills have, however, only been the subject of a small amount of research. Since there is a gap in the literature, this study intends to fill it and offer evidence-based perspectives on the efficiency of cooperative learning with manipulatives in improving students' performance in mathematical problem solving in algebra in the Asikuma Odoben Brakwa District's Junior High Schools. Despite the fact that this study would be conducted in Ghana, the results would be a valuable source of literature for international and domestic researchers and experts interested in educational development in developing countries, as well as those interested in similar studies in developing countries.

1.2. Objectives of the study

The study sought to:

i. examine the effect of cooperative teaching and learning with manipulatives on Asikuma Odoben Brakwa pupils' academic performance in mathematics problem solving.
ii. determine if there are any differences in performance between male and female students who are taught utilizing the cooperative teaching and learning with manipulatives approach.

1.3. Research Hypothesis

For the purpose of the study, the following hypotheses were tested:

H_{01}: There is no significant difference in mean score between students taught by cooperative approach with manipulative and students taught employing lecture method with manipulative.

H_{02}: The mean scores of male and female students taught utilizing the cooperative teaching and learning with manipulatives technique do not differ significantly

2.0. Literature Review

2.1 The Concept of Cooperative Teaching and Learning Strategy (CPL)

CPL is a form of collaborative learning in which students of varying levels of readiness work together to accomplish a common goal. CPL is a teaching strategy in which learners' study and collaborate on academic tasks in small groups. It comprises dividing students into small groups of mixed abilities. It is based on the idea that students collaborate in small groups to achieve a common objective in a cooperative and interdependent manner (Wendy, 2005). In a similar spirit, (Slavin, 2015) views CPL as an instructional strategy for organizing small groups of students to collaborate on a common aim. As a result, CPL comprises classroom-based learning in which students convey ideas in order to finish a task.

CPL is a practical learning technique that encourages students to take charge of their education. To put it another way, it favours a social setting (Van Wyk, 2015). CPL is also defined by Adams & Hamm (1996) as a method of social training for small groups of students with varied degrees of academic capability. As a result, CPL is an instructional design that encourages learners to participate actively on particular concerns expected of them in a small group supervised by the instructor (Johnson, 1993; Farzad, 2015). In addition, Adam (1996) and Wyk (2010) regard CPL as an educational technique in which students collaborate to achieve a desired goal. In a similar vein, Slavin (2008) refers to CPL as a research method to mathematics instruction. Learners collaborate and assist one another. When goals are linked with individual accountability, studies shows that group learning mathematics has a big positive effect (Slavin et al., 2013). Students exchange knowledge in a socially controlled manner and each student is accountable for either his or her own mastery of the contents and the understanding of others. Vermette (2001) defines CPL as a collaborative activity in which students of diverse levels work together to master a body of knowledge. The team spirit is one of constructive dependency, with each student accountable for both his or her own comprehension and that of the other pupils.

According to Johnson and Johnson (2017), CPL is a teaching and technique which include characteristics such as each learner being accountable for his or her individual comprehension as well as the team's comprehension. Additionally, incentives should be incorporated into the CPL process to ensure that each learner reduces his efforts to comprehend and encourage the rest of the group to do the same. McCafferty et al. (2006) define CPL as a collection of strategies that enable students to interact effectively. CPL is distinguished from group work in that students in CPL should have equal opportunities to participate and talk in order to produce the output, whereas in group learning, assignments may be assigned to a few students without being dispersed to the full group.

To summarize, CPL is a highly effective form of instruction that has gained universal approval in the realms of education and research. Due to the fact that not every group activity is CPL-compliant, it has its own set of standards. CPL seeks to make learning more concentrated on the student than on the teacher. Positive interdependence is a guiding principle of CPL, as each team member should be accountable for both his or her own learning and the learning of others. Additionally, CPL should be goal-oriented, with students working cooperatively to finish a specific task. It is vital to make sure that all leaners have an equitable chance to engage in the CPL process.

It is probable that CPL and student-centred instruction date all the way back to the beginning of formal education. Confucius and Socrates, for example, argued in favour of curriculum that prioritized the learner over the subject (Henson, 2003). John Locke, a seventeenth-century philosopher, realized the importance of experiential education and invented the word. Rousseau & Pestalozzi (1929-1969) as cited in Whitbread (2007), among other Swiss educators, agreed, and in the late eighteenth century, the first learner-centred schools were formed. In America, cooperative student-centred learning dates all the way back to the mid-nineteenth century Common School Movement, when it was extensively embraced to meet the educational goals of the day (Johnson, Johnson, & Smith, 1991). Dewey (1906), thought that students should pursue interests and experiences

that are unique to them. “When we have an experience, we act on it,” he explained (Dewey, as cited in Sutinen, 2008). Dewey argued for proper learning above passive learning in order to meet the needs of children. He also observed that students possessed both a psychological and a social dimension, and that both must be handled if education is to be successful.

Dewey, dubbed the "Father of Progressive Education," sought to establish authentic learning experiences for students (Sadker & Sadker, 2000). He felt that education should be as near to adult life as feasible. It should equip youngsters to be effective members of a democratic society, citizens capable of thinking critically and debating ideas openly with others (Sharan & Sharan, 2013). He felt that learning should be a problem-based and pleasant for youngsters in order for them to be able to create an intrinsic encouragement to learn. Dewey felt that problems should be resolved cooperatively, with learners participating. “The only way for a child to reach their full potential was in a social environment,” he asserted (Henson, 2003). CPL remained in use, at least in part, through the mid-twentieth century, and gained popularity as research demonstrated that students could acquire just as much, if not more, utilizing the CPL methodology (Pulliam & Patton, 2003). CPL and the research on its educational impact are underpinned by a variety of theoretical frameworks.

Among these is the cognitive developmental perspective, the perspective on social interdependence, and the perspective on behavioural learning theory (Johnson & Johnson, 2009).

2.2 Manipulatives

Manipulatives have been defined by many authorities. To Kennedy (1999), materials that can be seen, felt, carried about, and rearranged that attracts several senses and be handled by children are said to be manipulatives. Smith (2009) defines manipulatives as “teaching and learning tools that are physical objects which actively engages learners in hands-on doing of mathematics. Manipulatives are materials that represents abstract mathematical concepts in a virtual and concrete form. They have auditory, visual, audio visual and tactile sense attraction and can be controlled by students through hands-on practical activities (Moyer, 2001).

For the purpose of this study, manipulatives are explained as locally or commercially made items that are sensitive to the sense organs; can be controlled during hands-on activities to enrich experiences, construct, consolidate and aid in high rate of retention of mathematical concepts and skills by learners.

That is, manipulatives can be obtained and improvised from local materials readily available in the environment to assist learners comprehend and *do* mathematics meaningfully which in turn avoids route learning.

These include but are not limited to algebra tiles, geared clock, xy-coordinate pegboards, bucket balance, counters, angles set, attribute blocks, snap cubes, base-ten blocks, pattern blocks, colour cubes, colour tiles, dice, geoboards, fraction cubes, fraction circles, fraction tiles, abacus, tangrams, hundreds board, Cuisenaire rods, and cm cubes. Common household items can also serve as manipulative materials, such as: beans, coins, scales, toothpicks, straws, sticks, crayons, pebbles, plant leaves and checkers.

2.2.1 Usefulness of Manipulatives in Teaching and learning mathematics

Results of different studies indicate that manipulatives play significant roles in the teaching and learning process. Four of these include;

2.2.1.1 Meaningfulness of learning

Manipulatives are essential tools to assist learners think and reason in a more logical and meaningful manner. According to Stein and Bovalino (2001), when manipulatives are made available to learners with it appropriate and effective use ensured by teachers, an enrichment of learners’ experience is catered for as it serves as a concrete material.

2.2.1.2 Manipulatives arouse and sustain interest and enhance understanding

As learners are engaged in mathematical problem-solving activities with the use of manipulatives, their joy with the use of these materials is long-lasting and by so doing with guidance on the effective use of the materials, understanding of mathematical concepts is ensured. (Florence, 2012; Xie, Antle & Motamedi, 2008; Swirling, 2006; Moyer, 2001; Shaw, 2002).

2.2.1.3 Provision for Individual differences and learning styles

Learners’ construct**,** abstract, assimilate, adapt and accommodate mathematical concepts differently using their senses at their own pace. In view of this, guiding learners to use manipulatives that appeals to their senses will help each of them construct mathematical knowledge appropriately and reason logically to solve mathematical problems with understanding of the details of their diverse solutions. (Sundstorm, 2012; Boggan, Harper & Whitmire, 2010).

2.2.1.4 Transition from Concrete to Abstract

Manipulatives when used in conjunction with written and symbolic representations helps learns to connect mathematics concepts appropriately which aids in the appreciation and retention of mathematics concepts by learners as real-life experiences and not some body of knowledge that do not exist because they cannot experience it. (Boggan, Harper & Whitmire, 2010).

A study conducted by (Ross, 2019) , on "The effect of mathematical manipulative materials on 3rd grade

learners' participation, engagement, and academic performance" at the University of Central Florida, Olando concluded that manipulatives increased the performance of learners.

(Larbi & Mavis, 2016) conducted a study to examine the efficacy of using algebra tile manipulatives in junior high school students' performance. The study sample comprised 56 students from two schools purposely selected from two towns within the Komenda Edina Eguafo Abirem municipality. They found that the manipulative used in the study improved the performance of the students.

3.0. Methodology

The study adopted the mixed method with an experimental and causal comparative design specifically a quasi-experimental design. This design allowed the researcher to control the experiment or treatment condition. It's useful for determining the causal effect of a given intervention on the target population. The experimental group were treated using the Students Team Achievement Division (STAD) cooperative technique. STAD is a CPL technique that employs four-person learning teams with a range of performance levels, gender, ages, and ethnicities. The facilitator presents the lesson, and learners work in groups to ensure that it is understood by everyone. Following that, each student completes an individual lesson quiz. Learners' quiz scores are considered and examined with their previous scores, and points are awarded to those who maintains or increase their previous performance. The total of these points is used to compute the team score, and teams that meet specific conditions may be awarded certificates or other recognition. This is a type of research that uses pretests and post-tests to investigate the independent variables' impact on the dependent variable. While the treatment group were subjected to treatment, the control group were exposed to lecture method thus, a teacher-centered approach where in most cases, the teacher presented the information directly for students to do the listening with little or no participation.

3.1 Population

The population for the study comprised of second-year Junior High School students (i.e., Grade 8) in the Asikuma Odoben Brakwa District Schools in the Central Region of Ghana who makes a total of 2,920 (AOB – District Education Statistical Department, 2020).

3.2 Sample and Sampling Procedure

A multi-stage sampling method was employed in selecting the participants for the study. The first stage involved a purposive selection of all junior high school second-year students of Jamra Methodist Basic School from the 124 Junior High Schools (JHS) in the Asikuma Odoben Brakwa District (AOB) in the Central Region of Ghana
The second stage involved a simple random selection of a sample of 100 second-year junior high school students out of a total of 120 JHS 2 students from Jamra Methodist Basic School. This sample comprise of 50 students each from both the first and second batches (2FB & 2SB).

At the third stage, a pre-test was administered to each of the 50 participants from each of the classes. Participants were presented with five problems to solve individually in 60 minutes Following the administration and scoring of the pre-test items, 40 out of the 50 participants from each of the two classes making a total of 80 participants comprising a mix of those who performed poorly in the test (that is, obtain very low scores) and those who performed well in the test (that is, obtain average scores or higher), from both classes were selected using the purposive sampling procedure to form the experimental and control groups respectively.

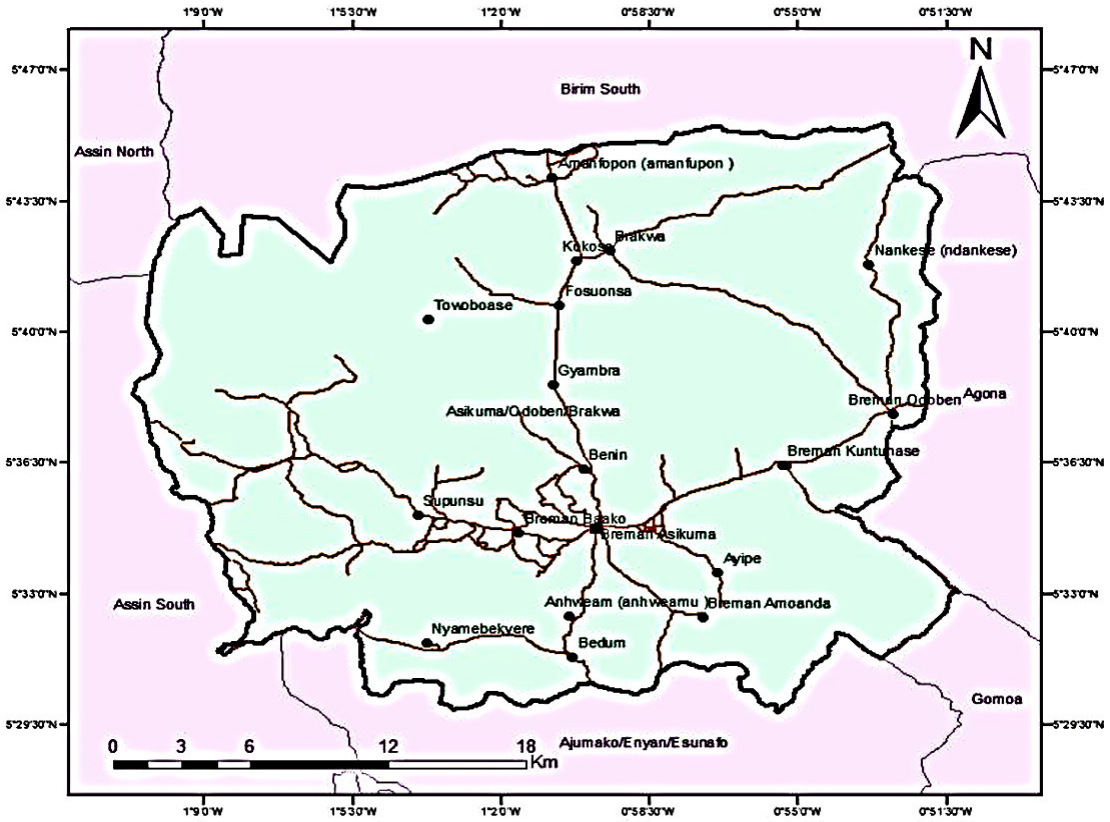
At the fourth stage, each of the two classes consisting of 40 participants that makes two major groups (CPL group and the lecture group) was then subdivided into two minor groups each that makes four minor groups for the study using ranking order based on pre-test achievement and gender.

3.3 Study area

The Asikuma Odoben Brakwa District is one of the 20 districts that make up Ghana's Central Region. Breman Asikuma, the capital, has about 21 sub-settlements. It can be found in the Central Region's north-central region. To the north, South Birim District shares a boundary with Ajumako-Enyan-Essiam District. On the opposite side of the district, Assin South District and Assin North Municipal share a border. Agona West Municipal is located to the east of South Birim District.

The district has an area of about 884.84 square kilometres. The ratio of land area to region is 0.09:1 (9 percent of the Central Region's total land area). The district is an undulating low-lying area with outstanding highlands, ranging from 15 to 100 meters above sea level. In some parts of the lowlands, there are swampy areas.

The district is drained by a number of rivers, the most important of which are the Osia and Ochi rivers, with tributaries such as the Boyow, River Atresu, Bemu, Ninsin, Suponso, and Supuna rivers. The relief and drainage may facilitate rapid human settlement, all-year-round irrigation farming, and general agriculture development, resulting in a purely farming community with high cocoa and other cash crops, as well as livestock production.



Source: Google Map Search, Accessed: 21st January 2021

Figure 3: Functional Map of Asikuma Odoben Brakwa District

3.4 Instruments

To collect data for the study, two instruments were created and used. They were a non-routine accomplishment exam in mathematics and an interview guide. The MNRAT (Mathematical Non-Routine Achievement Test) is the main data gathering tool in this project. The achievement tests comprised of two sections. The students' demographic information is contained in the first section. The second section contained five algebraic non-routine mathematics word problems test items to assess participant's ability to solve algebraic non-routine problems in Junior High School. The pre-test consisted of five algebraic non-routine word problems to be done individually in 60 minutes, and the post-test also consisted of small groups of five jointly and individually solving five algebraic non-routine word problems. The items were drawn from already recognized sources such as mathematics textbooks, TIMSS achievement assessments, and past questions from the West African Examinations Council's Basic Education Certificate Examinations (WAEC). The test items were designed in conjunction with the supervisor, four senior mathematics instructors from two Senior High Schools outside the district, and two other basic school mathematics teachers within the district, in order to preserve content validity.

3.5 Instrument Reliability.

The Mathematical Non-Routine Achievement Test and the interview guide was pilot-tested at Jamra St. Joseph's Catholic Basic School, a public school that shares similar characteristics as Jamra Methodist Basic School. The exercise involved forty students. The degree to which a test accurately assesses what it is intended to assess is measured by its reliability coefficient. The MNRAT's reliability was determined using Cronbach's Alpha coefficient which was found to be 0.782 and 0.798 for the pretest and posttest respectively. The data were subjected to the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) to find out its appropriateness for the Exploratory Factor Analysis (EFA). The outcome of the KMO and BTS analyses is shown in Appendix XV. Since the KMO of both the pre-test items and post-test items were 0.585 and 0.558 respectively and both were significant at $p = 0.05$, the data were deemed to be fit for factor analysis (Crothers et al., 2009; Sahin, 2011). As a result, no item was delated from both the pre-test and post-test items.

4.0. Results

4.1 Pretest - Descriptive Statistics of the Teaching Methods

Pre-test score of the four groups (cooperative with manipulative, cooperative without manipulative, lecture with manipulative, lecture without manipulative). The pre-test scores for the four groups are shown in Table 1.

Table 1: Descriptive Statistics of the Teaching Methods

Teaching Methods	N	Mean	SD	Std. Error
Lecture with manipulative	20	3.05	1.61	0.36
Cooperative with manipulative	20	2.95	1.00	0.22

Table 1 displays descriptive statistics for the various methods used in the experimental investigation. The table show that the mean scores of the students during the pre-test are very closed; lecture with manipulative (mean=3.05, SD=1.61), cooperative with manipulative (mean = 2.95, SD = 1.00), Lecture without manipulative (3.00, SD = 1.30) and Cooperative without manipulative (mean = 2.95, SD = 1.43). However, to determine whether significant differences occur between the teaching methods employed or not, the pre-test results are analyzed using ANOVA. The results from the ANOVA are shown in Table 2.

Table 2: ANOVA Test of the Type of Teaching Method employed during the Pre-test

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	0.138	3	0.046	0.025	0.995
Within Groups	138.850	76	1.827		
Total	**138.988**	**79**			

Table 2 above illustrates the comparison of the various groups based on the pre-test scores. It could be seen that there is no significant difference between the various groups (P = 0.995). This means that all the various groups are at the same level. This implies that there is no discrepancy between the groups and hence the performance of the groups is at the same level. Therefore, after the treatment the effects of all the methods applied can easily be identified, making comparison easy.

4.2 Hypothesis Testing

4.2. 1 Research Hypothesis One

H_{01}: There is no significant difference in mean score of students taught using cooperative teaching and learning strategy with manipulative and lecture with manipulative on post-test.

To test this hypothesis, means and standard deviation was estimated. This is shown in Table 3. T-test was employed to test whether significant difference exist between students taught using cooperative with manipulative and lecture with manipulative on post-test. The result is shown in Table 3.

Table 3: T-test Analysis of Lecture with Manipulative and Cooperative with Manipulative

Teaching Methods	N	Mean	SD	T	Df	Sig (2-tailed)
Lecture with manipulative	20	5.05	1.05			
Cooperative with manipulative	20	7.30	1.49	-5.52	34.14	< 0.001

Table 3 shows the mean scores of students taught using lecture method with manipulative and students taught using cooperative method with manipulative. The result shows that students taught using cooperative with manipulative have high average score (mean=7.30, SD = 1.49). Interestingly, the average mean of the lecture increases from 3.05 to 5.05. This could be as a result of the manipulative that were used to support the lecture method. In addition, it is not surprising that the average score of the students taught using cooperative with manipulative were above average mark (mean=7.30 >5.00). Also, the average score of the students taught cooperatively with manipulative (mean = 7.30, SD = 1.49) is higher than the average score of the students taught using lecture with manipulative (mean = 5.05, SD = 1.05) with t (34.14) = -5.52, and $p < 0.001$. The p-value in Table 4 was less than 0.05, hence, the null hypothesis was rejected and concluded that, there is significant difference in the post-test scores between the students taught using lecture with manipulative and students taught with cooperative with manipulative.

4.2.2 Research Hypothesis Two

H_{02}: ***There is no significant difference in mean scores of male and female students taught using CPL approach.***

To test this hypothesis, means and standard deviation was estimated, this is shown in Table 4. In addition, independent t-test was used to test whether significant difference exist between male and female students taught using CPL approach. The result is shown in Table 5.

Table 4: T-test of Male and Female Students taught using Cooperative Method

Teaching Methods	N	Mean	SD	T	Df	Sig (2-tailed)
Males	19	6.21	1.27			
Females	21	6.95	1.50	-1.55	38	0.13

From Table 4, the mean scores of female students taught though cooperative method is 6.95 while male

students taught through cooperative method had a mean score of 6.21. The result shows that female students appear to have high mean score (mean=6.95, SD = 1.50) than their male counterparts (mean = 6.21, SD=1.27) when both were taught using the cooperative method with manipulatives. However, the P-value of 0.13 is greater than 0.05. Hence, the null hypothesis H_{02} was accepted. This shows that there is no significant difference in the performance ability of male and female students when both groups were taught using cooperative method with used of manipulative. Surprisingly female students when exposed to the cooperative method performed equally as their male counterparts in mathematics.

Table 5: Interview of the students based on Gender and Group

Student	**Gender**	**Group**	**View on the lesson**	**Students View on the test**
A	Male	Cooperative with manipulative	Lesson taught within the three weeks make mathematics interesting and enjoyable. In fact, the topic is the easiest topic so far. In addition, since we were working in groups, we were able to share ideas and seek assistance from our colleagues	The second exams were easier than the first one and I will score more than 80%.
B	Female	Cooperative with manipulative	This is one of the lessons I have enjoyed since I came to Junior high school. Even though I used to dislike mathematics, but how the teacher handles the topic make it easily. In addition, the materials also facilitated the understanding of the topic.	In fact, the second exams are the easiest mathematics test I have ever solved. Getting 90% in mathematics was just like magic.
C	Male	Cooperative without manipulative	I enjoyed the whole lesson, in fact learning mathematics this way seems more like playing but I understood every aspect of the lesson topic. I didn't like this topic but now I can solve any question posed on this topic.	The post-test was very manageable as compared to the pre-test questions.
D	Female	Cooperative without manipulative	Initially, I feel a bit confused but as later, I enjoyed the topic especially as my group member begin to share ideas about the topic. Learning mathematics this way is also not frustrating since everybody's views were taking into consideration. I wish the rest of the topic be handle in this way	The post-test was easy as compared to the pre-test questions. This is because I could easily solve most of the questions.
E	Male	Lecture with manipulative	I understood some aspect of the lesson well especially when worksheets and materials were used to explain the concepts.	The second exams were within our level but I could not answer all the questions.
F	Female	Lecture with manipulative	I enjoyed the lesson small, as the teacher uses materials to explain some aspects of the lesson but not much excited about the whole lesson.	I was able to answer more questions in the second exams than the first exams even though I couldn't score high marks.
G	Male	Lecture without manipulative	This is the way our teachers have been teaching as since I came to Junior high school. Unlike the primary school, my interest in mathematics has reduced	The second exams were a bit easy than the first one.
I	Female	Lecture without manipulative	I did not enjoy the lesson since everything look so abstract. This is the reason why I don't like mathematics.	Both the first and the second exams were difficult.

From Table 5, it could be observed that, both male and female students appreciated the lessons taught through the use of cooperative approach. In addition, some of the students taught through cooperative approach when interviewed were of the view that the post test was very easy than the pre-test. Nevertheless, students taught through lecture approach did not show much interest in the subject and complained that both tests were of the same difficulty level.

5.0. Discussion

5.0.1 effects of cooperative teaching and learning with manipulatives on Asikuma Odoben Brakwa pupils' academic performance in mathematics problem solving

The study reveals that the exist differences between students taught using lecture with manipulative and students taught using cooperative with manipulative. In addition, the study found out that students taught through using cooperative with manipulative outperform their counterparts taught using lecture method with manipulative. This could be as a result of the teaching resources coupled with the student-centered approach since it has been revealed by researchers that student centered approach improves students' academic achievement. In other words, there is evidence that positive relationship exists between academic performance and student-centered approach like enquiry, discovery, cooperative etc. One interesting thing about the result is that even though the students taught through cooperative with manipulative is higher than student taught using lecture with manipulative, however the performance of the students was found to have increased tremendously from the performance of their pre-test scores. The evidence that student performed better when taught using cooperative with manipulative than when taught using lecture method with manipulative is supported by the following studies. Even though research have shown that manipulatives have the tendency of improving students' performance (Meke et al., 2018), the current study shows that the effects of manipulatives will be much felt when associated with student centered approach than when students are taught using lecture methods. This is supported by Adipo (2015) who pointed out that if a teacher uses appropriate manipulative to support his or her teaching, it enhances the students' innovative and creative thinking and consequently helps them to become more enthusiastic in learning the subject. In addition, Instructional approaches to help manipulation should be adapted to boost the performance of students in mathematics (Gurbuz, Catlioglu, Birgin & Erdem, 2010).

5.0.2 Gender and Cooperative Learning with Manipulatives

According to the current study, when male and female students were taught cooperatively, there was no significant difference in their recall abilities with and the use of manipulatives. Surprisingly, when exposed to the cooperative method, female students performed as well as their male counterparts in mathematics. Additionally, even though the difference was not statistically significant, the mean mark for females was higher than the mean mark for males in the post-test. This demonstrates that when a student-centered approach is combined with effective instructional resources, females' mathematics performance can be significantly improved. The following research substantiates this:

According to Barham et al. (2002), despite female students achieving higher grades, male students demonstrated more positive attitudes toward mathematics. On the other hand, female students were more enthusiastic about applying for CPL. Also, Tonkaboni (2012) compared the effects of CPL versus lecture teaching approaches on student learning and satisfaction. The research enrolled 120 4th graders of elementary school with 60 females and 60 males each. The findings indicated that the CPL approach had a greater impact on students' performance than the lecture method. Additionally, female learners expressed greater satisfaction with the CPL teaching technique than male students.

Ismail (2000) a Pakistani Muslim discovered no significant difference in the experimental and control groups' attitudes toward mathematics. The short treatment time of three and a half weeks could account for the lack of statistical significance between the two groups. Additionally, the study compared the effects of CPL on mathematics performance and attitudes toward mathematics between experimental group students in Boys' and Girls' schools and discovered that experimental group students in Boys and Girls schools performed similarly following CPL implementation. This, however, contradicts Kolawole's (2007) result that cooperative learning was much more successful than competitive learning. Additionally, males outperformed females in both learning strategies

6.0. Conclusion

Throughout the research, the following conclusions were drawn:

i. The study discovered that students who were taught cooperatively using manipulatives outperformed those who were taught through lecture with manipulatives. Hence, conclude that CPL is an effective teaching approach which has a positive effect on students' PS skills in mathematics as well as stimulates students' interest in mathematics.
ii. No significant difference in performance was seen between male and female students who were taught cooperatively (with and without the use of manipulative). Surprisingly, female students performed equally well in mathematics as their male counterparts when introduced to the cooperative technique. Thus, the study concluded that cooperative teaching and learning as an instructional approach which is gender friendly and has no significant effect on students' performance with respect to gender

7.0. Recommendation

In view of the summary of the findings, the study recommended that:

i. Teachers, Non-Governmental Organizations (NGOs), schools and other stakeholders collaboratively should be encouraged to supplement lecture method with the use of manipulatives in the teaching and learning of mathematics concepts to help improve performance of students.

ii. Cooperative teaching and learning strategy, as well as the use of manipulatives, should be encouraged and supported in schools particularly at the basic level by the directorates of AOB districts to bridge the perceived gender gap in mathematics performance as this approach was found to be gender friendly in this study.

8.0. References

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