UNIVERSITY OF EDUCATION, WINNEBA

EXAMINING THE USE OF MANIPULATIVE MATERIALS IN TEACHING MATHEMATICS AMONG JUNIOR HIGH SCHOOL TEACHERS IN THE WA MUNICIPALITY

EDWARD ABATANIE PADMORE

(8150030008)

A THESIS IN THE DEPARTMENT OF BASIC EDUCATION, FACULTY OF EDUCATIONAL STUDIES, SUBMITTED TO SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFULMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN BASIC EDUCATION

AUGUST, 2017

DECLARATION

STUDENT'S DECLARATION

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

Name of student: Edward Abatanie Padmore

Signature: …… Date: ……..

SUPERVISOR'S CERTIFICATION

I hereby certify that the preparation and presentation of the thesis was supervised in accordance with guidelines and supervision of thesis laid down by the University of Education, Winneba.

Principal Supervisor: Michael J. Nabie (Ph.D.).

Signature …… Date: ……

ACKNOWLEDGEMENT

My gratitude goes to the Almighty God, my friend and Mentor in all things who saw me through thick and thin during the writing of this work. As beneficiaries of his guidance and constructive criticisms, I am highly appreciative of the contribution of my supervisor, Michael J.Nabie (PhD) a lecturer of the Mathematics Department of the University of Education, Winneba. I am deeply grateful to all the schools in the Wa Municipality I visited to make this work a success and to the entire staff of the University of Education, Winneba, especially Ngman-WaraErnest (PhD) (former HOD of the integrated science department), Mr. Esia Donkoh (HOD) of the basic education department, who in diverse ways made this dream a reality. I also wish to record my appreciation to my uncle, Mr. Adams Rogation Kaleo for his financial support and fruitful suggestions and encouragement. Finally, special profound thanks goes to my mum madam Mercy Padmore Bagyinah for bring forth a bless son like me and who has been very supportive in terms of everything. Mum you are indeed lovely and I am proud to have a mother like you. To my wife madam Insah Fusata I say thanks for your support. Then to all other concerned people who in one way or the other helped me in producing this work, I say thank you.

DEDICATION

This work is dedicated to the Almighty God with due reverence to my late father Mr. Bagyinah John Padmore, also to my late grandmum madam Juliena Kaleo. I also dedicate it to my handsome boys: Bagyinah Ebenezer, Baginah Elvin Sung-Wae and Bagyinah Elisah Aganmwine. I also dedicate this work to my supervisor Michael J. Nabie (PhD), my wife Insah Fusata. This work is also dedicated to my uncle Mr. Adams Rogation Kaleo. My mum madam Padmore Mercy, my siblings Adams Cletus, Padmore Eunice, Padmore Diana, Padmore Eric and Padmore Ziemah and to my late siblings Padmore Bismark, Padmore Mahama and Padmore Naah.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

GES- Ghana Education Service

CS- Circuit Supervisors

BECE – Basic Education Certificate Examination

JHS- Junior High School

MEO- Municipal Education office

WAEC- West Africa Examination Council

CRDD- Curriculum Research and Development Division

MoE - Ministry of Education

PTA- Parent Teacher Association

SMC- School Management Committee

ABSTRACT

The Ministry of Education (MoE)/Ghana Education Service (GES) requires all mathematics teachers to use manipulative materials to teach mathematics in Junior High Schools (JHSs) because they have the potential to demystify learning of the subject. The study was designed to examine the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality of the Upper West Region of Ghana. Three instruments, namely,questionnaire, interview guides and observation guideswere used to collect data from94 teachers, 10 headteachers sampled from 54 JHSs, and the only mathematics coordinator in the municipality. Descriptive statistical analysis was applied to the quantitative data obtained from the questionnaire while content analysis was applied to the qualitative data from the interviews and observations. The study showed that teachers'use ofmanipulative materials in teaching mathematics was at variance with their practice in the classroom. Even though teachers knew the benefits of manipulative materials in learning, four factors challenged their use in the classroom: inadequate supply of manipulative materials, lack of continuous training on the use of manipulative materials, high cost materials, and lack of user guides on manipulative use. The study concluded that most JHS teachers in the municipality do not use manipulative materials in their classrooms because of the foregoing challenges. The study recommends that stakeholders in education in the Wamunicipality should boost up the supply of manipulative materials and organise periodic in-service training for JHS teachers on the use and development of manipulative materials for teaching mathematics. Supervision should also be strengthened to ensure that mathematics teachers do what they are supposed to do.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background of the study, problem statement, purpose of the study, objectives of the study, research questions, hypotheses, the significance of the study, delimitation, limitation and the organisation of the study.

1.1 Background to the Study

Mathematics is one of the important subjects within the list of core subjects that constitute the core curriculum for basic school education in most countries throughout the world. The subject occupies a privileged position in the school curriculum. The ability to cope with more mathematics improves one's chances of academic and social advancement (Jordan, Hansen, Fuchs, Siegler, Gersten, & Micklos, 2013). Mathematics attained this position when it was taken as a core subject, and as a screening device for students' entry into higher education and certain professions (Charles-Ogan, & Otikor, 2016).

According to Charles-Ogan and Otikor (2016), the importance of mathematics can be seen from its application in our daily lives and its role in technology. No other subject forms a strong binding force among the various branches of science subjects than mathematics. Without mathematics, knowledge of science often remains superficial. The inclusion of mathematics as a core subject in the Junior High Schools' (JHSs') curriculum is due to the key role it plays in education. Mathematics is so vital to the achievement of educational objectives such as promoting science and technology, provision of trained skilled work force in the applied sciences, technology and commerce. The subject aids in acquisition of appropriate skills, abilities and

competences both mental and physical, as tools for functional life and development of the society (Federal Republic of Nigeria, 2014). Mathematics enables students to achieve deeper understanding of scientific concepts by providing ways to quantify and explain scientific relationships. With a good background in mathematics, one has the chance of doing well in science and science related subjects. This indicates that without a proper understanding of the underlying principles in mathematics, the necessary skills and concepts in Science and Technology cannot be effectively acquired and applied by pupils (Charles-Ogan, & Otikor, 2016).

Ghana as a nation cannot develop fast if sustainable efforts are not put in place to improve upon the teaching and learning of mathematics at the JHS level. This is because the students at the JHS level constitute the future leaders of the nation. If the educational structure is unable to give learners at this level a good mathematical foundation, then they cannot have the requisite mathematical know-how to effectively contribute their quota towards national development. This is the reason why every child who enters the educational system has to study mathematics at the pre-university level to the highest level of education. Therefore, mathematics should be made simpler and easier for students at the basic level (Ministry of Education, 2012&Obeng, 2013) by teaching it using manipulative materials.

Mathematics is widely recognised as a problem in many circles. Most candidates fail to get admission into higher institutions because of failure in mathematics (Ghana Education Service, 2016). Research in mathematics instruction revealed that pupils' mathematics understanding will be more effective if manipulative materials are used (Alghazo & Al-Awidi, 2010; Swan & Marshall, 2010) and this

will not make most pupils shy away from it since mathematics is one of the important subjects and pupils know its usefulness.

The use of manipulative materials in teaching mathematics improves performance. Pupils who had failed a symbolic algebra assessment, were found to score 100% pass when manipulative materials were used (Goracke, 2009). The concrete nature of manipulative materials typically requires users to exert physical actions on the manipulative materials (Cooper, 2012) to gain experiential understanding. The incorporation of physical action enhances memory and understanding (McNeil & Jarvin, 2007).

In Ghana, the use of manipulative materials in teaching and learning plays a key role in deepening pupils' understanding of mathematical concepts among at the basic school level (Ministry of Education, 2012& Cope 2015). When manipulativematerials are use in teaching and learning pupils can easily explore to understand the subject effectively. According to Cope (2015), the use of manipulative materials in teaching mathematics motivates students in learning the subject. In addition, pupils can easily remember what they have learnt. Rosli, Goldsby and Capraro (2015) contend that the use of manipulative materials during mathematics lessons supports pupils' acquisition of symbolic and mathematical language. Teachers are mandated to use manipulative materials in teaching mathematics as curriculum requirement.

The importance of the use of manipulative materialsin helping pupils form mathematical concepts is well known (Ministry of Education, 2012). Using manipulative materials provides a foundation of practical experience on which pupils can build abstract ideas. It encourages them to be inventive, creative, helps to develop their confidence and encourages independence among pupils at the JHS level.

Teachers need to make use of an appropriate range of apparatus to focus on students' thinking on the concept to be developed, modifying the manipulative materials as students' understanding grow.

Manipulative materials have also been useful in making abstract ideas concrete for learners and thereby making conceptual understanding easy (Ministry of Education, 2012) . No wonder, since the sixties it was believed that, the use of mathematics manipulative materials was often justified on the basis of the ancient proverb: "I hear and I forget", "I see and I remember" and "I do and I understand" (as cited in Mohd & Mohd, 2010). This proverb is still relevant today and used as a justification for the use of manipulative materials. This proverb has a ring of truth to it, because the use of manipulative materials improves the performance among pupils in mathematics.

The Curriculum Research and Development Division (CRDD) sees manipulative materials as important tools for teaching and learning of mathematics. All teachers are required to include manipulativematerials in preparing their lessons notes and using them in teaching in the classroom (Ministry of Education, 2012). Different type of manipulative materials suggestedin the mathematics curriculum materials. Headteachers and Circuit Supervisors supervise to check the type and appropriateness of manipulative materials teachers use in teaching mathematics and to assist them.

1.2 Problem Statement

Manipulative materials help students to learning mathematics meaningfully. They are suitable for students of all academic ability as well (McIntosh, 2012). For mathematics to be easier and simpler for pupils to understand and improve their performance at the JHS level, the Ministry of Education (2012) recommends and

promotes the use of manipulative materials as tools for instruction. The mathematics syllabus also emphasized and encouraged the use of manipulative materials during pre-service and in-service training.

In spite of government support to promote the use of manipulative materials in the mathematics classroom to enhance pupils' performance, the Basic Education Certificate Examination (B.E.C.E.) results for the Wa municipality consistently indicate massive failure of students in mathematics (Ghana Education Service 2016). In 2014, 56.3% failed in mathematics as compared to 41.4% and 42.2% who failed in English and Science respectively. In addition, 2015 saw an increase in the failure to 58.7% in Mathematics as compared to 42.6% and 44.3% in English and Science respectively. The 2016 failure in Mathematics further increased to 60.3% as compared to 35.8% and 40.7% in English and Science respectively (Ghana Education Service, 2016). Notwithstanding the pivotal role of manipulative materials in teaching and learning mathematicsyet most teachers fail to use manipulative materials (Fuchs et al., 2013) and others consider them as toys only to be used on special occasions or for a short period of time (Green, Flowers, & Piel, 2008). It was against this backdrop that the study was designed to focus on JHS teachers' perceptions and use of manipulative materials in teaching mathematics in the Wa Municipality.

1.3 Purpose of the Study

The research was designed to examine the use of manipulative materials in teaching mathematics among JHS teachers in the Wa municipality of the Upper West Region of Ghana. Specifically, it was designed to identify: the type of manipulative materials JHS teachers' use; the teachers' sources of manipulative materials; how the manipulative materials are used; teachers' perceived benefits of using manipulative

materials; and the challenges teachers' face in using manipulative materials in their classrooms.

1.4 Objectives of the Study

The objectives of the study were to:

1. Identify the type of manipulative materials JHS teachers use in teaching mathematics in the Wa municipality
2. Identify how JHS teachers obtain manipulative materials for teaching mathematics in the Wa municipality.
3. Identify the teaching methods JHS teachers use for teaching mathematics with the use of manipulative materials in the Wa municipality.
4. Determine JHS teachers' perceived benefits of using manipulative materials in teaching mathematics in the Wa municipality.
5. Identify the challenges of using manipulative materials in teaching mathematics among JHS teachers in the Wa municipality.

1.5 Research Questions

1. What types of manipulative materials are often used by JHS teachers in teaching mathematics in the Wa municipality?
2. How do JHS teachers in the Wa municipality obtain their manipulative materials for teaching mathematics?
3. What are the teaching methods JHS teachers used in teaching mathematics with the use of manipulative materials in the Wa municipality?
4. Whatare the perceived benefits of using manipulative materials in teaching mathematics among JHS teachers in the Wa Municipality?

5. What are the challenges JHS teachers in the Wa municipality face in the use of manipulative materials in teaching mathematics?

1.5.1Hypotheses

To further answer research questions 4 and 5, the following null and alternative hypotheses were tested to find out the extent of the benefits and challenges of using manipulative materials in the mathematics classroom in the Wa municipality.

Ho: There are no significant benefits of using manipulative materials in teaching mathematics at the JHS level in the Wa municipality.

H_1: There are significant benefits of using manipulative materials in teaching mathematics at the JHS level in the Wa municipality.

Ho: There are no significant challenges of using manipulative materials in teaching mathematics at the JHS level in the Wa municipality.

H_1: There are significant challenges of using manipulative materials in teaching mathematics at the JHS level in the Wa municipality.

1.6 Significance of the Study

The relevance of this study to teachers cannot be over emphasised because the findings from the study would reveal the appropriate manipulative materials to be used in teaching mathematics and the benefits associated with the used of manipulative materials. This would add knowledge in teaching skills to mathematics teachers of which they can use to impact knowledge in students positively. In addition, the findings would generate information that could inform policy makers on the ways of implementing the national policy on the use of manipulative materials in teaching and learning of mathematics in the classroom.

The findings of the study would inform the curriculum developer of the types of manipulative materials and their associated benefits and challenges, which would help guides developed mathematics curriculum. Similarly, the study would provide empirical evidence and database for stakeholders and further researchers who intent to research further into this area of study.

The study would also go a long way to influence school heads positively to appreciate the essence of using manipulative materials and the type of manipulative materials to use in teaching mathematics, which would serve as guide of supervising their teachers and also encouraging and motivating their teachers to use manipulative in teaching mathematics.

1.7 Delimitations of the Study

Despite the fact that there are many districts in the Upper West Region of Ghana, the study was confined to JHS teachers in the Wa municipality only. Also, the study was delimited to examining the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality of the Upper West Region of Ghana. Specifically, it focused on identifying the type of manipulative materials, the sourcesof obtaining these manipulative materials, the methods used in teaching mathematics with the use of manipulative materials and the benefits and challenges of using manipulative materials only.

1.8 Limitations

Limitations are conditions, which go beyond the researcher's control and place some difficulties on the conclusions of the study (Best &Khan, 1993). This means that limitations are the challenges the researcher face in the course of the study and of which he or she has no control. Purposive sampling technique was used to select few

experienced headteachers and only JHS teachers in the Wa municipality were sampled for the study. Consequently, the result may lack generalibility. The municipality was vast and travelling to fifty-four Junior High Schools scattered across the municipality did not just come without cost and stress on the researcher. This reflected on a month and more long period for which the researcher permitted respondents to use to respond to the questionnaires and after which the researcher had to go round to interview heads and observe teachers as they teach. With the issues of the mathematics coordinator, it was not easy reaching him because of his busy schedules.Some bias may appear because the researcher has a passion for teaching mathematics. That may show up without the researcher noticing even though the researcher tried to stay neutral. The researcher tried to go into an interview with an open mind and not in a leading manner such as "Don't you agree…".

1.9 Organisation of the Study

This study is organised into five major chapters. Chapter One contains the introduction, background to the study, problem statement, research objectives, research questions, hypotheses, purpose of the study, significant of the study, delimitations and limitations of the study. Chapter Two reviews literature related to manipulative materials on the following areas:

- concepts of manipulative materials;
- manipulative materials and cognitive development;
- types of manipulative materials in teaching mathematics;
- sources of manipulative materials for teaching mathematics;
- teachers use manipulative materials for teaching mathematics;
- factors to consider when using manipulative materials;
- benefits of using manipulative materials in teaching mathematics; and

- challenges of using manipulative materials in teaching mathematics among JHS teachers.

Chapter Three focused on the methodology used. It discusses the research design used, the population, sample and sampling methods, instruments for data collection, data analysis, and the ethical considerations of the study. Chapter Four presents and discusses the results of the study. Chapter Five dwells on the summary of findings, conclusion and recommendations.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Overview

The study was to examine the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality of the Upper West Region of Ghana. This chapter review literature related to the study. Literature was reviewed in the following areas:

- the concepts of manipulative materials;
- manipulative materials and cognitive development;
- types of manipulative materials JHS teachers use in teaching mathematics;
- sources of manipulative materials for teaching mathematics;
- the methods usedin teaching mathematics with the use of manipulative materials for teaching mathematics;
- factors to consider when using manipulative materials for teaching mathematics;
- benefits of using manipulative materials in teaching mathematics;
- the challenges of using manipulative materials in teaching mathematics among JHS teachers in the Wa municipality.

2.1 Concept of Manipulative Materials

Manipulative materials are valuable tools that help students of any academic level to understand mathematics well and it is not just for students of low academic ability but also suitable for students of high academic ability as well (McIntosh, 2012). Also, Van de Walle, Karp and Bay Williams (2013) define a manipulative as, “any object, picture, or drawing that represents a concept or onto which the relationship for that

concept can be imposed. Manipulative materials are objects that pupils and teachers can use to illustrate and discover mathematical concepts, whether made specifically for mathematics (e.g., connecting cubes) or for other purposes (e.g., buttons)" (p. 24). Manipulative materials are used to demonstrate a mathematics concept (Elida, Jamilah, Carolyn, & Angela, 2015). Manipulative materials can been seen as learning aids and believed to reinforce the learning since they stimulate, motivate, and activate learners within instructional process (Boggan, Harper & Whitmire, 2010). Learning aids, which include visual aids, audio-visual aids, real objects and many others, are instructional materials and devices through which teaching and learning are conducted in educational settings (Boggan, Harper & Whitmire, 2010). Manipulative materials are small, usually very ordinary objects that can be touched and moved by pupils to introduce or reinforce a mathematical concept (Mohd & Mohd, 2010).

All the definitions discussed above centred on using manipulative materials well in teaching and learning of mathematics to help improve the understanding of mathematics among pupils but little is said about harmfulness with the use of some of this manipulative materials. Therefore, manipulative materials are concrete objects that are not harmful to both the teacher and learner and can be used to improve performance inside or outside mathematics classroom.

2.2Manipulative and Cognitive Development

The study was anchored on Piaget's stages of cognitive development theory. According to the theory, learners are born to understand abstract concepts later but with only the understanding of concrete materials at the initial stage of their learning development (Elida, Jamilah, Carolyn & Angela, 2015). According to Piaget (1952), mathematical understanding in young children is closely associated with sensory perception and concrete experience. Children begin to understand symbols and

abstract concepts only after experiencing the ideas on a concrete level. Manipulative materials are effective tools in mathematics education by helping children move from a concrete to an abstract level of understanding. Students who see, touch, take part, and manipulate physical objects begin to develop clearer mental images and can represent abstract ideas more completely than those whose concrete experiences are limited (Dennis, 2011).

O'Donnell, D'amico, Schmid, Reeve and Smith (2008) stated that by learning Piaget's approach, teachers can offer pupils classroom environments that are stimulating, interesting, and complex enough to nurture them into higher order thinking. Pupils should be allowed to discover ideas by themselves using manipulative materials. That is in line with Piaget's cognitive development theory and his discovery-based learning theory. Teachers should avoid teaching methods that place students in passive mode of thinking but rather adopt methods that encourage students to explore the objects and activities around them (Piaget, 1952). This implied that when students use manipulative materials in the mathematics lessons, they become enthusiastic and more open to learn the subject (Pham, 2015). This signified that students understanding of mathematics concept are high and easier with the use of manipulative materials in teaching and learning process.

2.3.1Types of Manipulative Materials for Teaching Mathematics

The correct used of manipulative materials by teachers is important, and so teachers should have a fair idea of the type of manipulative materials to be used at any given period. Not all manipulative materials should be used for all concepts or for teaching all topics (McNeil & Jarvin, 2007). Therefore, teachers should know which manipulative to use in the classroom that will contribute to the teaching and learning

of mathematics since some manipulative materials are designed for specific mathematics topics and cannot be used across all topics. This may suggest why in Ghana for example, the syllabus suggests the type of manipulative materials to be used to teach the individual topics in mathematics. The Ministry of Education (MoE, 2012) and Obeng (2013) suggested the type of manipulative materials that can be used by teachers for the various topics in the mathematics syllabus. Table 2.1 displays the various topics and the suggested manipulative materials from JHS1 to JHS3.

Table 2.1: Suggested manipulative materials for teaching JHS mathematics

Topic	Type of Manipulative Materials
Number and Numerals	Abacus, Colour-coded materials, Place value chart, Bug Counters.
Sets	Stones, sticks beans maize bottle tops, books pencils, pens, erasers, chalk, Attribute Blocks etc.
Fractions	Strips of paper, Fraction charts, Addition machine tape, Colour Tiles, Cuisenaire rods.
Shape and Space	Empty chalk boxes, Cartons, Tins, Cut-out shapes from cards.
Length and Area	Garboard, Graph paper, Rubber band Cut-out shapes (including circular shapes), Thread, Graph Paper, AngLegs, Centimeter Cubes
Powers of Natural Numbers	Counters, Bottle tops, Small stone, sticks Bug Counters, Base Ten Blocks.
Capacity, Mass, Time and Money	Tea and Table spoons, Bucket Balance.
Angles	Protractor, Cut-out triangles
Properties of Quadrilaterals	Cut-out shapes (rectangles, parallelograms, kites, trapeziums and rhombus) AngLegs,
Probability	Colour tiles, coin, die or dice
Vectors	Graph sheet, Protractor, Ruler
Rigid Motion	Geoboard, Cut-out shapes, Mirror, Graph paper, Tracing paper
Properties of Polygons	Cut-out plane shapes, AngLegs, Protractor, Scissors and Graph sheets, Attribute Blocks

Source:(Oberg, 2013; MoE, 2012; Landman, 2009).

2.3.2Forms of Manipulative Materials

Manipulative materials in Table 2.1 can be categorised into physical, pictorial and visual. Physical manipulative materialsare designed to be moved by hands toenable learners develop motor skills or understanding of abstractions, especially in mathematics (Muser, Peterson, & Burger, 2014). Physical manipulative materials range from everyday items such as the Algebra tiles for learning algebraic concepts including adding and subtracting polynomials, factoring trinomials, the Zero Principle, and solving first and second-degree equations. Each tile represents the quantities x, x^2, x and one (1) along with their additive inverses (Cope, 2015). Other physical manipulative materials include the die which usually comes mostly in white, red and black colours with six faces numbered one up to six; the Coin which come in currency form with a metallic body with only two faces described as the "Head and "Tail"; and the Centimeter Cubeswhich come in different colours. The Dice and Coins are used for teaching probability, while the Centimeter Cubes are used to teach counting, patterning, and spatial reasoning. They Centimeter Cubes are suitable for measuring area and volume and may be used to generate data for the study of probability (Landman, 2009).

There are physical manipulative materials for measuring angles, shapes and space, sorting, patterns, and algebra. According to Landman (2009), AngLegs enable students to study polygons, perimeter, area, angle measurement, side lengths, and more. The set includes 72 snap-together AngLeg pieces (12 each of six different lengths) and 2snap-on view protractors. In addition, there are attribute blocks set includes five basic shapes (triangle, square, rectangle, circle, and hexagon) displaying different attributes that come in three different colours, two different sizes, and two different thicknesses used for shapes and space. Similarly, Bug Counters contains

counters in six different shapes (grasshopper, bumblebee, beetle, spider, dragonfly, and caterpillar) and six colours. Attribute Blocks and bug Counters are used for sorting, patterns and counting (Rystedt & Trygg, 2010).

Base ten blocks are constructed in powers of ten, representing ones, tens, hundreds, and thousands. They include 1-centimeter unit cubes to represent ones, 10-centimeter rods to represent tens, and 10-centimeter square blocks to represent hundreds. There areused to teach number and place value concepts, such as regrouping in addition and subtraction. Also, DecaDots: The vertical ten-frame tiles provide an intuitive and visual representation of patterns for numbers up to 10. They can be used to learn shortcuts, such as counting the spaces remaining instead of counting the number of dots. They emphasize the importance of 10 in place value (Morrison, 2011).

Colour Cubes are available in plastics and wood forms in six different colours in a set: red, orange, yellow, green, blue, and purple. They help children through hands-on exploration of basic mathematics and geometric relationships as they stack, count, sort, and work with patterns (Morrison, 2011).Similarly, Colour tiles are a collection of one-inch square tiles in four colours, namely, red, blue, yellow, and green. Colour tiles have applications in all areas of the mathematics curriculum. They are useful for counting, estimating, measuring, building understanding of place value, investigating multiplication patterns, solving problems with fractions, exploring geometric shapes, carrying out probability experiments, and more. A supply of these tiles provides versatile assistance to mathematics instruction at all grade levels (Morrison, 2011).

Cuisenaire Rodsare rods of ten different colours. Each colour corresponds to a specific length. White Rods, the shortest, are one cm long. Orange rods, the longest, are ten (10) cm long. Rods allow students to explore all fundamental mathematics

concepts, including addition and patterning, multiplication, division, fractions and decimals, and data analysis (Obeng, 2013).

Deluxe Rainbow Fraction circle consists of nine colour-coded, 3 ½ inch plastic circles representing a whole, halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths. The circles enable pupils to explore fractions, fractional equivalences, the fractional components of circle graphs, and more (Cramer, Behr, Post & Lesh, 2009). Similarly, Deluxe Rainbow Fraction Squares consists of nine colour-coded, 10-cm plastic squares representing a whole, halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths. The squares enable pupils to explore fractions, fractional equivalences, and more (Mohd & Mohd, 2010). Fraction Circle Rings are plastic rings used with the deluxe rainbow fraction circles to make measurements related to circles and fractions of circles. The set consists of a degree measurement ring, a fraction measurement ring, a decimal measurement ring, a percent measurement ring, and a time measurement ring (Rystedt & Trygg, 2010).

In addition, Fraction Circles have six circles that show halves, thirds, fourths, sixths, eighths, and one whole. Each circle is a different colour, with plastic pieces that can be put together and taken part to show different fractions. Circles are ideal for introducing students to basic fraction concepts (Cramer et al., 2009) and faction tower equivalency cubes snap together to demonstrate fractions, decimals, and percentages. Each tower is divided into stacking cubes that represent a whole, halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths. Each cube is labeled with the part of a whole that it represents. One side shows the fraction, another shows the decimal, and a third shows the percentage. The fourth side is blank. Students can turn the cubes

or towers to see each of the representations of the same value. Towers, or portions of towers can be compared with each other (Rystedt & Trygg, 2010).

Geared Clocks are made of plastic and have hidden gears that reflect accurate hour and minute relationships. The hour and minute hands are colour-coded to match hour and minute markings on the clock face. Clocks allow children to explore telling time on analog clocks and calculating elapsed time (Landman, 2009). Similarly, Write-on/wipe-off clocks are 4.5-inch-square clocks, which are laminated so that pupils can write the digital time below the movable hands of the clock face. Clocks are also used to give pupils plenty of hands-on practice measuring time. Clocks can also help pupils practice addition, subtraction, and problem solving (Landman, 2009).

Geoboardis 7.5 inch square and made of plastic. One side has a 5-peg grid. The other has a circle with a 12-peg radius. Pupils stretch rubber bands from peg to peg to form geometric shapes. Geoboardscan be used to study symmetry, congruency, area, and perimeter (Rystedt & Trygg, 2010). Also, the Geo Reflector is made of coloured, transparent plastic so that the mirror image of an object placed in front of the mirror appears superimposed on the background behind the mirror. Geo Reflectorhelps students to understand transformations, symmetry, and congruence (Landman, 2009). Similarly, Graphing mats are double-sided materials that have square grids. There are used to introduce graphing data, sorting and classifying geometric shapes (Obeng, 2013).

The Inchworms Ruler is made of plastic. Each inch of the ruler is marked with an Inchworm to help pupils see the units of measurement clearly. The ruler can be usedwith compatible Inchworms products to explore using standard units to measure length, width and height (Morrison, 2011). In addition, pattern blocks are a collection

of six shapes in six colours green triangles, orange squares, blue parallelograms, tan rhombuses, red trapezoids, and yellow hexagons. The shapes are designed so that the sides are all the same length except for the trapezoid, which has one side that is twice as long. This feature makes it possible for the shapes to nest together and provides for a wide range of explorations (Morrison, 2011).

According to Landman (2009) a Rekenrek is an arithmetic frame designed to help children visualize addition and subtraction strategies. The 20-bead Rekenrek features two rows of 10 beads. Each of these sets of ten are broken into two sets of 5 beads using contrasting colours–red and white–to help pupils see numbers, as well as to visualize how numbers can be composed and decomposed. The Rekenrek combines features of the number line, individual counters, and base-ten models such as Base Ten Blocks. This model allows children to think in groups of those benchmark numbers, 5 and 10.

Relational GeoSolids are 14 three-dimensional shapes that can be used to teach prisms, pyramids, spheres, cylinders, cones, and hemispheres. GeoSolids facilitate classroom demonstrations and experimentation. The shapes can be filled with water, sand, rice, or other materials to give pupils a concrete framework for the study of volume (Landman, 2009) and bucket balancefeatures removable liter buckets. The balance helps pupils explore the measurement of mass.

A Snap Cubecan be connected to another cube. Cubes can be used to teach a variety of different mathematics concepts. Use cubes to explore number sense and operations with activities involving counting, place value, addition, and subtraction. Cubes can be use to show measuring using nonstandard units and they can be used to demonstrate patterning and basic geometry (Rystedt & Trygg, 2010). Similarly,

sorting circles can be used to teach beginning algebraic thinking by having pupils sort objects into given sets and for classifying geometric shapes by attribute (Cramer et al., 2009).

Two-colour counters are thicker than most other counters and are made easy for pupils to manipulate. They can be used to teach number and operations concepts, such as patterning, addition, subtraction, multiplication and division and can be used to introduce pupils to basic ideas of probability (Ministry of Education, 2012) .

Furthermore, a pictorial manipulative material is a stationary model that helps students visualizes mathematics concepts. According to Muser, Peterson, and Burger (2014), drawing a picture may be helpful when the learner wants to gain a better understanding of the problem, when a visual representation of the problem is possible, or when the problem involves a physical situation, geometric figures or measurements. It is important to note that a physical manipulative can be represented as pictorial manipulative (by creating a drawing of it), but the pictorial manipulative will lack the tangible and dynamic attributes of the physical manipulativematerial. Pictorial manipulative materials are use when especially this is lack of the physical manipulative material of which a picture of the physical manipulative is used.

Lastly, a virtual manipulativematerial is very similar to a physical manipulative. It is a dynamic object with interactive features. Virtual manipulative materials are "computer based renditions of common mathematics manipulative materials and tools" (Dorward, 2002, p. 329) and "an interactive, web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge" (Moyer, Bolyard, & Spikell, 2002, p. 373). Virtual manipulative materials develop

students' visualization skills by connecting words, pictures, and symbols simultaneously.The key difference between a virtual and a pictorial manipulative is that virtual manipulative materials are dynamic, while pictorial manipulative materials are static. The main factor that distinguishes virtual and physical manipulative materials is that virtual manipulative materials are digital and therefore two dimensional, while physical manipulative materials are three-dimensional.

Virtual manipulative materials are equipped with the variability, inwhich the learner can colour parts of the objects, or increase or reduce the quantity of certain object. Unlimited supply which resolves the issue of an insufficient number of physical manipulative materials in class (Chang, Yuan, Lee, Chen & Huang 2013). Virtual manipulative materials also save teachers from the time-consuming distribution and organisation of teaching aid (Lee, & Chen, 2015). Virtual manipulative materials can also be design in cardboard for which can be used to support instruction in the classroom especial in the absent physical manipulative.

2.4 Sources of Manipulative Materials for Teaching Mathematics

Mathematics manipulative materials come in many varieties and as objects that are used to engage students in the hands-on learning of mathematics (Landman, 2009). Most often the supply of manipulative materials by the Ministry of Education may not be regular or may not happen at all and the teacher will have to find his or her own from other sources. There are many sources from which a teacher can obtain manipulative materials for use in teaching mathematics, These include:

Purchasing: Manipulative materials like the tangrams; Cuisenaire rods; numicon patterns; colour tiles; base ten blocks (also known as Dienes or multibase blocks); interlocking cubes; pattern blocks; coloured chips; links; fraction strips, blocks, or

stacks; Shape Math; Polydron; Zometool; rekenreks and geoboards that may not the environment of school can be purchased (Landman, 2009).

Supplies from the Ministry of Education: In addition to purchasing manipulative materials, it is also the duty of Ministry of Education and the Ghana Education Services to ensure the manipulative materials are available for schools to use in ensuring quality learning in mathematics. Teacher can also obtain their manipulative materials from the offices at which their work under.

Donations: Another source of obtaining manipulative materials can be through donations from Non-Governmental Organisations (NGOs) like the UNICIEF, Plan Ghana international, and World Vision etc. Schools sometimes even appeal to some of these NGOs to come to their aids in the supply of some basic needs, which includes manipulative materials since they may not have adequate supplies. Again, Parents-Teachers Association (PTAs) and School Management Committee (SMCs) can or do sometimes used their internal generated funds to supply manipulative materials to their schools. Through the PTA dues paid by parents, heads of schools can appeal to the PTA to supply them with manipulative materials. Some PTA sometimes asked their heads and teachers to identify their needs for them to make provision of these materials for them, which most at times includes manipulative materials. Somephilanthropists, who have their children education at heart, do sometimes donators some materials to schools, which sometimes include manipulative materials.

Improvisation: These teachers most often are compelled to improvise some manipulative materials. Even though all manipulative materials cannot be easily be improvised by these teachers, yet manipulative materials like beans and bean sticks or

bundles of ten popsicle sticks and single popsicle sticks, cut-out of different shapes like the cube, cuboids etc. can easily be improvised.

School Environment: Lastly, some manipulative materials can easily obtained from the immediate school environment. Examples of such manipulative materials include the stone pebbles, sticks, bottle-tops, can easily be picked for use in the mathematics classroom. Teachers must explore all these avenues to acquire manipulative materials for teaching and learning mathematics for the benefit of the students, they teach (Mohd & Mohd, 2010).

2.5 The Teaching Methods Used When Using Manipulative Materials in the Mathematics Classroom

The correct use of manipulativematerialsin the classroom depends on the methodsteachers use. There are many methods teacherscan use effectively to explainmathematical concepts in the classroom. Not all methods can be used in teaching mathematics with manipulative materials. The appropriate methods one can use in teaching mathematics involving manipulative materials in the classroom at the junior high school level are now discussed.

Firstly, the lecture method is usually characterised by one-way communication that is information or ideas passed on to pupils orally while they listen. Adu-Yeboah (2008) asserts that lecturing is the most frequently used method of instruction that has dominated formal education over the years. Bligh (2002) asserts that the purpose of the lecture is to clarify information to a large group in a short period. The teacher presents ideas or concepts while students listen and take down notes. Such method of instruction is just not appropriate for mathematics classroom especial the area were

manipulative materials are used since the used of manipulative materials needs the pupils to be active participants in lesson delivery.

Discussion method can be used with the entire class or in small groups to review information, illuminate ideas or solve problems. It is used, as a period of oral comments, questions and answers led by the teacher in which class members actively participate (Huze, 2011). In this method of teaching even though every person in the classroom is involved in the discussion process, but it involve mostly by oral communicates which involve mostly questioning and answering. This method of teaching is not appropriate for mathematics lessons were manipulative materials are used since the used of manipulative materials needs pupils to be involved in any activity in the classroom.

In demonstrations, an activity is performed for learners to observe how it is done.The teacher shows a skill while pupils watch. This prepares learners to transfer theory to practical application (Kizlik, 2013). To carry out a demonstration effectively, the intended activity must be carefully planned, kept simple and thorough enough to meet the objectives of the lesson. According to Kizlik (2013), demonstrations may be augmented with other visuals and learners are given the opportunity to practice what they have watched. This teaching method helps visual learners, enhances self-confidence, provides opportunity for targeted questions and answers and allows attention to be focused on specific details rather than general concepts and is appropriate for use in mathematics classroom were manipulative materials are used (Kizlik, 2013).

Brainstorming is a process for generating multiple ideas or options in which judgment is suspended until a maximum number of ideas have been generated (Kizlik, 2013).

Options are then typically analysed, a best solution identified, and a plan of action developed. Pupils are usually asked to throw out as many ideas as possible in a short time, in either groups or whole class, while someone often writes the ideas down. Brainstorming actively involves learners in higher levels of thinking, promotes peer learning, critical thinking and creates synergy. It also helps groups reach consensus. Brainstorming requires learners discipline their inputs to the discussion. Brainstorming may also not be effective with large groups (Kizlik, 2013). With brainstorming method manipulative materials can be used effectively where pupils can be ask to use various manipulative materials to develop an activity and come out with solutions to problems thrown to them in the classroom.

According to Kizlik (2013), role-playing introduces problem under study dramatically and provides opportunity for students to assume roles of others and thus value another point of view allowing for discovery of solutions and providing occasion to practice skills. The author adds that role-playing dynamically involves members adding diversity, authenticity, and specificity to the learning experience. It also develops problem-solving and verbal expression skills providing practice to build skills for real-manipulative materials can be extremely helpful to pupils, but they must be used correctly. Pupils must understand the mathematical concept being taught rather than simply moving the manipulative materials around. Smith (2009) stated that there are probably as many wrong ways to teach with manipulative materials as there are to teach without them. The mathematics manipulative materials should be appropriate for the pupils and chosen to meet the specific goals and objectives of the mathematical programmeme. “The complexity of the materials provided will increase as pupils’ thinking and understanding of mathematical concepts increase” (Seefeldt & Wasik. 2006, p.93).

It is also important for teachers to allow their pupils to have free time to play with the manipulative materials. After the pupils have explored the manipulative materials, "the materials cease to be toys and assume their rightful place in the curriculum" (Smith, 2009, p.17). Teachers should provide children with opportunities to work with materials with open-ended objectives that have no specific preset goals. These opportunities allow the children the chance to explore their own questions and generate a variety of answers. "These experiences help children think about their world in alternative ways and help them understand that there are multiple ways to solve problems. Generating multiple solutions to problems in an essential strategy in mathematics" (Seefeldt & Wasik, 2006, p. 250).

Another important method of teaching is the activity method, which is the best method of teaching mathematics especial when manipulative materials are to be used (Hussain, Anwar, & Majoka, 2011). According to the author, activity centre is one way of organising instruction so that pupils can direct their own learning. The activity method is unique and effective to attract pupils. The teachers who are involved in implementing this method have developed activities for each learning unit, which facilitated readiness for learning (Hussain, Anwar, & Majoka, 2011). Activity method allows a child to study according to his/her aptitude and skill and encourages independence and team learning, provides a wide variety of manipulative, and provides pupils experience and active participation in the exploration of their environment, make pupils advance at their own rate (Stößlein, 2009). That is, with their abilities, interest and motivations, encourages self-reliance and development of initiative in an atmosphere of trust, encourages children to follow many of their own interests and desires to learn mathematics using manipulative materials (Hussain, et, al., 2011).

Problem-solving situations call upon pupils to retrieve previously learned information and apply it in new or varying situations (Leikin & Levav-Waynberg 2007). According to Swan and Burkhardt (2014), problem solving consists of using generic or ad hoc methods, in an orderly manner, for finding solutions to problems. The method also, critical create deep understanding and learners are encouraged to explore the new knowledge independently (Ferreira & Trudel, 2012). Problem solving is a best method of teaching mathematics with manipulative materials. In solving problem with manipulative materials, the student and the teacher will solve a problem together and the student will solve others independently.

2.5.1 Factors to Consider When Using Manipulative Materials

Manipulative materials have potential to deliver excitement and a higher level of conceptual knowledge to a mathematics class at any level if the tools are part of carefully sequenced instruction that makes the mathematical meaning of the objects understandable to pupils. Before introducing a lesson with manipulative materials, there are several factors to consider.

Manipulative materials do not impart mathematical knowledge on their own. Swan and Marshall (2010) contend, “Without the appropriate discussion and teaching to make the links to the mathematics explicit, the very opposite may be true: children may end up with mathematical misconceptions”(p.19). The concrete-representational-abstract (CRA) method can assist in making the transition from concrete to abstract (Sousa, 2008).

Manipulative materials are not just toys to make mathematics fun, if they do not assist in learning mathematics, then the activity is not worthwhile. Finally, when deciding on which manipulative materials to use, the teacher should ensure that the tools do not

require a complex set of rules to follow and the objects are not familiar to the pupils in other non-school settings (McNeil & Jarvin, 2007). Teachers should always keep in mind the purpose of manipulative materials is to help pupils understand the underlying concepts of abstract mathematics. The end goal should be for pupils to be proficient in the abstract calculation apart from the manipulative materials.

Manipulative materials should not be used for all concepts or for teaching all topics: Be careful not to overuse manipulative materials for all concepts. Not all manipulative materials can be used to meet curriculum expectations (McNeil & Jarvin, 2007). Teachers may need to develop new ideas for their pupils that may or may not include manipulative materials. Teachers must determine which manipulative to use in the classroom that will contribute to the teaching and learning of mathematics. Some manipulative materials are designed for specific mathematics topics and cannot be used across all topics. For example, the Cuisenaire Rods are teaching learning materials, which are use to teach fractions, addition and subtraction of counting numbers whose. Teachers should have the learning outcome in mind and consider the pupils when planning the lesson will help selectthe best manipulative (McNeil & Jarvin, 2007). Manipulative materials selected must be appropriate for a mathematics topic and can make meaning to pupils for their development.

Use relevant previous knowledge in every lesson when teaching mathematics with manipulative materials. In teaching and learning of mathematics pupils must be encourage to share what they have learned orally or in written form (McNeil & Jarvin, 2007). This will always help pupils to benefit from presenting their explanation. Teachers in the class can also assess the use of the manipulative materials based on the pupils' explanation. If the manipulative materials aid in understanding, check for understanding when the manipulative material is not being used.

In addition, the use of manipulative materials for a longer period can lead to behavioral challenges.Behavioral challenge is a big deterrent from using any manipulative for a lengthy period of time (McNeil & Jarvin, 2007). Most pupils will become distracted when manipulative are for longer period. So, teacher should outline rules at beginning of a lesson as well as allowing for some "free play" when first introducing the manipulative will help deter them from wanting to play when they need to be learning. Measures likes constant monitoring must be putin place by teachers for pupils not to play with manipulative materials in the course of teaching and learning (Elida, el al, 2015).

Manipulative materials that can be made by the teacher or the pupil can be time consuming especially if it is a large class. For example, with pattern blocks, the teacher needs several blocks for each pupil. That will involve a lot of cutting even the teacher can print a pattern and have pupils to do the cutting. Sometimes making the manipulative is a mathematics lesson in itself is time consuming.

2.6 The Benefits of Using Manipulative Materials in Teaching Mathematics

Mohd and Mohd (2010) said the use of manipulative materials will enhance what teachers tend to reach, by directing their attention toward introducing the facilitation of students understanding and conceptualization of mathematical ideas. The use of manipulative materials gives the teacher an additional alternative assessment method to measure students' performance in a real situation (Mohd & Mohd, 2010). The National Council of Teachers of Mathematics Principles and Standards for Mathematics encourage the use of manipulative materials in the mathematics classroom (National Council of Teachers of Mathematics, 2008).

Manipulative materials introduce variety to class activities and capture the interest of students, which can increase student motivation (Cooper, 2012). Multi-representational teaching builds on students' innate of physical objects, which can lead to a better foundation for abstract representations of algebraic expressions and equations (Florence, 2012). In addition, it has been demonstrated that when students are physically active throughout learning, memory and understanding are improved (McNeil & Jarvin, 2007). It is a widely accepted belief in education that when multiple learning styles are used to teach the same concept, a larger audience will be reached and students will acquire greater depth of knowledge by thinking about a problem in different ways (National Council of Teachers of Mathematics, 2008).

McIntosh (2012) stated that the use of manipulative is highly effective in teaching mathematics and manipulative materials are valuable tools to help students of any academic level understand mathematics. It is not just for students of low academic ability but also suitable for pupils of high academic ability as well. According to McIntosh (2012), "It is clear that even with minimal exposure, students of all intelligence levels can benefit greatly from the use of manipulative materials" (p. 6). According to Brooke (2014), manipulative materials are interactive and adaptable in which teachers can use to help any students of various academic abilities. Pupils build on what they already know using manipulative materials and pupils' strengths and weaknesses develop at young age and new mathematics concepts build on top understanding of previous ones (Brooke, 2014).

Manipulative materials can help weak pupils rebuild their foundational knowledge by exploring the abstract mathematics theories in concrete. Hence, improve in their learning while pupils with higher mathematical skills could benefit from manipulative

materials by enriching what they have already learned and take the mathematics concepts to the next level (Brooke, 2014).

Manipulative materials can be an important tool to help students think and reason in a more meaningful way. National Council of Teachers of Mathematics (2008) said by providing manipulative materials, teachers could create a more meaningful experience for students by offering a concrete form. Manipulative materials are able to facilitate the creation of a learning environment that encourages engagement and enables understanding. Florence (2012) argues that mathematics manipulative materials can help engage students for a longer period by helping them stay focused on particular tasks. The believe that lecture based teaching can often seem boring but that manipulative materials allow students to be actively involved in learning. Xie, Antle, and Motamedi (2008) linked enjoyment and engagement in their study of the use of tangible objects in the learning process.

A study by Swirling (2006) showed that the use of concrete or virtual manipulative materials could improve students' learning when dealing with complicated concepts. It was found that when manipulative materials were used effectively, student understanding and engagement increased. Moyer (cited by Bouck & Flanagan, 2010) believes the benefits of virtual manipulative materials include facilitating the introduction or revision of mathematics ideas, aiding the understanding of visual concepts using visuals, scaffolding learning, and engaging students in learning (p.187).

Using manipulative materials in mathematics increases the students' confidence to complete difficult mathematics problems. Shaw (2002) suggests that many children see mathematics as a struggle so they give up on the task. The author also suggests that the use of manipulative materials can counter this. "When students physically

move manipulative materials to show various relationships, their sense of touch is actively engaged" (Shaw, 2002, p. 3). This works to engage the kinesthetic side of the learner, thus aiding understanding.

Manipulative materials can be a useful tool to cater for different learning styles and are particularly appropriate for kinesthetic and visual learners (Sundstorm, 2012). Kinesthetic learners learn best by physically touching objects and playing with them. Mathematics manipulative materials allow children to handle objects in order to get a real representation of mathematics concepts. Mathematics manipulative materials for visual learners can include flash cards or posters that allow students to gather a clearer understanding of the mathematics problems (Sundstorm, 2012).

Manipulative materials can also be used to cater for individual learning needs, particularly for those students who tend to struggle with mathematics concepts. Some students need to use concrete materials to learn how to count, while other students need manipulative materials to increase their understanding of place value. Research indicates that using manipulative materials is especially useful for teaching low-achievers, students with learning disabilities, and English language learners (Boggan, Harper & Whitmire, 2010).

According to Uttal (2003), students could use either written form or manipulative form but could not combine the two to gather meaning. He discovered that "they often could succeed with manipulative materials or with written representations, but they failed to connect the two" (p. 4). McNeill andJarvin (2007) suggest that this problem arises when the "teacher fails to explicitly make the link to their Mathematics purpose in the activity" (p. 1). This highlights the important role of the teacher in helping the child to make connections.

In contrast, Boggan, Harper and Whitmire (2010) suggest that using manipulative materials in mathematics is beneficial for students' learning. They found that "manipulative materials help students learn by allowing them to move from concrete experiences to abstract reasoning" (p. 4). Manipulative materials are an effective teaching tool because teachers can use them toteach students how to bridge the gap between concrete and abstract learning (Hawkins, 2007). However, the timing of the movement to abstract learning is important. "The use of manipulative materialsenhances concept formation when both the concrete and the connecting stages are fully understood before moving to the abstract" (Kentucky Center for Mathematics, 2012, p. 1).

Manipulative materials are physical objects that can be used in an explorative sense when wants to teach effectively in a mathematics classroom. The idea is to give the pupils something they can see, touch and examine (Cope, 2015). Manipulative materials are meant to create a deeper understanding of mathematical concepts. It is only when manipulative materials are used in the teaching and learning environment students can easily explore to effectively understand the subject. According to Cope (2015), the used of manipulative materials in teaching mathematics motivate students in learning the subject. In addition, students can easily remember what they have learnt. Rosli, Goldsby, and Capraro (2015) contend that the use of manipulative materials during mathematics lessons support students' acquisition of symbols and mathematical language.

Manipulative materials are valuable tools that help students of any academic level understand mathematics well. It is not just for students of low academic ability but also suitable for students of high academic ability as well (McIntosh, 2012). According to McIntosh (2012), "It is clear that students of all intelligent levels can

benefit greatly from the used of manipulative materials" (p. 6). Manipulative materials are interactive and adaptable in which the teachers could use to help any students of various academic abilities. The students build on what they already know using the manipulative materials. Student's strengths and weaknesses develop at a very young age and once that initial foundation is established, the new mathematics concepts build on previous ones.

Manipulative materials can help weak students rebuild their foundational knowledge by exploring the abstract mathematics theories in concrete and straightforward ideas. Whereas, students who have advanced mathematical skills could benefit from manipulative materials by enriching what they have already learned and take the mathematics concepts to the next level. However, manipulative materials could be very challenging to incorporate especially when the teachers are not confident in using them. McIntosh (2012) further elaborates this notion when she stated, "Without further information on teachers' beliefs towards their training and their confidence levels, teachers may unknowingly be teaching their students mathematical misconceptions through manipulative use" (p. 19).

Studieshave also shown that in lessons whereby manipulative materials were used, students appeared to be interested, active, and involved in their learning, seeing mathematics as a fun activity (Carbonneau, Marley, &Selig, 2013). It is interesting now to see the changes in perspective regarding the subject with students who are given the opportunity to use manipulative materials in their classrooms. The lessons become interactive, engaging, and student driven. Some researchers had even reported students become more independent when they were given the opportunity, or choice, to use manipulative materials provided for them by their teacher (Sundstorm, 2012; Boggan, Harper & Whitmire, 2010). Having manipulative materials available

for them to use bring about understanding of the concepts and allowed the students to devise their own solution strategies, promote thinking, and create confidence in learning mathematics.

The role of manipulative materials in mathematics education has been studied extensively throughout, especial in this 21st century, and researchers agree that manipulative materials can help students to make sense of abstract mathematical concepts (Swan & Marshall, 2010). Much of the interest in manipulative materials stems from the assumption that their concrete nature makes them particularly appropriate for young students as they use manipulative materials to develop mathematical meaning for concepts (Manches, O'Malley, & Benford, 2010). However, there is a lack of research on the effectiveness of manipulative materials in JHS and JHS settings where students are likely to use manipulative materials differently than primary level. Additionally, much of the research on manipulative materials focuses on ways in which manipulative materials are useful, while the ways in which they help students developed understanding has not been addressed. There is a need to show whether manipulative materials can help high school students to build, mathematical understanding and how they may do so at all level of education.

Using manipulative materials has become one way of involving students' performance in mathematics and students' have fun learning the subject. Manipulative materialsare useful in making abstract ideas concrete for learners and thereby making conceptual understanding easy. No wonder, since in the sixties it is believed that, the use of mathematics manipulative materials was often justified on the basis of the ancient proverb: "I hear and I forget", "I see and I remember" and "I do and I understand" (as cited in Mohd & Mohd, 2010). This proverb is still stands as a justification for the use of manipulative materials particularly in the early years.

2.7 Challenges in Using Manipulative Materials

Despite many benefits and advantages of using manipulative materials in the mathematic classroom, there are also challenges that come with it. The lack of mathematical content knowledge, pedagogical knowledge, and technological/manipulative knowledge including the time requirement and availability of manipulative materials are discussed in this section.

Teachers have the thinking that manipulative materials are only for children who are struggling or challenged. That is perpetuated over the years. Students should be free to get up and use the manipulative materials they choose. Manipulative materials should be readily available for any student, whether mathematically challenged or mathematically gifted, at any time (Pham, 2015). The challenges arise in the methodology of manipulative materials use by teachers. Complications arise as clarity starts to blur because the overlapping use of one type of manipulative. For example, the base 10 blocks can cause confusion because they are used for whole numbers and decimal. When using it as a decimal, depending on what the whole is, the decimal representation changes, and pupils can still be in their zone of whole number rather than decimal. For example, in the nearest hundredth, the whole become the large cube, the flat become the tenth, the rod becomes our hundredths, and it is disconnected. As a teacher if you overuse the manipulative materials to the point where students do not understand that will hinder their learning (Pham, 2015). Some teachers believed manipulative materials are useful but when the same teachers were asked to identify what made the manipulative helpful in understanding mathematics they could not identify (Swan & Marshall, 2010). If teachers do not understand the philosophy behind manipulative materials, it is unlikely they will communicate the meaning effectively to their students.

Furthermore, mathematics teachers need to be careful when choosing manipulative materials for mathematics lesson (Anna & Plan, 2015). If children are used to a particular manipulative material and use it as a toy, these childrenmay found difficult to view it as a mathematics symbol (McNeil, 2009). Another obstacle is if a student has seen an object used in teaching one concept and is told to be used it in another way. This can cause confusion and thus have the opposite effect of that student.

Lastly, the lack of professional development (PD) may provide evidence as to why manipulative materials may be used or not improperly in teaching mathematics. Continuous professional development is a critical component in showing teachers how to effectively teach concepts and skills and achieving an increase in pupil achievement (Brown, 2012; Coleman & Goldenberg, 2010; Francis-Poscente & Jacobsen, 2013).

Teacher collaboration with one another is a critical component of teachers' instructional practice. Brown (2012) maintained that teachers should be willing to take the time to learn and implement new teaching strategies, even if they are challenging and demanding. Regularly participating in professional development activities according to Zambo and Zambo (2008), can change teachers' beliefs on the use of manipulative materials and mathematics materials teachers feel more confident in teaching mathematics.

Continuous professional development (CPD) programmes positive increased teachers' knowledge on the use of manipulative materials and pupils stands to increase their achievement in mathematics (CPDRG, 2007). Teachers benefited most when the CPD focused primarily on learning theories, pedagogy, and teaching strategies. As a professional teacher myself for more than six year now the GES orMOE or any other

bodies for once has never organise CPD programmemes on the use of manipulative materials for teachers in the municipality and this do not even encourage mathematics teachers to see the need for using manipulative materials in teaching and learning of mathematics.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology that was used in the study. Specifically, it described the research design, thepopulation, sample and sampling procedures, research instruments data collection procedures, data analyses procedures and ethical issues.

3.1 Research Design

A research design according to Burns and Grove (2009) is a blueprint for conducting a study with control over factors that may influence the validity of the findings. In addition, Politand Beck (2012) see research design as the overall plan of answering research questions. A research design as defined by Parahoo (2006) is a plan that describe how, when and where data are to be collected and analysed.

Therefore, in order to answer the research questions, the researcher adopted a cross-sectional design to draw both quantitative and qualitative data for the analyses. A cross-sectional design involves collecting data at one point and over a short period to provide a 'snapshot' of the outcome and the characteristics associated with a population at a specific time (Alhassan, 2012). The rationale for the adoption of a cross-sectional design is that it relies on large-scale data from a representative sample of a population with the aim of describing the nature of existing conditions. Cross-sectional research offers advantages in terms of economy and the chance to sample a large population (Vogt, 2007).

Also, Cross-sectional design was adopted because it allows flexibility in using different instruments for data collection (OUT, 2010). Therefore, the design employed

mixed method approaches to get an in-depth view of examining the use of manipulative materials in teaching mathematics among JHS teachers since one approach alone cannot adequately provide all the answers. Creswell (2009) stated that adopting both qualitative and quantitative method of data collections allows the researcher to gain an in-depth understanding of the phenomena under study.

3.2 Population

A population is the total number of units such as individual, artifacts, events and organisation from which data can be collected (Parahoo, 2006). While Hayes (2011) defined target population as the entire population in which the researcher is interested and to which he or she would like to generalize the results of a study. In this study, the target population constituted 164 made up of one hundred and four (104) mathematics teachers, all the fifty-nine (59) public school headteachers and the only mathematics coordinator of the Wa Municipality.

3.3 Sample Size

Asample is a subset of a larger group called population (Fink, 2003). Pilot and Beck (2004) also see sample as a subset of a population selected to participate in a study. A sample can be seen, as a part of a whole population taken to take part in a study. A sample size of 105 participants made up of 94 (89.5%) mathematics teachers comprising 77(81.9%) males and 17(18.1%) females, 10 public school headteachers comprising 8(80%) males and 2(20%) females and the only male mathematics coordinator were sampled for the study.

The sample size for the mathematics teachers (n = 94) was used to ensure representation of the JHS mathematics teachers across the Wa municipality. This, Alhassan (2012) explained that, “the law of representation says that the larger the

samples size the more representative it is in the population" (p. 72). In addition, the sample size of 10 out of 59 public school headteachers is representative of the target population of headteachers because Gay (2003) suggested that 10% or more of the population was adequate to serve as a study sample. Therefore, the sample size of 105 used is valid for any statistical analysis and conclusions.

3.4 Sampling Procedures

Sampling is taking a portion of the population of a study as a representation of the whole population (Seidu, 2015).The researcher had intended to sample teachers from all the public 59 JHS for the study to ensure the sample had fair representation of the population (Kusi, 2012) of mathematics teachers from all the JHSs in the Wa Municipality. However, the researcher could select only 54 out of the 59 public schools. The schools left out in the study had only one teacher who was either not available or too busy to be involved.

Simplerandom sampling technique was used to select the teachers from the respective schools. Simplerandom sampling involves selecting at random from a list of the population and which offers a fair way to select a sample by making generalization easy and flexible (Owu-Ewie, 2011). Similarly, Seidu (2015) sees simple random sampling as a sampling technique that provides equal opportunity for all participants in a population for selection.

In the case of any school visited, the names of the mathematics teachers were obtained from the headteachers and written on pieces of paper. The pieces of paper bearing the names were folded and kept in a basket. The researcher picked two papers at random without replacement. However, a school that had only one or two

mathematics teacher(s) was/were automatically considered. Through this process, ninety-four (94) teachers were selected for the study.

However, purposive Sampling was used to select headteachers of the public JHS and the only mathematics coordinator for the qualitative data. In purposive sampling, researchers intentionally select individuals and sites to learn or understand the central phenomenon (Creswell, 2008). The headteachers were purposively selected because of their long services as well as their roles as immediate supervisors of teachers, and ensuring that teachers are using the right teaching and learning materials, methodology and activities during teaching. Themathematics coordinator at the Wa Municipal Education Office was purposively selected since he is the only mathematics coordinator in the office and with a wealth of experience in ensuring effective mathematics education in the municipality.

3.5 Research Instrument

A research instrument is a tool used to collect data, or one that is designed to measureknowledge, attitude and skills (Parahoo, 2006). Because the study employed mixed method approach data analysis, the researcher used questionnaire, interview guides and observational guides as instruments for data collection for the study.

3.5.1Questionnaires

A questionnaire is a document containing questions designed to elicit appropriate information for analysis (Babbie, 1990). Questionnaires contained prepared documents of items designed to elicit responses from participants for understanding the research problem under study (Babbie, 1990). The researcher adopted questionnaire because a large number of respondents was covered and with little involvement of money time and effort (Kusi, 2012 &Osula, 2004).

The questionnaires consisted of items grouped in six sections namely: A, B, C, D, E and F. The items in section "A" were both open and close ended which was to obtain bio data of respondents. That is, their sex, age, qualification, period of teaching at the JHS and period of teaching mathematics at the JHS. Section "B" contains 44 items, which consist of a three-point Likert-scaled type items and open-ended items to collect data on the type of manipulative materials teachers used in teaching the individual topic in mathematics at the JHS level. They rated the extent to which they agreed or disagreed with the statement of the items. The three-point Likert-scale used ranged from Agree (1), Uncertain (2) and Disagree (3) for respondent to choose. The open-ended items were to collect data on the manipulative materials that were not stated by the researcher butcan be used to teach the individual topics listed. In addition, these parts collected data on the type of manipulative materials used mostly and why they use them any time they were to teach those topics.

Section "C" contained nine (9) items, which sough answers on how teachers obtained their manipulative materials for teaching mathematics at the JHS. Section "D" also contained two items on the teaching method used in teaching mathematics with the used of manipulative materials. Here also respondents were to select from lists of teaching methods suitable for teaching mathematics with manipulative materials at the JHS level and an open -ended questions seeking other methods used by these teachers but not indicated the researcher.

Section "E" contained eight (8) Likert-scaleitems to seek answers on the teachers' perceived benefits of using manipulative materials in teaching mathematics at the JHS level. Section "F", which contained eleven (8) Likert-scale items seeking to collect data on the challenges of using manipulative materials in teaching mathematics by

ticking either Agree one or Disagree two or Uncertain 3 and also, to provide other challenges of using manipulative materials but not in the items provided.

Questionnaires were designed and delivered to the respondents by the researcher in all the selected fifty-four (54) JHSs in the Wa municipality to obtain data from teachers. Ninety-four (94) questionnaires were delivered to teachers in the various schools. One-month duration was given to respondents to complete the questionnaires. The researcher called respondents frequently to remind them and after the one-month period, the researcher then went round and collected the completed questionnaires from the teachers with the help of the head teacher at the various schools. The questionnaire items were carefully designed based on the research questions of the study. The variables were obtained through careful review of related literature and worded with both closed and open-ended questionnaire after the supervisor and other colleagues had proofread and scrutinized the questionnaires.

3.5.2 Interview

According to Annum (2015), an interview is an interaction between an interviewer and an interviewee in which questions are posed orally from the interviewer to gather oral responses from the interviewee. Semi-structured interviews were conducted on ten (10) headteachers and themathematics coordinator at the municipal office. The interview took place in the various offices of all the ten headteachers and the mathematics coordinator. This happened during working hours of which participant took part of their time to participate in the interview section in each head's office of the various schools. The same applied to the mathematics coordinator.

About 10 minutes was used in each interview section through oral communication between the interviewer and interviewee to seek responses on how teachers obtained

their manipulative materials and how lessons are taught when manipulative materials are used for teaching mathematics. In addition, the benefit and challenges associated with the used of manipulative were also areas interviewer collected data on. The headteachers and the mathematics coordinator were notified a week on a plan to administer the interviews on them.Semi-structured interviews allowed flexibility in the interview process (Kusi, 2012)and data obtained in the presents of both the researcher and the respondents such that questions that were not understood could be clarified.

3.5.3 Observation

According to Agudzeamegah (2014),observation involves descriptions of activities, behaviours, actions, dialogue, interpersonal interactions, organisation or any other aspect of observable human experience. The data gathered from observations consist of detailed descriptions of the environment within which the observation was made (Lemanski & Overton, 2011). According to Asare-Forjour (2009), direct observation of behaviour is an essential means of evaluating the works of schools and teachers. In the field of education, observation comes handy to critically determine a teacher's teaching skills and assessment of practical skills (Agudzeamegah, 2014).

Observation was carried among ten mathematics teachers out of the sampled number of hundred (100) mathematics teachers in the Wa municipal to ascertain teachers' use of manipulative materials in teaching mathematics when questionnaires was applied on them. A maximum of seventy (70) minutes duration was used for each of the observation carried out in various classrooms of participants. Teachers were pre - informed as to the researcher's intention to carry out observation in their various

classes, but the date of observation was not communicated to teachers because researcher wanted the intention of the observation not to influence teachers' normal way of delivering lessons.

One week of classroom teaching was intended tobe used for the observation. However, two weeks were spent due to cancellation of scheduled lessons on holidays that fell on working days. Written descriptions were used to collect data.

3.6 Reliability and Validity

It is easy for one to overlook a mistake and ambiguities in question layout and construction when designing items (Wilkinson & Birmingham, 2003). It was for these reasons that the researcher conducted a pilot study in the Wa West district of the upper west region of Ghana to ascertain the validity and reliability of the instruments.

According to Cohen, Minion and Morrison (2007), validity is the extent to which the instruments used during the study measure the issues they are intended to measure while reliability is the extent to which the measuring items would produce consistent scores when the same groups of individuals are repeatedly measured under the same conditions. To ensure validity of the instruments, the instruments were developed under a close guidance of the supervisor. The aim of the pilot study was to help identify ambiguous items in the instruments and be able to realign them to the research questions.

The researcher administered one type of questionnaire to teachers and using Cronbach reliability test, an Alpha value of 0.753 was attained implying that the items were suitable for assessing the research questions because (Tavakol, & Dennick, 2011) accept the minimum alpha value of 0.70.

To ensure the validity of the interview guides and observational guides, draft copies were given to two lecturers from the University for Development Studies, who read through and made necessary corrections to ensure face validity.After this review, interview and observational guides were sent to the researcher's supervisor for further review. From the responses in the pilot study, it was clear that respondents understood the items as they were fully answered well.

3.7Data Analysis

In this study, three research instruments were used: a questionnaire that produced quantitative data and interview guides and observation guides that produced qualitative data.The quantitative data were analysed using descriptive statistics. Using Statistical Product and Service Solutions version 20 software, the questionnaire data were cleaned, coded, and entered into the software to calculate the descriptive statistics (frequencies, percentages, mean and standard deviation) of the sample. Similarly, matrix-ranking method was used to rank the frequency of teachers using specific types of manipulative materials for teaching mathematics. While one sample chi-square test at 0.05 alpha level; 95.0 significance level was used to test the hypotheses of the extent of the benefits of using of manipulative materials in teaching mathematics and how that challenges teachers in the use.

According to Cohen, Manion and Morrison (2007), qualitative data analysis involves the procedure of categorising, structuring and putting meaning to collected data. Analysis of qualitative data involved stages of categorising and filtering the data in order to identify the exact dominant themes that were common in responses. The interview data were analysed using content analysis, which according to Krueger (1988) is comparing of the similar words used in the answers of the respondents in the

same themes. Initially, the researcher studied the field notes, reduced the tapes into transcripts and carefully read them. This was done to look for themes and similar ideas or responses to the questions that were posed to the respondents of which the respondents' information or speeches were translate into specific categories of themes for the purposes of analysis. Similarly, Goldenkoff (2004) is of the view that a brief summary and analysis, highlighting major themes, is sufficient where decisions must be made quickly, the results are readily apparent or the purpose of the group is purely exploratory.

Lastly, observation data on teachers was analysed on the extent teachers actually used manipulative materials in their classroom and the type of teaching methods these teachers used in teaching either with the use or not use of manipulative materials, and the extent of the benefits of using of manipulative materials in teaching mathematics. Observation notes were studied and similar themes were carefully taken not of which the researcher used to support the claims of teachers use of manipulative materials when questionnaires were applied.

3.8 Ethical Issues

Kombo and Tromp (2006) asserted that researchers whose subjects are peoples must consider the conduct of their research, and give attention to the ethical issues associated with carrying out their research

At the onset of data collection, the researcher sought permission from the Municipal Education Officer, who intent introduced the researcher to the headteachers of schools through writing. The headteachers also introduced the researcher to the teachers. In addition, each questionnaire contained an opening introductory letter requesting for the respondents cooperation in providing the required information for the

study. The respondents were further assured of the confidentiality of the information provided and that the study findings would be used for academic purposes only. Respondents were further assured of their personal protection and that they had authority to refuse or accept to be interviewed or to be observed.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Overview

The study examined the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality. The study involved one (1) mathematics coordinator, ten (10) headteachers, ninety-four (94) JHS mathematics teachers sampled from fifty-four (54) schools. Out of the ninety-four (94) mathematics teachers, 77 (81.9%) were males and 17(18.1%) were females. The ten (10) headteachers were made up of 8 (80%) males and 2(20%) females.

The instruments used to collect the data were the questionnaire, interview guide, and observation guide. The questionnaire yielded quantitative data while the interview guide and observation guide produced qualitative data. This chapter presents and discusses the results of the analyses. Data were analysed using descriptive statistics – frequencies, percentages, matrix ranking and hypotheses tested using one sample chi-square test at 0.05 alpha level– and the results presented in Tables and Graphs.

4.1 Demographic Characteristics

Section "A" of the questionnaire was made up of five items that required teachers' bio-data. Teachers' responses to the items were analysed using frequency counts, which were converted into percentages. The results of the analysis of teachers bio-data is as presented in Table 4.1 and Figure 4.1

Table 4.1: Demographic Characteristics of Respondents

Variables	Categories	Frequency (%)
Sex	Male	77 (81.9)
	Female	17(18.1)
	Sub-Total	94(100)
Age	20-25yrs	36(38.3)
	26-30yrs	NIL
	31-35yrs	35(37.2)
	36-40yrs	12(12.8)
	Above 40yrs	11(11.7)
	Sub-Total	94(100)
Qualification	Diploma	23(24.5)
	First degree	65(69.1)
	MEd/MPhil	4(4.3)
	Other (specify)	2(2.1)
	Sub-Total	94(100)

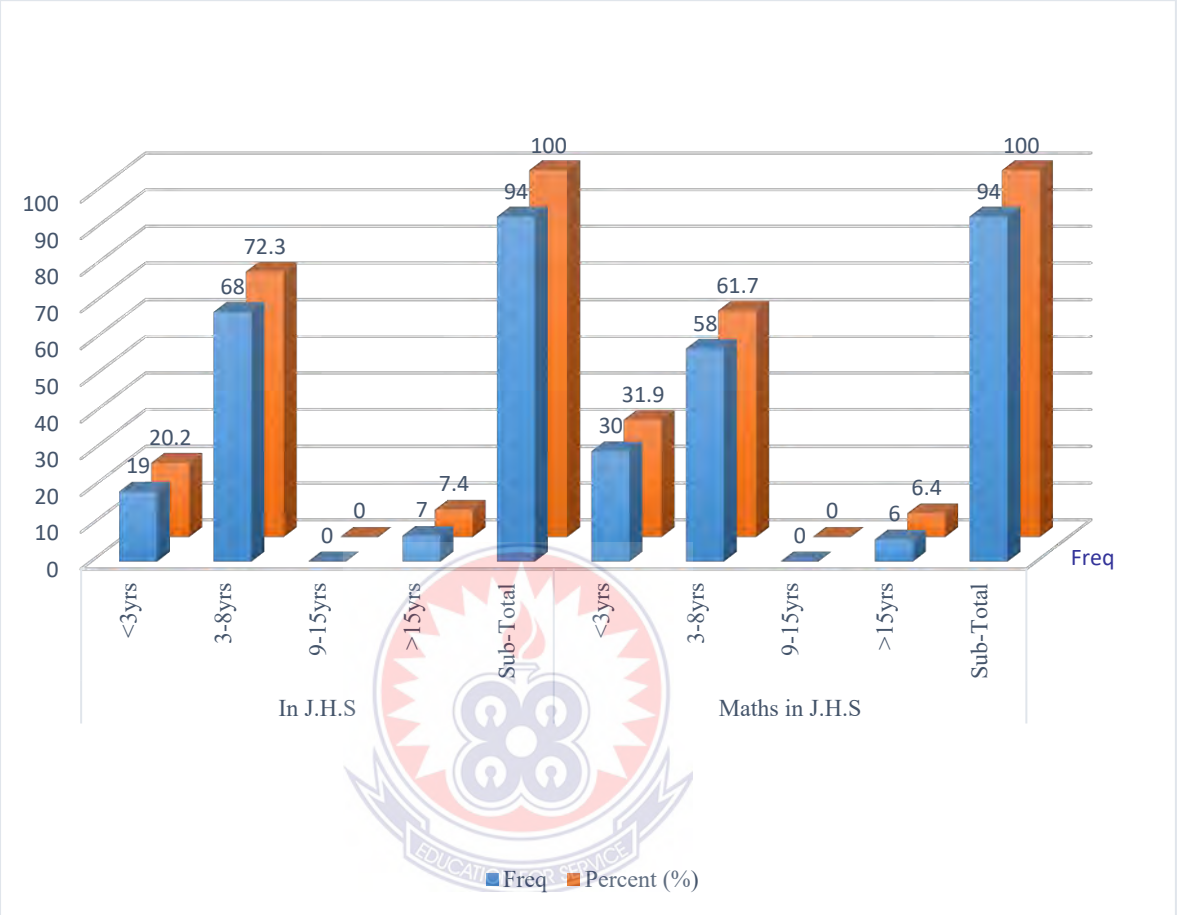
Source: This Study Field Survey, May, 2017

From Table 4.1, more males 77(81.9%) and few females 17(18.1%) were teaching mathematics in JHSs in the Wa Municipality. The age distribution shows that, about two-fifths 36(38.3%) of the teachers were between the age of 20-25 years old and a similar proportion 35(37.2%) were in the 31-35 years range. Relatively few teachers were of age between 36-40 years old 12(12.8%) and fewer were above 40 years old 11(11.7%). The age statistics suggeststhat most of the JHS mathematics teachers in the Wa municipality were relatively young, energetic and active enough to use manipulative materials in teaching mathematics in the JHS.

Basedon their highest qualification, above average 65(69.1%) of the respondents had first degree certificate in related fields while quarter 23(24.5%) of the respondents were diploma certificate holders. Notwithstanding, very few 4(4.3%) of the respondents had master's degree either Masters in Education (MED) or Master of Philosophy (MPhil) and others 2(2.1%) still holding Certificate "A". Again, the range of qualifications suggeststhat most of the mathematics teachers in the municipality had,at least, the basic qualification and knowledge to use manipulative materials in

teaching mathematics. Teachers' responses on the length of period of teaching were organised into a bar graph as in Figure 4.1:

Figure 4.1: Teachers length of teaching mathematics in JHS.



Source: This Study Field Survey, May, 2017.

Figure 4.1 shows that, generally, majority 68(72.3%) of the teachers have taught in JHS between 3-8 years. However, few taught for less than three years19 (20.2%) and more than 15 years 7(7.4%) in the JHS. In relation to mathematics, more than three-fifth 58 (61.7%) of the teachers have taught mathematics in JHS between 3-8 years. Less than one-third 30(31.9%) of the teachers taught for less than 3 years and very few 6(6.4%) taught for more than 15 years in the municipality. The data suggest that most teachers had taught in the JHSsin the municipality for 3-8 years and would have had enough experience in the use of manipulative materials for teaching mathematical concepts.

4.2 Types of Manipulative Materials JHS Teachers Use in TeachingMathematics in the Municipality

The purpose of this section is to identity the types of manipulative materials respondents use in teaching mathematics at the JHS level. The types of manipulative materials used by respondents were analysed using frequency, percentages, mean and standard deviation. Matrix ranking was also used to ascertain which of the type of manipulative materials teachers used most in teaching various topics in the JHS syllabus. The matrix representing the proportion of teachers who use or do not use the particular type of manipulative materials is presented in Tables. In matrix ranking respondents were ask to indicate which manipulative materials they used most in the teaching the individual topics at the JHS. The manipulative materials are categorised to reflect the topics in the JHS mathematics syllabus as:

Table 4.2a: Number and Numeral, Sets and Fractions.

Table 4.2b: Shapes and Space, Length and Area

Table 4.2c: Capacity, Properties of Quadrilaterals, and Probability

Table 4.2d: Vectors, Properties of Polygons, Rigid Motion.

Table 4.2.a: Matrix of Manipulativematerials JHS teachers use or not use inteaching Number and Numeral, Sets, and Fractions

Topics	Type of Manipulation	Matrix Ranking		Use of Manipulative			Mean (M)	Std. Dev. (SD)
		Scores	Ranks	Used	Not used	Not sure		
Numbers and Numerals	Place Value Chart	63	1st	88(93.6%)	3 (3.2%)	3(3.2%)	1.10	0.39
	Abacus	55	2nd					
	Bug counters	10	3rd					
	Coloured-coded	4	4th					
	Bottle Tops	3	5th					
Sets	Bottle Tops	62	1st	90(95.7%)	Nil	4 (4.3%)	1.04	0.20
	Stones	42	2nd					
	Sticks	40	3rd					
	Books, Pen and Pencils	39	4th					
	Erasers	17	7th					
	Chalks	25	5th					
	Attributes Blocks	14	8th					
	Bug Counters	18	6th					
Fractions	Strips of Papers	61	1st	87 (92.6%)	1 (1.1%)	6 (6.4%)	1.09	0.32
	Fraction Charts	54	2nd					
	Addition Machine Tape	6	5th					
	Cuisenaire Rods	16	3rd					
	Oranges	9	4th					

Source: This Study Field Survey, May, 2017;

In Table 4.2a, majority 88 (93.6%) with a mean of 1.10 and standard deviation (SD) of 0.39 of the respondents use manipulative materials in teaching numbers and numerals. However, few 3 (3.6%) do not use manipulative materials whiles 3 (3.6%) were uncertain as to the use of manipulative materials in teaching the topic. The most frequently type of manipulative materials used in teaching numbers and numerals were ranked as: place value chart (1st) and abacus (2nd), bug counters (3rd), coloured-coded (4th) and bottle tops (5th), This shows that majority of teachers use varied manipulative materials in teaching numbers and numerals in the municipality.

In teaching sets, majority 90 (95.7%) of the teachers (mean=1.04; standard deviation = 0.20) use manipulative materials. However, only 4 (4.3%) were uncertain about the use of manipulative materials in teaching the topic. The manipulative materials were ranked to ascertain the type often used in teaching sets. From the table: bottle tops (1^{st}), stones (2^{nd}), sticks (3^{rd}), books, pens, and pencils (4^{th}) and chalks (5^{th}). The least frequently used manipulative materials were bugs of counters (6^{th}), erasers (7^{th}), and attributes blocks (8^{th}).

In teaching fractions, Table 4.2a shows that majority 87 (92.6%) of the teachers (mean=1.09; standard deviation=0.32) indicated they used manipulative materials to teach pupils. However, only 1 (1.1%) teacher responded not using manipulative materials and few 6 (6.4%) were uncertain. On the most frequent type of manipulative materials used in teaching fractions, were: strips of papers (1^{st}), and fraction charts (2^{nd}), cuisenaire rods (3^{rd}), and oranges (4^{th}).The least used manipulative material was the addition machine tape which occupied the fifth (5^{th}) position.

When teachers were requested to suggest why they use a particular type of manipulative materials in teaching numbers and numerals, sets and fractions in the open-ended item in the questionnaire, some of the responses include:,

Teacher 1 wrote.

> *I use place value chart and abacus so frequently to teach numbers and numerals because the use of these manipulative materials involves the child in the process of learning and pupils can easily understand.*

Similarly, Teacher 2 states:

> *Place value and abacus are always available in the school office and I can lay my hands on them any time I want to use them to teach the topic numbers and numerals*.

Teacher 3 put it that:

> *Using stones, pencils, pens, sticks to teach "set" make pupils to understand better, these materials are also easy to be obtained and they give clear visual ability making sorting easier*.

Teacher 4 wrote:

> *Strips of papers and fractional charts are easy to be obtained and* they *facilitates teaching and learning and gives a clear view of the fractions*.

A careful study of their responses brought to fore their varied views on why a particular manipulative material is used for a particular topic.

These teachers responses confirm Ministry of Education's (MoE, 2012) and Obeng's (2013) suggestion that in teaching "Number and Numerals", teachers should use manipulative materials like Abacus, Place value chart while a topic like "Fractions" should best be taught with Strips of paper, Fraction charts, and "sets" are taught using stones bottle topic pencils pens.

Table 4.2.b: Matrix of Manipulative materials JHS teachers use or not use in teaching shapes and space, length and area, and power and numbers (n = 94)

Topics	Type of Manipulative	Matrix Ranking		Use of Manipulative materials			Mean	Std. Dev.
		Scores	Ranks	Used	Not used	Not sure	(M)	(SD)
Shapes and Space	Empty Chalk Boxes	52	2nd	90 (95.7%)	1 (1.1%)	3 (3.2%)	1.05	0.27
	Cartoons	20	8th					
	Tins	38	3rd					
	Cut-out shapes Cards	62	1st					
	Real objects of diff. shapes	35	4th					
	Solid shapes from boards	31	6th					
	Prism cubes and cuboids	30	7th					
	Cylinder	17	9th					
	Rectangular, circular and triangles Pyramids	34	5th					
Length and Area	Geoboard	18	5th	86 (91.5%)	2 (2.1%)	6(6.4%)	1.11	0.37
	Graph paper	53	1st					
	Rubber band cut-out shapes	47	2nd					
	Threads	29	3rd					
	Centimeter	25	4th					
	Tape measure	8	6th					
	Rule	4	7th					
Power and Numbers	Counters	38	2nd	80 (85.1%)	2 (2.1%)	12 (12.8%)	1.17	0.43
	Bottle tops	42	1st					
	Stone	28	4th					
	Sticks	26	5th					
	Base-ten block	29	3rd					

Source: This Study Field Survey, May 2017.

In Table 4.2b, majority 90 (95.7%) of teachers with a mean score of 1.05 and standard deviation of 0.27, used manipulative materials in teaching shapes and space. Only one teacher 1 (1.1%) does not use manipulative materials and few 3 (3.2%) were uncertain as to the use of manipulative materials in teaching the topic. Also, the most frequently used manipulative materials for teaching shape and space are ranked as: cut-out shapes (1st), empty chalk boxes (2nd), tins (3rd), real objects of different shapes (4th), rectangular, circular and triangle pyramids (5th), solid shapes from boards (6th), prism cubes and cuboids (7th), cartons (8th) and cylinders (9th).This suggests that varied materials are used to teach shape and space but the least used is the cylinder.

In teaching the topic, "length and area" majority of the teachers 86 (91.5%) with a mean of 1.11 and standard deviation of 0.37 indicated the used of manipulative

materials. Few teachers 6 (6.4%) were uncertain as to the use of manipulative materials in teaching the topic and only 2 (2.1%) do not use manipulative materials. The most frequently used manipulative materials as ranked in teaching length and area: were graph paper (1st), rubber band (2nd), threads (3rd), and centimeter cubes (4th) and least to include; geoboard (5th), tape measure (6th) and rule (7th). The results suggest that manipulative materials are used by mathematics teachers in teaching the topic length and area in the Wa municipality.

Table 4.2b further indicates that majority 80 (85.1%) of teachers use manipulative in teaching power and numbers. The number of users has a mean=1.17 and standard deviation=0.43. Few teachers 12 (12.8%) were uncertain while only 2 (2.1%) do not use manipulative materials. The most frequent manipulative used in teaching power and numbers in the curriculum when ranked gave: bottle tops (1st) counters (2nd), base-ten blocks (3rd), stones and sticks (4th).

In response to why they used these particular materials for teaching the topic in the open-ended question,

A teacher wrote:

> "*using cut-out shapes and empty boxes facilitates teaching and learning and more child centred*"

Another one states:

> "*cut-out shapes and empty boxes can easily begotten from the school and home environment and pupils are normal asked to bring them when necessary, hence the reasons why I often used them in teaching shapes and space*" (Teacher).

> *"I do not use any manipulative to teach power and numbers because, I do not know which manipulative to use and even how to use them to explain to the understanding of the pupils"* (Teacher).

Again, a teacher expressed the view:

> "*I am encouraged to use cut-out shapes and empty boxes to teach shapes and space because there are less expensive and even the boxes are available free in the environment which I and my pupils can lay our hands.*

A teacher who indicated using manipulative materials said:

> "*I use graph papers to teach shapes and space because it gives accurate representation and measure of the topic".* Similarly, the fifth teacher explained her view saying:

> *I used graph papers to teach length and area because it is practical and demonstration oriented. Whilst others served as complementary items for the pupils to understand". In addition*, "*pupils understand power & numbers when I used bottle tops and counters because children are more familiar with them and easily accessible*

From the foregoing, it suggest that teachers' use of manipulative materials in teaching mathematics in JHS, it's choice and frequency of use depends on the availability of these manipulative materials. This confirms the suggestion by (Anna & Plan, 2015) that a manipulative material should be used based on its suitability and accessibility to both teachers and pupils.

Table 4.2.c: Matrix of Manipulative materials JHS teachers use or not use in teaching Capacity, properties of quadrilaterals, and probability (n= 94)

Topics	Type of Manipulation	Matrix Ranking		Use of Manipulative materials			Mean (M)	Std. Dev. (SD)
		Scores	Ranks	Used	Not used	Not sure		
Capacity, time, money and mass	Tea and Table Spoon	22	4th	84(89.4%)	3(3.2%)	7(7.4%)	1.14	0.43
	Soft drink cans or bottles	58	1st					
	Bucket balance	18	5th					
	Measuring cylinder	56	2nd					
	Jugs and Scale balance	38	3rd					
	Real money	17	6th					
	Clocks	15	7th					
Properties of Quadrilaterals	Cut-out shapes	90	1st	85 (90.4%)	2(2.1%)	7(7.4%)	1.12	0.38
	AngLegs	22	2nd					
Probability	Coin	80	1st	87 (92.6%)	2(2.1%)	5(5.3%)	1.10	0.36
	Die or Dice	77	2nd					
	Stones	09	3rd					
	Balls	04	6th					
	Pen corks	06	4th					
	Colour-coded materials	05	5th					

Source: This Study Field Survey, May, 2017.

In Table 4.2c, majority of the teachers 84 (89.4%) used manipulative materials in teaching capacity, time, money and mass and only 3 (3.2%) do not use manipulative materials and few 7 (7.4%) were uncertain as to the use of manipulative materials in teaching the topic capacity, time, money and mass. This shows an average score (mean=1.14) and a positive spread of the data from the mean (standard deviation=0.43). The most frequent manipulative materials used in teaching capacity, time, money and mass were: soft drink cans or bottles (1st), measuring cylinder (2nd), jug and scale balance (3rd), tea and table spoon (4th), bucket balance (5th), real money (6th), and clock (7th).

Also, in teaching "Properties of Quadrilaterals", majority of the teachers 85 (90.4%) agree they use manipulative materials in teaching and only 2 (2.1%) disagree they use manipulative materials and few 7 (7.4%) were uncertain as to the use of manipulative materials in teaching the topic. Showing an average (mean = 1.12) and a positive

spread of the data from the mean (standard deviation = 0.38). The most frequent manipulative materials use in teaching properties of quadrilaterals includes: cut-out shapes (1st) was the most type of manipulative used compared to angLegs (2nd)

Majority of the teachers 87 (92.6%) agree they use manipulative materials in teaching the topic "probability". Showing an average (mean = 1.10) and a positive spread of the data from the mean (standard deviation = 0.36). Whiles only 2 (2.1%) disagree they use manipulative materials and few 5(5.3%) were uncertain as to the use of manipulative materials in teaching the topic. Also, the most frequent used of manipulative in teaching probability includes: coin (1st), and die or dice (2nd) were the specific manipulative materials used often. However, others that were least used to teaching probability in JHSs include; balls pen corks (3rd) and coloured-coded (4th) materials.

When teachers were requested to suggest why they use a particular type of manipulative materials in teaching capacity, time and money, properties of quadrilaterals and probability, a careful study of their responses brought to fore their varied views to a particular issue of concerns. The following were of the respondent given by teachers in writings why some manipulative materials are used in teaching mathematics at the JHS.

A Teacher wrote:

> "*using bottle tops and cans are readily available. My brother just ask the children to bring them and it will be brought abundant, bottle tops are available and I don't hesitate to ask pupils to bring them any time we want to teach and learn capacity, time, money and mass*".

Another teacher wrote:

> "*using wall clocks to teach children to understand the topic "Time" is easier and pupils are active because they interact with these manipulates*"

Another teacher wrote:

> "*die, coins and rubber bands are available and one can easily lay hand on these materials*".

This confirms the suggestion that in teaching capacity, time, money and mass, manipulative materials like soft drink cans or bottles, measuring cylinder, jug & scale balance, tea and table spoon, bucket balance, real money and clock. While a topic like "properties of quadrilaterals" should be taught using manipulative materials like cut-out shapes and a topic like "Probability" should be taught using manipulative materials like coins, dice rubber bands etc (Ministry of Education, 2012&Obeng, 2013). However, the use of these manipulative materials by mathematics teachers at the JHS level in the municipal depends on its availability and suitability (Anna & Plan, 2015)

Table 4.2.d: Matrix of Manipulative materials JHS teachers use or not use in teaching Vectors, properties of polygons, and rigid motion (n = 94)

Topics	Type of Manipulation	Matrix Ranking		Use of Manipulative materials			Mean (M)	Std. Dev. (SD)
		Scores	Ranks	Used	Not used	Not sure		
Vectors	Graph sheets	77	1st	85 (90.4%)	3(3.2%)	6(6.4%)	1.13	0.42
	Protractor	45	3rd					
	Rule	55	2nd					
Properties of Polygons	Cut-out shapes	79	1st	86 (91.5%)	2(2.1%)	6(6.4%)	1.11	0.37
	Protractor	28	3rd					
	Graph sheets	31	2nd					
	AngLegs	15	4th					
	Attribute Blocks	11	5th					
Rigid Motion	Geoboard	27	4th	87 (92.6%)	Nil	7(7.4%)	1.07	0.26
	Cut-out shapes	43	3rd					
	Mirror	47	2nd					
	Graph sheets	68	1st					
	Tracing paper	19	5th					

Source: This Study Field Survey, May, 2017.

From Table 4.2d, majority of the teachers 85 (90.4%) (mean = 1.13; standard deviation = 0.42) agreed they use manipulative materials in teaching vectors. Few teachers 6 (6.4%) were uncertain and few 3 (3.2%) disagreed they use manipulative materials. However the most frequently use manipulative materials in teaching the topic by rank include: graph sheets (1st), rule (2nd), and the protractor (3rd). Similarly, in teaching properties of polygons, Table 4.2d shows that majority 86 (91.5%; mean=1.11; standard deviation=0.37) of the teachers agreed they use manipulative materials in teaching the topic. However, few 6 (6.4%) were uncertain and fewer 2 (2.1%) disagreed they use manipulative materials in teaching the topic. Ranking items in terms of frequent use gives cut-out shapes (1st), graph sheets (2nd), protractors (3rd), angLegs (4th) and attribute blocks (5th). Table 4.2d also reveals that majority 87 (92.6%) of the teachers (mean = 1.07; standard deviation = 0.26) responded that they use manipulative materials in teaching the topic rigid motion whiles few 7 (7.4) were uncertain as to their use of manipulative materials. However, ranking in terms of the most frequently manipulative materials used in teaching rigid motion, we have: graph papers (1st), mirror (2nd), cut-out shapes (3rd) and geoboard (4th) with tracing papers been least used (5th).

When teachers were requested to explain why they use a particular type of manipulative materials, a teacher had this to say:

> "*in teaching the topic "vector" it is easier to use graph papers and cut-out shapes because all the pupils have graph books and cardboards are usually bought by the school which can be used to cut in many different shapes and forms.*"

Another teacher wrote:

> "*In teaching the topic "rigid motion", I use graph papers and cut-out of cardboards because all the students were given graph books by the office and using the graph sheet to explain is easier because all the children can play with their manipulative materials"*

Another teacher wrote*:*

> *cut-out shapes are available in the school office and I can easily use them to teach the topic "Polygons"*

Teachers' responses confirm Ministry of Education (2012) and Obeng (2013) suggestion that a topic like "Vectors" should best be taught with manipulative materials like graph sheets, protractors and rulers. While a topic like "properties of polygons should be taught using the materials: cut-out shapes, protractor, graph sheet anglegs, and attribute blocks and "Rigid Motion" should be taught using the materials like geoboard, cut-out shapes, mirrors, graph papers and tracing paper.

Notwithstanding the overwhelming perception of teachers using manipulative materials in teaching mathematics topics, few of them were not sure and fewer were blunt to disagree across all the topics investigated. Revelations from the questionnaire prompted the researcher to observe how teachers used the manipulative materials in their mathematics classrooms.

Observation of JHS Teachers in Mathematics Classrooms

Ten teachers were observed in their mathematics classroom and field notes taken. The essence of the observations was to ascertain whether teachers actually practice what they have indicated in the questionnaire about the use of manipulative materials. Out of the ten (10) schools purposively selected to visit for observation, only one (1)

teacher used manipulative materials –coins and a die –when teaching probability. Although the remaining nine (9) teachers indicated in their lesson notes manipulative materials to use, they did not use them to teach pupils. For example, in one class a teacher indicated in the lesson notes that she was to use rulers, boxes, books tables, and the walls of the classroom to teach the concept perimeter. The teacher ended the class without referring to any of the materials listed. In another class, a teacher listed cut-out shapes to use to teach the topic "shapes and space" but these materials were not found in the classroom. Rather, the teachers used discussion and lecture methods of teaching the pupils. This suggests that teachers wrote their perceived thoughts of using manipulative materials in teaching on the questionnaire but in reality, their practice was far from the truth.

Teachers who indicated to use manipulative materials but did not use them in their lessons observed were interviewed. Explaining why manipulative materials were not used in the lesson, one said:

> "*I did not used any manipulative material stated in the lesson notes because there is no time and using manipulative materials takes too much of the lesson, thus, I used discussion method to teach topics more often*" (Teacher Interview, May, 2017).

Another had this to say:

> "*my brother, it is a normal practice to indicate the type of manipulative materials you intent to use in teaching every topic, but in reality most of us teachers don't used them because they are simple not available and I don't have that time to look for them. Look some of these manipulative materials are too expensive that I will never try to*

use my little salary to buy manipulative materials just for teaching (Teacher interview, May, 2017).

These explanations confirm that teachers were only fulfilling their mandatory requirement of stating they used manipulative materials in their lesson notes (Ministry of Education, 2012) but their actions were at variance with instructional requirements at the JHS level.

4.3 How do JHS Teachers in the Wa Municipality Obtain their Manipulative Materials for Teaching Mathematics?

Items 45-52 of the questionnaire required teachers to provide the sources of manipulative materials for teaching mathematics. They were also to indicate how frequently they received the supply of the materials from the sources stated. Teachers responses were organised using frequency counts and percentages as presented in Table 4.3.

Table 4.3: JHS teachers sources of manipulative materials (n= 94)

Source	Freq. of Supply	Basis of Supply			
		No Supply	Termly	Yearly	Once a While
Improvisation by teachers and pupils	72(76.6%)	5(5.3%)	58(61.7%)	4(4.3%)	27(28.7%)
Supply from MOE/GES	13(13.8%)	49(52.1%)	6 (6.4%)	11(11.7%)	28(29.8%)
Donations from NGOs or Assembly	2 (2.1%)	72(76.6%)	1(1.1%)	4(4.3%)	17(18.1%)
PTA and philanthropists	7 (7.4%)	65(69.1%)	3 (3.2%)	5(5.3%)	21(22.4%)

Source: This Study Field Survey, May, 2017.

From Table 4.3, teachers sources of manipulative materials for teaching mathematics in their classrooms include improvisation by teachers and pupils, supply from Ministry of Education (MOE) or Ghana Education Service (GES), donations from NGOs and Municipal Assembly, and the PTA. Among these, the major source that

supplies schools with manipulative materials was through improvisation by teachers and pupils 72(76.6%). Few teachers had their supplies from the MOE/GES 13 (13.8%), the PTA and philanthropist 7(7.4%), also, donations from NGOSs and Assembly (2.1%) agree they obtain manipulative materials from this source. Meaning that, many of the manipulative materials used by teachers in teaching mathematics in JHSs were improvised by themselves or the pupils.

The core mandate of the MOE/GES is to supply schools with enough manipulative materials. However, teachers receive very little from them because of inadequate funding. According to a headmaster,

> "*the only fund used by MOE/GES to supply schools with manipulative materials is through 'capitation' which is not enough and most times it is delayed to be received…once in a year*" (Headmaster, may, 2017). A teacher lamented this saying: "*this is the reason why some of us do not use manipulative materials to teach mathematics in class*" (Teacher, May, 2017).

Based on how often schools receive manipulative materials from the suppliers, Table 4.3 indicates that 58 (61.7%) teachers improvise manipulative materials termly, 4 (4.3%) yearly, 27 (28.7%) once a while and 5 (5.3%) not improvising at all. Confirming this, a teacher said

> "*I do improvise manipulative materials by myself because the office pay lip service to the supply of these manipulative materials forcing me to improvises any time I intent to use them in the classroo*m" (Teacher, May, 2017).

The results suggest that greater number of mathematics teachers in the municipality obtain their manipulative materials through improvising.

Table 4.3 further indicate that schools received manipulative materials termly 6 (6.4%), yearly 11 (11.7%), once a while 28 (29.8%) from MOE/GES and with no supply 49 (52.1%). Confirming this, the municipal mathematics coordinator said:

> "*since I entered into this office, I have never received any budgetary allocation for the supply of manipulative* materials *for teachers and when I ask the office, they simple tell me no funds has be allocated for that purpose and little can be done for now"*(Municipal Mathematics Coordinator May, 2017).

This suggests that the MOE/GES does not value the use of manipulative materials or is highly constraint to perform its duty of supplying manipulative materials to schools (Ministry of Education, 2012).

In addition, teachers obtain manipulative materials teamly 1(1.1%), yearly 4(4.3%), once a while 17(18.1%), and no supply 72(76.6%) from donations from NGOs and the Assembly. Also, few teachers indicate that they receive little supply of manipulative materials from PTA and other bodies termly 3 (3.2%), yearly 5(5.3%), once a while 21 (22.4%), and in most case no supply at all 65 (69.1%).

The results suggest that many teachers do not use manipulative materials in their classrooms and the few that use materials has to improvise. This means that improvisation plays a major role in the supply of manipulative materials for teaching mathematics in JHSs. The findings confirm Pham (2015) assertion that, many teachers do not use manipulative materials in teaching because they are not available in schools.

4.4 What are the Teaching Methods JHS Teachers Used in Teaching Mathematics with the Use of Manipulative Materials in the Wa Municipality?

To determine the methods JHS used in teaching mathematics with the use of manipulative materials in the classroom, Section "D" of the questionnaire asked teachers to select the methods they use when teaching mathematics with manipulative materials. Teachers' responses were organised and presented in a bar graph in Figure 4.2.

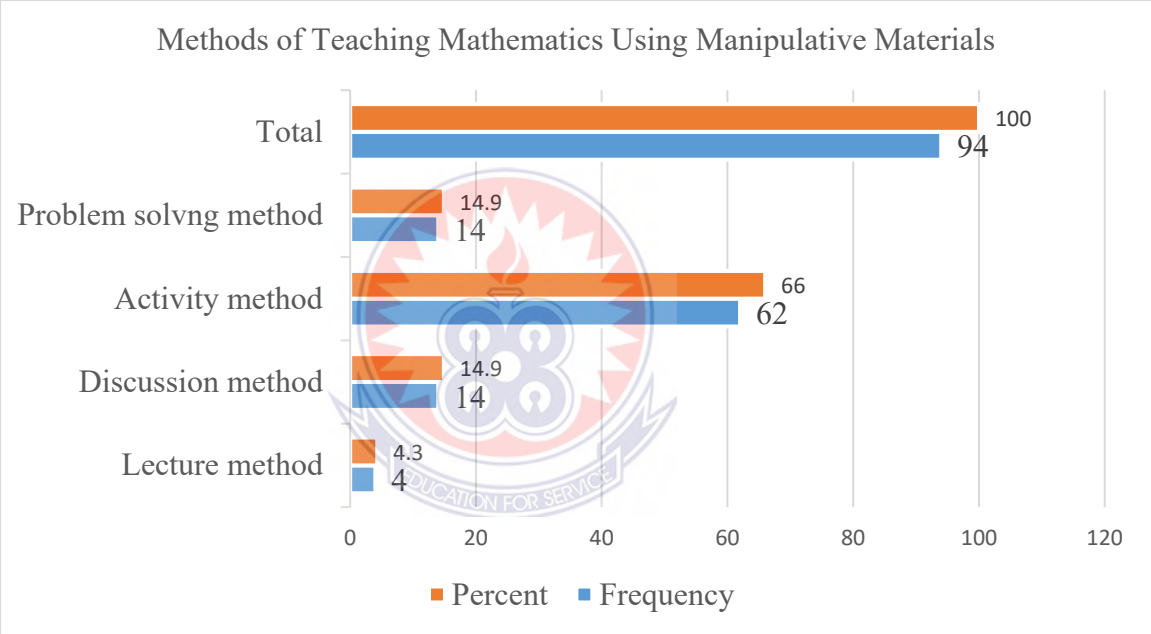


Figure 4.2: Teaching methods JHS teachers use in teaching mathematics using manipulative materials.

Source: This Study Field Survey, May, 2017

Figure 4.2shows that almost two-thirds 62 (66.0%) of the teachers indicated they use 'activity method' to teach mathematics with the aid of manipulative materials. Few 14 (14.9%) indicated they used discussion to teach mathematics with the aid of manipulative materials, also 14 (14.9%) of teachers indicate they used problem

solving to teach mathematics with the aid of manipulative materials and only 4(4.3%) used the lecture methods.

To probe more into methods used by JHS teachers in teaching mathematics using manipulative materials, an interview with teachers, headteachers and the Wa municipal mathematics coordinator came out with the following responses

> "*activity method of teaching mathematics is interactive and help pupils to understand concepts or topics well*" (Teacher, May, 2017).
>
> "*I make sure my teachers use the right methods in teaching and learning in the classroom. In the case of mathematics, I ensures my teachers use the activity method and problem solving method to teach the children because these methods are child- centred"* (Headteacher, May, 2017).
>
> "*with manipulative materials, teachers use the activity method but without manipulative materials, teachers used the discussion and lecture methods which I am strongly against, because lecture method especial is not a good method to be used for pupils at their level*" (Headteacher, May, 2017).
>
> *"I hardly visit teachers in the classroom to ensure the right methods are used, but trust me during workshops and in-service training for these teachers, we educate them to use the activity method, problem solving method in teaching mathematics. The use of these methods involves the child in the lesson"* (Mathematics coordinator,May, 2017).

Though assertions from the questionnaires and interview that activity method is used when teaching mathematics with manipulative materials, findings from the sit-in-observation proofed contrary to show that, among ten (10) schools purposively selected to visit; only one (1) teacher used activity method with manipulative materials in teaching probability (coin and die). While the remaining other teachers though stated in their lesson notes to use manipulative materials did not use them to teach pupils. In an interview with teachers, why they did not used manipulative materials and activity method or problem solving method of teaching, it was confirmed that,

> *"... activity or problem solving methods of teaching using manipulative materials is time consuming...also, most of us were not trained that way...therefore difficult for us to use...though stated in the syllabus*" (Teacher interview, may, 2017).

Another teacher state that

> "*I did not use manipulative materials stated in the lesson notes because there was no time and using manipulative materials takes too much of the lesson thus I used discussion method to teach topics more often*" (Teacher Interview, May, 2017).

Confirming the fact that, teachers were only fulfilling their mandatory requirement of stating they used manipulative materials in their lesson notes (Ministry of Education, 2012) at the blunt of deception.

Therefore, these confer on the fat that, teachers' refusal to use manipulative materials and the appropriate methodology in teaching mathematics affected pupils ability to understand mathematics and could be one of the reasons why many students hate and

fail mathematics, supporting the assertion that, the use of manipulative materials in teaching mathematics improves the performance of pupils (Skolverket, 2013). However, this could not yield result in this study because teachers' failed to exert physical actions on the manipulative materials stated (Cooper, 2012). As a result, pupils could not make acquisition of the mathematical symbols and language as contended (Rosli, Goldsby, & Capraro, 2015).

Therefore, the foregoing confer to the assertions that; most teachers failing to use manipulative materials (Fuchs et al., 2013) with the excuse that there is insufficient time and others consider manipulative materials as toys only to be used on special occasions or for a short period of time (Green, Flowers, & Piel, 2008).

4.5 JHS Teachers Perceived Benefits of Using Manipulative Materials in Teaching Mathematics

Section "D" of the questionnaire presented seven items Likert-Scale type statement for teachers to indicate their perceived position on the benefits of manipulative materials in teaching mathematics. Frequency counts were applied to teachers' responses and later converted into percentages as presented in Table 4.4.

Table 4.4: The Benefits of Using Manipulative materials for Mathematics Lessons in JHSs (n = 94)

Benefits of Using Manipulative materials	Agree	Disagree	Uncertain	Totals
The use of manipulative materials for mathematics lessons improves pupils easy understanding and they can construct their own knowledge of the subject easily	87(92.6%)	4(4.3%)	3 (3.2%)	94(100%)
The use of manipulative materials save a lot of time and more topics are easily covered	52(55.3%)	32(34.0%)	10(10.6%)	94(100%)
In using manipulative materials, pupils are motivated and their needs are attended to	70(74.5%)	17(18.1%)	7(7.4%)	94(100%)
Using manipulative makes pupils not to shy away from mathematics	75(79.8%)	10(10.6%)	9(9.6%)	94(100%)
The use of manipulative helps pupils to relate real world situations to mathematics symbolism	90(95.7%)	2(2.1%)	2(2.1%)	94(100%)
The use of manipulative helps pupils to work cooperatively in solving problems, discuss math's ideas and concepts	82(87.2%)	6(6.4%)	6 (6.4%)	94(100%)
Using manipulative is fun and easy way to introduce a mathematical concept	81(86.2%)	5(5.3%)	8 (8.5%)	94(100%)

Source: This Study Field Survey, May, 2017.

From Table 4.4, most teachers 90 (95.7%) are of the view that the use of manipulative materials in teaching mathematics helps pupils to learn how to relate real world situations to mathematics symbolisms. While few 2(2.1%) disagree and only 2 (2.1%) were uncertain This, a teacher confirmed in an interview saying:

> "*last week when I used doors, windows and cardboards to explain angles, the pupils understood the topic well…making the class interactive and active*".

Also, majority of teachers 87 (92.6%) agree, with few 4(4.3%) of the respondents disagreed and only 3(3.2%) not sure that using manipulative materials to teach mathematics help pupils to understand and construct their own knowledge of the

subject, while 82 (87.2%) were of the view the manipulative materials help the pupils to work collaboratively. However, where as slightly more than average 52 (55.3%) of the teachers agree that using manipulative materials for mathematics saves a lot of time, allowing teachers to cover many topics within a shorter possible period more than one-third 32 (34.0%) disagreed with that perception. This, a teacher explained as follows: "*manipulative materials rather waste their time when treating topics*" (Teacher, May, 2017). Similarly, more than three-quarters 75 (79.8%) of the teachers agree that using manipulative materials for mathematics made pupils not shy away from mathematics.

Also, majority 81 (86.2%) agree, with only 5 (5.3%) disagree and few 8 (8.5%) were uncertain that using manipulative makes mathematics' lessons interactive, fun and easy way to introduce mathematical concepts. A headteacher complemented this perception as expressed:

> "*teachers using manipulative materials to teach makes learning real, interactive for pupils understanding and makes teachers work easier*" (head teacher's interview, May, 2017).

An interview with the mathematics coordinator buttressed teachers perceived view of manipulative materials as helping tools for effective learning when he said:

> "*my brother, we all know that the used of manipulative materials helps in lesson delivery and helps improve pupil's performance in the subject. The teachers know this and that is why they indicate manipulative to be used in every lesson note they prepare"* (mathematics coordinator, May, 2017).

This confirms Cope's (2015) assertion that the use of manipulative materials in teaching mathematics motivates students in learning the subject and pupils can easily remember what they have learnt. However, to justify perceived benefits statements, hypotheses were tested to determine the extent to which teachers using manipulative materials affect pupils learning outcomes. A null hypothesis was used to run a one-sample chi-square test at alpha 0.05 and 95.0 confidence levels. The results of the tested hypotheses are presented in Table 4.4.1.

Table 4.4.1: Hypotheses testing on the extent of benefits of using Manipulative materials in teaching mathematics (n = 94)

Null Hypotheses	Test	Sig.	Decision
The categories of using manipulative materials for mathematics lessons improves pupils understanding and can construct their own knowledge of the subject easily occurs with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative materials saves a lot of time and more topics are easily covered occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative materials, pupils are motivated and their needs are attended to occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative materials makes pupils not to shy away from mathematics occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative materials helps pupils to relate real world situations to mathematics symbolism occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative materials helps pupils to work cooperatively in solving problems, discuss math's ideas and concepts occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of using manipulative is fun and easy way to introduce a mathematical concept occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses

Source: This Study Field Survey, May, 2017

**Asymptotic Significance are displayed. The Significance Level is 0.05.*

From Table 4.4.1, teachers' use of manipulative materials to teach mathematics has positive effect on the pupils learning outcomes. This, confirmed that; the categories of

using manipulative materials for mathematics lessons improves easy understanding and pupils can construct their own knowledge of the subject occurred with equal probabilities (sig. <0.05). The categories of using manipulative materials motivates pupils for their needs to be met occurred with equal probabilities (sig. <0.05).

The categories of using manipulative materials makes pupils not to shy away from mathematics' occurred with equal probabilities (sig. < 0.05). The categories of using manipulative materials in teaching mathematics' helps pupils learn to relate real world situation to math's symbolism occurred with equal probabilities (sig.< 0.05). The categories of using manipulative materials in teaching helps pupils to cooperatively solve problems, discuss mathematics ideas and concepts occurred with equal probabilities (sig. <0.05). In addition, the categories of using manipulative materials is fun and easy way to introduce a mathematics concept occurred with equal probabilities (sig. <0.05).

In an observation at a school where a teacher used manipulative materials to teach probability, the teacher shared her joy as expressed:

> *I was happy because the pupils understood almost everything I was doing. You can see from their results that pupils can solve problems on their own, you can see for yourself, they are scoring scored 5 out of 5 marks, looking at the exercise given to them.*

This confirms that pupils who failed a symbolic algebra assessment, scored 100% when manipulative materials were used (Goracke, 2009) and teachers' use of manipulative materials makes abstract ideas concrete for learners and thereby, making way for conceptual understanding by pupils (Skolverket, 2013).

In contrast, to an observation made in a school where manipulative materials were not used, the pupils did not understand the lesson well. Out of the 31 pupils in the class only 9 pupils scored 2 out of 5 with only one (1) student scoring 5 out of 5 marks. This suggests that failing to use manipulative materials affects pupils learning outcomes and a disincentive to pupils' performance in mathematics. However, the bottom line question asked here is that, "if teachers know all these positive benefits of how the use of manipulative materials affects pupils understanding of mathematics concepts, why was it that in practice, manipulative materials were largely ignored?

4.6 JHS Teachers Challenges in Using Manipulative Materials in Teaching Mathematics in the Wa Municipality

Research Question 5 sought to identify the challenges JHS teachers face in using manipulative materials in teaching mathematics. Eight Likert-scale type statements with three options –Agree, Disagree and Uncertain–were administered to teachers to indicate the option that best reflects their opinions. Frequency counts were applied to teachers' responses to each item and later converted into percentages as presented in Table 4.5.

Table 4.5: JHSs Teachers challenges in using manipulative materials in teaching Mathematics in the municipality

Challenges of Using Manipulative materials	Agree	Disagree	uncertain	Totals
Teachers little knowledge as to the use of manipulative materials	12(12.8%)	67(71.3%)	15(16.0)	94(100%)
Non-availability & inadequacy of manipulative materials in schools	57(60.6%)	25(26.6%)	12(12.8%)	94(100%)
Lack of continuous professional training for teachers as to the use of manipulative materials	66(70.2%)	(19.1%)	10(10.6%)	94(100%)
Inadequate user guide on the use of manipulative materials	55(58.5%)	28(29.8%)	11(11.7%)	94(100%)
Many work load prevents teachers from using manipulative materials	26(27.7%)	60(63.8%)	8 (8.5%)	94(100%)
Large class size affects teachers not to use manipulative materials	38(40.4%)	46(48.9%)	10(10.6%)	94(100%)
Time allocated for math's instruction is too short for teachers to use manipulative materials	34(36.2%)	54(57.4%)	6 (6.4%)	94(100%)
High cost of preparing some manipulative materials prevents teachers from using manipulative materials	61(64.9%)	29(30.9%)	4 (4.3%)	94(100%)

Source: This Study Field Survey, May, 2017

From Table 4.5, many issues challenged teachers' use of manipulative materials in teaching mathematics in JHS classroom. Majority of teachers agreed that lack of continuous professional training (70.2%), high cost of preparing some materials (64.9%), and non-availability or adequacy of manipulative materials in schools (60.6%) challenge their use of manipulative materials in the mathematics classroom. In addition, 58.5% of the teachers thought that inadequate guidance on the use manipulative materials is a challenge.

Surprisingly, teachers disagreed that limited knowledge (71.3%), high workload (63.8%), and allocated instructional time (57.4%) pose a challenge to the use of manipulative materials in the classroom. Interestingly, while 40.4% of the teachers indicated the large class size is challenge, 48.9% of them disagreed.

In an interview with the teachers and headmaster, a teacher asserted that,

> "*at times teachers do not use manipulative materials because they lack the interest…while some find it difficult anytime they tried…coupled with funding issues challenging its supply"(A Teacher)*.

Also, the mathematics coordinator shared the view that:

> "*lack of knowledge is the reason why some teacher run away from the used of manipulative materials in teaching mathematics and the office lacks the funds to organised continues professional training for teachers in this area*" (Mathematics Coordinator, May, 2017).

This suggests that teachers are challenged by several factors in the use of manipulative materials in teaching. Thus, confirmed the suggestion by Swan and Marshall(2010) that many teachers do not use manipulative materials because they did not understand how manipulative materials are used and also these materials are not use because the not adequate in the various schools

4.6.1 Testing of Hypotheses on the Challenges Teachers Faced in Using Manipulative materials in Teaching Mathematics

Similarly, to confirm the extent to which teachers were challenged in using manipulative materials, hypotheses were tested using one sample chi-square test at 0.05 alpha level. A summary of the results of the test are as presented in Table 4.5.1

Table 4.5.1: Summary of results on testing hypotheses

Null Hypotheses	Test	Sig.	Decision
The categories of teachers little knowledge as to the use of manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of non-availability & inadequacy of manipulative materials in schools occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories lack of continuous professional training for teachers as to the use of manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of inadequate user guide on the use of manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of many work load prevents teachers from using manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of large class size affects teachers not to use manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of time allocated for math's instruction is too short for teachers to use manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses
The categories of high cost of preparing some manipulative materials prevents teachers from using manipulative materials occur with equal probabilities	One sample Chi-square test	0.000*	Reject the null hypotheses

Source: This Study Field Survey, May, 2017

**Asymptotic Significance are Displayed. The Significance Level is 0.05.*

From the test results in Table 4.5.1, teachers did not use manipulative materials in teaching mathematics because they were challenged in several ways to include; inadequate supply of manipulative materials to teachers, lack of continuous professional training, and inadequate user guide for teachers on the use of manipulative materials and high cost in preparing manipulative materials. Whilst others like teachers little knowledge as to the use of manipulative materials, too much work load on teachers and large class size affected teachers not to use manipulative materials in teaching mathematics were least the challenge.

The test showed that the categories of teachers' little knowledge in using manipulative materials occurred with equal probabilities (sig. <0.05). The categories of non-availability or inadequacy of manipulative materials for teaching mathematics

occurred with equal probabilities (sig. <0.05). The categories of no-professional training for teachers on the use of manipulative materials occurred with equal probabilities (sig. <0.05). The categories of no or little adequate guide on the use of manipulative materials occurred with equal probabilities (sig. <0.05). The categories of too much workload prevented teachers from the use of manipulative materials occurred with equal probabilities (sig. <0.05). In addition, the categories of large class size limited teachers to use manipulative materials occurred with equal probabilities (sig. <0.05). Similarly, the categories of time allocated for mathematics was too short to use manipulative materials occurred with equal probabilities (sig. <0.05) and finally, the categories of high cost of preparing some manipulative materials prevented teachers from using them in class to teach mathematics occurred with equal probabilities (sig. <0.05).

Therefore, in conclusion, it could be said that; though the perceived thoughts of teachers to have been using manipulative materials in teaching mathematics, in reality, this proofed contrary due to the foregoing challenges. Yet, teachers, headteachers and mathematics coordinate found the use of manipulative materials to be beneficial to the learning outcomes of pupils gaining increased understanding in mathematical concepts among the perspectives. Suggesting that, the use of manipulative materials in teaching mathematics subject has significant positive (sig. <0.05) and negative (sig. <0.05) consequences for pupils in JHSs to understanding mathematical concepts if used and not used respectively. Thus, the use of manipulative materials for teaching mathematics was observed as a key area MOE/GES should place focus on to improve pupils understanding of mathematical concepts or ideas in basic schools. Supporting, the reasons why, the MOE has made it

mandatory for mathematics teachers to use manipulative materials in teaching mathematics in JHS (Ministry of Education, 2012).

CHAPTER FIVE

SUMMARYOF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The study examined the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality. Specifically, the study investigated on the following objectives:

- The types of manipulative materials used by teachers in teaching mathematics in JHSs;
- How manipulative materials are obtained for teaching mathematics;
- The methods JHS teachers used in teaching mathematics with the use of manipulative materials in teaching mathematics;
- The benefits of using manipulative materials in teaching mathematics;
- The challenges faced by teachers to using manipulative materials in teaching mathematics in JHSs in the Wa Municipality.

Using questionnaires, interviews and observations, data were collected from a sample of 94 teachers, 10 headteachers and a municipal mathematics coordinator. Data collected were analysed using descriptive statistics and hypotheses tested using one sample chi-square test at 0.05 alpha level of 95.0 confidence level. The results of the analysis is presented and discussed in Chapter 4. This chapter presents a summary of the research findings, conclusions drawn and the recommendations made.

5.1Summary of Findings

The study leaned on the fact that, using manipulative materials to teaching mathematics improves pupils ability to appreciate mathematical concepts as a result the MOE/GES require all mathematics teachers to use manipulative materials to teach mathematics in JHSs. Though the credit on the use of manipulative materials held by MOE/GES and teachers, little empirical evidence exist to demonstrate teachers' perceived and actual use of manipulative materials, its benefits to learning outcomes and the challenges faced by teachers in the use of manipulative materials in teaching mathematics.

5.1.1 Types of Manipulative Materials Use in Teaching Mathematics in JHSs

The study found that, majority of the teachers were only perceived to have been using manipulative materials in teaching. But in reality as observed through the sit-in observation by the researcher, the findings proofed contrary that, many teachers rather did not used the stated manipulative materials in their lesson note books.

5.1.2 How JHS Teachers Obtain Manipulative Materials for Teaching Mathematics in the Municipality

The findings was that, in many times where manipulative materials were used, they were improvised by teachers or pupils often with little supply from the MOE/GES and other benevolent groups like NGOs, Assembly, PTA and philanthropist normally either received termly, yearly or once a while. The MOE/GES insufficiency and inability to supply manipulative materials to schools is as a result of inadequate funding from government. Because, as current, the only source of funding by government for providing manipulative materials to schools is through "capitation grants" which takes years to be processed and approved. Therefore, these factors

compelled many teachers to ignore the use of manipulative materials in teaching mathematics in JHSs though some teachers, pupils' effort to improvise on their own, and supplements from benevolent groups.

5.1.3 The methods JHS Teachers Used in Teaching Mathematics with the Use of Manipulative Materials;

The study found that, majority of the teachers were only perceived to have been using activity method and problems solving method to teach pupils with the use of manipulative materials. But in reality as observed through the sit-in observation by the researcher, the findings proofed contrary that, many teachers rather did not used the stated manipulative materials in their lesson note books and taught pupils in a discussion or lecture mode though some teachers did used manipulative materials through activity method or problem solving teaching methodologies. As a result, many pupils did not understood the topics taught by teachers who did not used manipulative materials.

5.1.4 The benefits of Using Manipulative Materials in Teaching Mathematics in JHS

In addition, the study found that, teachers' use of manipulative materials in teaching mathematics in JHS was beneficial to pupils learning outcome in several ways. These include; manipulative materials improve pupils understanding and help them to construct their own knowledge of the subject easily, it saves a lot of time and allows teachers to cover more topics easily, motivates pupils and helps bring on boards their needs to be met. These help pupils not to shy away from mathematics but are able to relate real world situation to mathematical symbolisms, allowing pupils to work cooperatively in solving problems, mathematics ideas and concepts. Thus, makes

mathematics to be fun and easy way for teachers to introduce concepts. Therefore, the hypotheses confirmed that, teachers' use of manipulative materials to teach mathematics in JHS has positive effect on the pupils learning outcomes.

5.1.5 The Challenges Faced by Teachers in the Use of Manipulative Materials in JHS

Here, the findings were that, several factors could challenge teachers not to use manipulative materials in teaching mathematics in JHSs. However, the most significant one's includes; the non-availability and inadequacy of manipulative materials supplied to schools for teachers, high cost of preparing some manipulative materials for teaching and lack of continuous professional training for teachers in using manipulative materials for mathematics concepts. Because majority of the teachers disagreed that manipulative materials are not used because they had little knowledge as to the use of manipulative materials in teaching mathematics. Also majority of teachers disagreed that because teachers had no adequate user guide on the use of manipulative materials is the reasons they do not use manipulative materials. Similarly, teachers disagreed to say, "large class size and more work load on teachers prevented from using manipulative materials" though seemly close of the respondents agreed. These, the hypotheses also confirmed that, teachers did not use manipulative materials in teaching mathematics because they were challenged in several ways to include; inadequate supply of manipulative materials to teachers, lack of continuous professional training, inadequate user guide for teachers on the use of manipulative materials and high cost in preparing manipulative materials (sig.<0.05). Whilst others like teachers little knowledge as to the use of manipulative materials, too much work load on teachers and large class size affected teachers not to use manipulative materials in teaching mathematics were least the challenge (sig. <0.05).

5.2 Conclusion

The research examined the use of manipulative materials in teaching mathematics among junior high school teachers in the Wa municipality. The researcher suggests that where teachers perceived thought of using manipulative materials in teaching mathematics in JHSs were far from the truth in practicality, there is the need for authorities to relook at the situation and ensure a balance so that theories reflect the practicability of best teaching methodologies and strategies. Therefore, in dealing with teachers perception to reflect their practice, MOE/GES and school heads would have to strengthen supervision and monitoring to ensure that teachers used the best and appropriate tools and teaching methodologies to deliver lessons as demonstrated in their lesson note books. By so doing, the MOE/GES and other stakeholders like NGOs, Assembly, PTA, Philanthropist and Old school unions should be robust in the supply of teaching and learning kids like manipulative materials to enable teachers deliver their best for pupils understanding and learning outcomes. Because, findings on the benefits of manipulative on learning outcomes suggest that; teachers use of manipulative materials aids pupils to understand mathematics concepts easily, builds cooperative learning among themselves and help them relate real world situations with mathematical concepts and among others. However, these have largely not been achieved because teachers did not get regular supply of manipulative materials from the stakeholders, coupled with no continuous professional training and user guide as to the use manipulative materials in teaching mathematics.

As a result of the foregoing, made teachers to suffer high cost in the preparation of manipulative materials for teachers as teachers and pupils turn to improvise manipulative materials by themselves. These finally affected many teachers in the Wa

Municipality not to use manipulative materials in teaching mathematics topics though always stated in the lesson notebooks.

Notwithstanding, the study confirmed Piaget's stages of cognitive development which states that children finds themselves in the use of concrete operational activities which are demonstrated through the use of manipulative materials in teaching mathematics. Hence, in order to reap the full benefits of manipulative materials, by learning, teachers need to develop a classroom environment that are stimulating, interesting and complex enough to nurture pupils into higher order thinking. Meaning, pupils should be allowed to discover ideas by themselves using manipulative materials.

5.3 Recommendations

The study made discoveries on teachers' perception and use of manipulative materials in teaching mathematics in JHSs in the Wa Municipality. A number of issues were identified and if addressed would enhance teachers' use of manipulative materials in teaching mathematics in JHSs and improve learning outcomes of pupils in the Wa Municipality. They will also help to overcome the challenge faced by teachers in the use of manipulative materials while making pupils to embrace mathematical concepts as an everyday activity. The following are suggested recommendations to help address the issues identified:

1. Teachers perceived used of manipulative materials were found to be at variance their practice in the classroom. This could be attributed to inadequate supply of manipulative materials compelling teachers to improvise. To curtail this, it is recommended that, the MOE/GES and other benevolent groups like NGOs, PTA, Philanthropist and Old school unions who provide support in the supply of manipulative materials to schools

boost up their supply frequently to make manipulative materials available for teachers use. Also, organise in-service training for teachers as to the use and formation of manipulative materials.

2. Then after, it is recommended that, the MOE/GES, circuit supervisors and headteachers strengthen supervision and monitoring to ensure that teachers used the manipulative in teaching mathematics in JHSs; regularly among headteachers (once every week), circuit supervisors (once every two weeks), and MOE/GES (once a team).

3. In addition, it is recommended that, same supervision and monitoring be ensured to make sure that teachers used the right teaching methodology – either the activity or problem solving methods in teaching mathematics in JHSs than the lecture and discussion methods.

4. Again, it is recommended that, the MOE/GES roll out continuous professional user guide training for teachers as to the use of manipulative materials in teaching mathematics in JHSs to upgrade their skills and teaching methods. These all are necessary to help increase the benefits of teachers' using manipulative materials in teaching mathematics in JHSs for a robust teaching and learning outcomes between teachers and pupils.

REFERENCES

Adu-Yeboah, C. (2008). *Transacting the social studies programmeme in junior high schools in the Obuasi Municipality in the Ashanti Region of Ghana*. MPhil. Thesis. Department of Basic Education of the Faculty of Education. University of Cape Coast, Ghana.

Agudzeamegah A. (2014). *Developing three-dimensional instructional materials from locally available resources for science education in primary schools, Ghana*: B.A. Industrial Art Thesis, A thesis submitted to the School of Graduate Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Alghazo, I., Alsawaie, O., & Al-Awidi, H. (2010). Enhancing counting skills of preschoolers through the used computer technology and manipulative materials. *International Journal of Learning, 17*(9), 159-176.

Alhassan E. (2012).*Gender Access Gap:* Factors affecting gender disparity in enrolment and attendance in basic schools in Northern Region of Ghana. PhD Thesis. Published by University of Ghana. (www.ug.edu.gh)

Anna J. &Plan B. P. (2015). Manipulative materials in the Math Classroom. Required for the Degree in Masters of Montessori Education, University of Wisconsin-River Falls

Annum, G. (2015). *Research instrument for data collection.* Kumasi. Page 1-4

Asare-Forjour, E. (2009). *Development of a methodology in drawing for students in the department of publishing studies.* KNUST(Doctoral Thesis). Department of General Art Studies, Kwame Nkrumah University of Science and Technology, Ghana.

Babbie, E. R. (1990). *Survey research methods*. Belmont, CA: Wadsworth.

Best, J. W., & Khan, J. V. (1993). *Research in education* (7th ed). Boston: Allyn and Bacon.

Bligh, D. (2002). *What is the Use of Lectures*? San Francisco: Jossey Bass.

Boggan, M., Harper, S., & Whitmire, A. (2010). Using manipulative materials to teach elementary mathematics. *Journal of Instructional Pedagogies*, 31-6.

Bouck, E. C., & Flanagan, S. M. (2010).Virtual manipulative materials: What they are and how teachers can use them. *Intervention in School and Clinic, 45*(3), 186-191.

Brooke E. B. (2014). *The effectiveness of manipulative materials in a high school Algebra Ii Class.* Bachelor of Science project work, Ball State University, Muncie, Indiana.

Brown, A. B. (2012). Non-traditional pre-service teachers and their mathematics efficacy beliefs. *School Science & Mathematics, 112*(3), 191–198.

Burns, N., & Grove, S. K. (2009). *The practice of nursing research: Appraisal, synthesis, and generation of evidence* (6th ed). St. Louis, Missouri: Elseviers

Carbonneau K. J., Marley S. C., & Selig J. P. (2013).A meta-analysis of the efficacy of teaching mathematics with concrete manipulative materials. *Journal of Educational Psychology, 105,* 380-400.

Chang, K. (2008). Study suggests math teachers scrap balls and slices. *New York Times.* Retrieved September 10, 2016, from http: *//www.nytimes.com/2008/04/25/science/25math.html*

Chang, W. L., Yuan, Y., Lee, C. Y., Chen, M. H., & Huang, W. G. (2013).Using Magic Board as a teaching aid in third grader learning of area concepts. *Educational Technology and Society, 16*(2), 163-173.

Charles-Ogan, G. I. & Otikor, M. S., (2016). Practical utility of mathematics concepts among senior secondary school students in rivers state. *European Journal of Mathematics and Computer Science*, *3* (1), 2059-9951.

Cohen, L., Manion, L.,& Morrison, K. (2008). *Research methods in education* (6th ed). USA: Routledge.

Coleman, R., & Goldberg, C. (2010). What does research say about effective practices for English learners? *Kappa Delta*, *46* (1), 10.

Continuing Professional Developmnt Review Group. (2007). *Continuing professional developmnt (CPD:* What do specialist do in CPD programmes for which there is evidence of positive outcome for pupils an teachers? Retrieved from http://eppi.ioe.ac.uk/cms/LinkClick.aspx?fileticket=27_OKOKeWnl%3D&tabid=2275&mid=4198.

Cooper, T. E. (2012). Using Virtual Manipulative materials with Pre-Service Mathematics Teachers to Create Representational Models. *International Journal for Technology in Mathematics Education*, 19(3), 105-115.

Cope, L. (2015). "Math Manipulative materials: Making the Abstract Tangible", *Delta Journal of Education*, *5* (1), 11.

Cramer, K., Behr, M., Post T., Lesh, R., (2009). *Rational Number Project: Initial fraction ideas*. Originally published in 1997 as *Rational Number Project: Fraction lessons for the middle grades - Level 1.*Dubuque, IA: Kendall/Hunt Publishing

Creswell, J. W. & Garrett, A. L. (2008). The "movement" of mixed methods research and the role of educators. *South Africa Journal of Education*, *28* (3), 321-333.

Creswell, J. W. (2008). *Educational research planning, conducting and evaluating quantitative and qualitative research*, (3rd ed.). New Jersey: Pearson Education.

Creswell, J. W. (2009). *Research Design: Qualitative, and mixed approaches*. Thousand Oaks, CA: Sage Publications.

DeLoache, J. S., Peralta de Mendoza, O. A., & Anderson, K. N. (1999). Multiple factors in early symbol use: Instructions, similarity, and age in understanding a symbol-referent relation. *Cognitive Development*, *14*, 299-312.

Dennis, C. (2011). *The effects of the use of manipulative materials on the comprehension of math concepts among fifth-grade students*. (Order No. 3492172, North central University). ProQuest Dissertations and Theses, 115. Retrieved fromhttp://search.proquest.com/docview/915645190?accountid=14771.

Dorward, J. (2002). Intuition and research: Are they compatible? *Teaching Children Mathematics, 8(6), 329-332.*

Elida V. L., Jamilah R. J., Carolyn D., & Angela K. M., (2015). What Makes Mathematics Manipulative materials Effective? Lessons from Cognitive Science and Montessori Education. *SAGE Open, 5*(2), 2158244015589588; DOI: 10.1177/2158244015589588.

Federal Republic of Nigeria (2014). National policy on education, Lagos: Nigerian Educational Research and Development Council Press**.**

Ferreira, M., M., &Trudel, A., R. (2012). The impact of problem-based learning (PBL) on students' attitudes towards science, problem-solving skills, and sense of community in the classroom. *Journal of Classroom Interaction*, *47*(1), 23-30.

Fink, A. (2003). *How to sample in surveys*, London, (Thousand Oaks):Sage

Florence, H. (2012). *The effects of Mathematics manipulative materials*. Retrieved September, 19, 2016 from http://www.ehow.com/info_8040301_effects-Mathematics-manipulative materials.html

Francis-Poscente, K., & Jacobsen, M. (2013). Synchronous online collaborative professional development for elementary mathematics teachers. *International Review of Research in Open & Distance Learning, 14*(3), 319-343. Retrieved from*http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=89237264&sc.*

Fuchs, L. S., Schumacher, R. F., Long, J., Namkung, J., Hamlett, C. L., Jordan, N. C., & Changas, P. (2013). Improving at risk learners' understanding of fractions. *Journal of Educational Psychology,* (3), 683.

Fyfe, E. R., & McNeil, N. M. (2009). *Benefits of "concreteness fading" for children with low knowledge of mathematical equivalence*. Poster presented at the Cognitive Development Society, San Antonio, TX.

Fyfe, E. R., McNeil, N. M., Son, J. Y., & Goldstone, R.L. (2014). Concreteness fading in mathematics and science instruction: A systematic review. *Educational Psychology Review,* 26*, 9-25.*

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice.* New York: Teachers College Press.

Ghana Education Service (2016). Report on analysis of the BECE results from 2014 to 2016 of the Wa Municipality. Wa Municipal Education Service report. Unpublished

Goldenkoff, R. (2004). Using focus groups. In J. S. Wholey, H. P. Hatry & K.E. Newcomer (Eds.), *Handbook of practical program evaluation* (2nd ed., pp. 340-362). San Francisco: Jossey-Bass.

Goracke, M. A. (2009). *The role of manipulative materials in the eighth grade mathematics classroom master's action research project*. University of Nebraska, Lincoln, NE. Retrieved from:http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1022&context=mathmidactionreseach

Green, M., Flowers, C., & Piel, J. (2008). Reversing education majors' arithmetic misconceptions with short-term instruction using manipulative materials. *Journal of Educational Research* (Washington, D.C.), *101*(4), 234-42.Retrieved from Education Full Text databases.

Hawkins, V. H. (2007). *The effects of Mathematics manipulative materials on student achievement in Mathematics.* Retrieved from http://books.google.com.au/books?id=1W5Shy78OG4C&printsec=frontcover&dq=Mathematics+manipulative materials&source=bl&ots=standard deviationJWGyE6WY&sig=qgtlMwRCsYUZ54tE9RY0WbtftSA&hl=en&sa=X&ei=VItRUMoXicyYBbfcgKgP&redir_esc=y#v=onepage&q&f=false

Hayes, W. (2011). Glossary of Research Terms. Retrieved August, 2016 from https:// www.hayesinc.com/hayes/wp-content/uploads/2011/07/Glossary-of-ResearchTerms-7-25-2011-FINAL.pdf.

Hollins, E. R. (2011). Teacher Preparation for Quality Teaching. *Journal of Teacher Education*,*62*, 395.

Hussain, S., Anwar, S. & Majoka, M. I. (2011). Effect of peer group activity-based learning on students' academic achievement in physics at secondary level. *International Journal of Academic Research*, *3*(1), 940-944.

Huze, E. (2011). A Comparative Study of the Teaching and Learning of Basic Design and Technology in Private and Public Schools (A Case Study of Junior High Schools in the Ejisu-Juaben Municipality), MA Thesis. Department of General Art Studies, Kwame Nkrumah University of Science and Technology, Ghana.

Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., & Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *Journal of Experimental Child Psychology*, 116(1), 45-58.

Kelly, C. A. (2006). Using manipulative materials in mathematical problem solving: A performance based analysis [Electronic version]. *The Montana Mathematics Enthusiast, 3*(2), 184-193

Kentucky Center for Mathematics (2012). Using manipulative materials to improve performances. Retrieved from *http://kentuckyMathematics.org/manipulative materials.php.*

Kizlik, B. (2013). *Instructional methods information*. Retrieved August 2, 2016 from *http://www.adprima.com/teachmeth.htm.*

Kombo, D.K. & Tromp, D. L. A. (2006). *Proposal and thesis writing: An introduction.* Nairobi:Paulines Publishers Africa.

Krueger, R. A. (1988). *Focus group: A practical guide for applied research*. Thousand Oaks, Sage.

Kusi H. (2012). *Qualitative Research: A Guide for Researchers.* Emmpong Press. Accra, Ghana.

Landman, W. G., (2009). *Manipulative materials in secondary school mathematics. Dept of mathematics and statistics.* Pomona: California State Polytechnic University.

Laski E. V., & Siegler R. S. (2014). Learning from number board games: You learn what you encode. *Developmental Psychology, 50*, 853-864.

Lee, C.-Y., & Chen, M. J. (2015). Effects of worked examples using manipulative materials on fifth graders' learning performance and attitude toward mathematics. *Educational Technology & Society*, *18*(1), 264–275.

Leikin, R., & Levav-Waynberg, A. (2007). Exploring mathematics teacher knowledge to explain the gap between theory-based recommendations and school practice in the use of connecting tasks. *Educational Studies in Mathematics, 66*, 349-371.

Lemanski, T. & Overton, T. (2011). UK Physical Sciences Centre: An Introduction to Qualitative Research. Retrieved November 30, 2016 from http://www.heacademy.ac.uk/assets/ps /documents /primers/primers/qualitative_research.pdf.

Manches, A., O'Malley, C., & Benford, S. (2010). The role of physical representations in solving number problems: A comparision of young children's use of physical and virtual materials. *Computers & Education*, *54*, 622-640.

Martin T. (2009). A theory of physically distributed learning: How external environments and internal states interact in mathematics learning. *Child Development Perspectives, 3*, 140-144.

McIntosh, G. V. (2012). *Testing instrumentation validity for measuring teachers' attitudes toward manipulative use in the elementary classroom*. Retrieved from http://search.proquest.com/docview/1312423428?accountid=14771

McLeod, J. (2012). Conceptual visibility and virtual dynamics in technology-scaf folded learning environments for conceptual knowledge of mathematics. *The Journal of Computers in Mathematics and Science Teaching, 31*(3), 283; 283-310; 310.

McNeil N. M. & Jarvin L. (2007). When theories don't add up: Disentangling the manipulative materials debate. *Theory into Practice, 46,* 309-316.

McNeil N. M., Uttal D. H., Jarvin L., & Sternberg R. J. (2009). Should you show me the money? Concrete objects both hurt and help performance on mathematics problems. *Learning and Instruction, 19*, 171-184.

McNeil, N. M. & Uttal D. H. *(2009).* Rethinking the use of concrete materials in learning: Perspectives from development and education. *Child Development Perspectives, 3,* 137-139.

Ministry of Education (2012), National Syllabus for Mathematics: Junior High School (1-3). Curriculum Research and Development Division (CRDD), Accra, Ghana.

Mohd, M., & Mohd, B. N. (2010). The effect of using manipulative materials on the Mathematical Achievement of the First Grade Students: *Damascus University Journal*,*26*(4), 37-54.

Morrison, M. (2011). Math tracks: What pace in math is best for the middle school child? *Montessori Life, 23*(4), 26-35.

Moyer, P., Niezgoda, D., & Stanley, M. (2005). Young children's use of virtual manipulative materials and other forms of mathematical representation. In W. Masalski& P. Elliott (Eds.), *Technology-supported mathematics learning environments* (pp. 17-34). Reston, VA: NCTM

Munger, D. (2007). *Children learn and retain math better using manipulative materials.* Retrieved November 19, 2016, from http://scienceblogs.com/cognitivedaily/2007/10/children_learn_and_retain_math.php

Musser, G.L, Peterson, B.E., & Burger, W.F. (2014). *Mathematics for elementary teachers*: *A contemporary approach*, (10th ed.). Wiley.

National Council of Teachers of Mathematics (2008). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Governor's Association Center for Best Practices, & Council of Chief State School Officers (2010). *Common core state standards in mathematics.* Washington, DC: Authors.

O'Donnell, A., D'amico, M., Schmid F.R., Reeve, J., & Smith, J. (2008).*Educational Psychology: Reflection for Action*, (Canadian Ed.). John Wiley & Sons, Inc.

Obeng, A., (2013). *Teacher's guide mathematics for ghanaian schools, junior high school book 2*. Kumasi-Ghana: Approacher's (Ghana) Limited.

Osuala, E. C. (2005). *Introduction to research methodology*. Nigeria: African First Publishers Limited.

OUT (2010). Research methodology for postgraduate students. Dar es Salaam: OUT.

Owu-Ewie, C. (2011). *Learn to do research an introduction to research methods*. Winneba: University of Education, Winneba.

Parahoo, K. (2006). *Nursing research: Principles, process, and issues.* New York: Palgrave Macmillan.

Pham, S. (2015) Teachers' Perceptions on the Use of Math Manipulative materials in Elementary Classrooms. Master of Teaching Thesis, Ontario Institute for Studies in Education of the University of Toronto.

Piaget, J. (1952). *The child's concept of number*. New York: Humanities Press.

Polit, D.F., & Beck, C. T. (2004). *Nursing research: Appraising evidence for nursing practices* (7thed). Philadelphia: Wolters Kluwer Health/Lippincott William & Wilkins.

Polit, D.F., & Beck, C. T. (2012). *Nursing research: generating and assessing evidence for nursing practices*. Philadelphia: Wolters Kluwer Health/Lippincott William & Wilkins.

Richland, L. E. (2008). Gesturing to promote higher-order thinking cross-cultural differences. In *Proceedings of the Thirtieth Annual Conference of the Cognitive Science Society* (pp. 893-898). Austin, TX.

Rosli, R., Goldsby, D. & Capraro, M. (2015). Using Manipulative materials in Solving and Posing Mathematical Problems. *Creative Education*, *6*, 1718-1725.

Rystedt, E. & Trygg, L., (2010). *Laborativmatematikundervisning: vad vetvi*?. Göteborg: Nationellt centrum förmatematikutbildning, Göteborgsuniversitet.

Seefeldt, C., & Wasik, B. A. (2006). *Early education: three-, four-, and five-year-olds go to School* (2nded.). Upper Saddle River: Pearson Education.

Seidu A. (2015). *Writing a Theses: A guide for social science students*. Accra: Supreme Concept.

Shaw, J. M. (2002). Manipulatives enhance the learning of mathematics. Retrieved Mar 8, 2015, from *http://www.eduplace.com/state/pdf/author/shaw.pdf*

Siegler R. S., & Ramani G. B. *(2009).* Playing linear number board games—But not circular ones—Improves low-income preschoolers' numerical understanding. *Journal of Educational Psychology, 101*, 545-560.

Skolverket (2013). PISA 2012: 15-åringars kunskaperimatematik, läsförståelseochnaturvetenskap [PISA 2012: 15 year old students' knowledge in mathematics, reading and science] (Skolverkets rapport, 2013:398). Stockholm: Fritzes. Retrieved from *http://www.skolverket.se/statistik-och-utvardering/internationella-studier/pisa/kraftigforsamring-i-pisa-1.167616*

Smith, S. S. (2009). *Early Childhood Mathematics* (4thed.) Boston: Pearson Education Using manipulative materials (2009). Retrieved October 09, 2016, from:*http://www.teachervision.fen.com/pro-dev/teaching-methods/48934.html*

Sousa, D. (2008). *How the brain learns mathematics*. Thousand Oaks, CA: Corwin Press

Stößlein. M. (2009). *Activity-based learning experiences in quantitative research methodology for (Time-Constrained) young scholars course design and effectiveness.* POMS 20th Annual Conference, Orlando, Florida, U.S.A.

Sundstorm, K. (2012). How to teach basic Mathematics. *Journal of Instructional Pedagogies.* Retrieved from *http://www.aabri.com/manuscripts/10451.pdf.*Retrieved September, 12, 2012,

Swan, M., & Burkhardt, H. (2014). Lesson Design for Formative Assessment. *Educational Designer, 2*(7).This issue. Retrieved from:http://www.educationaldesigner.org/ed/volume2/issue7/article24

Swan, P. & Marshall, L., (2010). Revisiting mathematics manipulative materials. *Australian Primary Mathematics Classroom, 15*(2), 13-19.

Swirling, L. S. (2006). *The use of manipulative materials in Mathematics instruction*. Retrieved September, 12, 2016, from http://www.ldonline.org/spearswerling/The_Use_of_Manipulative materials_in_Mathematics_Instruction

Tamakloe, E. K., Amedahe, E. K. & Atta, E. T. (2005). *Principles and Methods of Teaching*. Accra: Ghana University Press.

Tavakol, M., & Dennick, R., (2011). Making sense of Cronbach's alpha.*International Journal of Medical Education, 2*, 53-55.

Uttal D., H. (2003) On the Relation Between Play and Symbolic Thought: The Case of Mathematics Manipulatives. *Information Age Publishing, Inc, 1-10.*

Uttal D., H., O'Doherty K., Newland R., Hand L., & DeLoache J. *(2009).* Dual representation and the linking of concrete and symbolic representations: I link therefore I am good at mathematics. *Child Development Perspectives, 3, 156-159.*

Van de Walle, J.A., Karp, K.S., & Bay Williams, J.M. (2013). *Elementary and middle school mathematics: Teaching developmentally*. (8th ed.). Boston: Pearson.

Vogt, P. W. (2007). *Quantitative research methods for professionals*. Boston, MA: Allyn and Bacon.

Wilkinson, D. & Birmingham, P. (2003). *Using research instruments: A guide for researchers*.New York, NY: RoutledgeFalmer. ISBN 0-415-2727-3.

Xie, L., Antle, A. N., & Motamedi, N. (2008). *Are tangibles more fun? Comparing children's enjoyment and engagement using physical, graphical and tangible user interfaces*. doi:10.1145/1347390.1347433

Zambo, R., & Zambo, D. (2008). The impact of professional development in mathematics on teachers' individual and collective efficacy: The stigma of underperforming. *Teacher Education Quarterly*, *35*(1), 159–168.

APPENDICES

APPENDIX A

QUESTIONNAIRE FOR TEACHERS

UNIVERSITY OF EDUCATION, WINNEBA

Dear Sir/Madam,

My name is Padmore Edward Abatanie. I am a student of the University of Education, Winneba**. I am exploring JHS teachers' perception and use of manipulative materials in teaching mathematics in the Wa municipal** as part of my MPhil programme me in the university. The attached questionnaire is for you as a teacher in the JHS to respond to. Your response will provide scientific on the use and challenges of using manipulative in the Municipality to inform policy-practice. Your accurate response and cooperation is very important for this study. The information collected will be treated as confidential and only be used for research purposes. For anonymity, do not write your name in the questionnaire.
Thanks for your kind cooperation**.**
Please read the following statements and kindly provide the information required.

SECTION A: Background information
Please tick [√] in the appropriate space provided below and supply answers where required.

1. Sex: (1) Male [ ] (2) Female [ ]
2. Age: 20yrs-25yrs [1] 26yrs-30yrs [2] 31yrs-35yrs [3] 36yrs-40yrs [4] Above 40 yrs [5]
3. Qualification: Diploma [1]. First Degree [2]. MED/MPhil [3]. If other(s) Please specify ……
4. Period teaching in the JHS: Less than 3 yrs [1] 3-8 yrs [2] 8- 15yrs [3] More than 15 yrs [4]
5. Period teaching mathematics in the JHS: Less than 3 yrs [1] 3-8 yrs [2] 8-15yrs [3] More than 15 yrs [4]

SECTION B: **Type of manipulative materials used in teaching the underlisted mathematics topics in your classroom**
The GES curriculum materials suggest the use of manipulative materials for teaching mathematics in the classroom .Below is a table of mathematics topics in the JHS syllabus and the types of manipulative materials suggested for teaching them. For each topic and the type of manipulative materials, they are three options -Agree [1] Uncertain [2] Disagree [3]. Choose the option that best reflects your opinion by ticking [√] either Agree [1] Uncertain [2] or Disagree [3] on the use of the manipulative materials for teaching the topics. If there are others that you use but are not in list, please list them in the space provided.

Topic	Types of Manipulative materials Used	1	2	3
6. Numbers and Numerals	Abacus, Colour-coded materials, Place value chart. Bug Counters **Others, please list……**			
7. Which among the above type of manipulative materials do you use in teaching ……. 8. Why the use?				
9. Sets	Stones, sticks, beans, maize, bottle tops, books pencils, pens, erasers, chalk, Attribute Blocks. **Others, please list……**			
10. Which among the above type of manipulative materials do you use in teaching sets……. 11. Why the use?				
12. Fractions	Strips of paper, Fraction charts, Addition machine tape, Cuisenaire rods, etc. **Others, please list** ……			
13. Which among the above type of manipulative materials do you use in teaching fractions 14. Why the use?				
15. Shape and Space	Empty chalk boxes, Cartons, Tins, Cut-out shapes from cards. Real objects, Solid shapes made from card boards: prisms -cubes, cuboids, cylinders; pyramids -rectangular, triangular and circular pyramids. **Others, please list** ……			
16. Which among the above type of manipulative materials do you use in teaching Shape and Space…… 17. Why the use?				
18. Length and Area	Geoboard, Graph paper, Rubber band Cut-out shapes, Thread, Graph Paper, Centimeter Cubes. **Others, please list** ……			
19. Which among the above type of manipulative materials do you use in teaching Length and Area…… 20. Why the use?				
21. Power of numbers	Counters, Bottle tops, stone, sticks, Base Ten Blocks etc Others, please list ……			
22. Which among the above type of manipulative materials do you use in teaching Power of Number…… 23. Why the use?				
24. Capacity, time, money and mass	Tea and Table spoons, Soft drink cans and bottles, Bucket Balance, Measuring cylinders, Jugs and Scale **Others, please list**……			
25. Which among the above type of manipulative materials do you use in teaching capacity, Time Money and Masss……				

26. Why the use?				
27. Angles	Protractor, compass, Cut-out triangles, stones, threads. **Others, please list** ……			
28. Which among the above type of manipulative materials do you use in teaching Angles 29. Why the use?				
30. Properties of quadrilaterals	Cut-out shapes (rectangles, parallelograms, kites, trapeziums and rhombus), AngLegs **Others, please list** ……			
31. Which among the above type of manipulative materials do you use in teaching Quadrilaterals. 32. Why the use?				
33. Probability	Coin, die or dice, stones. **Others, please list** ……			
34. Which among the above type of manipulative materials do you use in teaching Probability…… 35. Why the use?				
36. Vectors	Graph sheet, Protractor, Ruler. **Others, please list** ……			
37. Which among the above type of manipulative materials do you use in teaching Vectors 38. Why the use?				
39. Properties Of Polygons	Cut-out plane shapes, Protractor, Scissors and Graph sheets, AngLegs, Attribute Blocks **Others, please list**……			
40. Which among the above type of manipulative materials do you use in teaching Properties of Polygons…… 41. Why the use?				
42. Rigid Motion	Geoboard, Cut-out shapes, Mirror, Graph paper, Tracing paper **Others, please list**……			
43. Which among the above type of manipulative materials do you use in teaching Rigid Motion ……. 44. Why the use?				

SECTION C: HOW JHS TEACHERS OBTAIN MANIPULATIVE MATERIALS FOR TEACHING MATHEMATICS IN THE MUNICIPALITY

45. Which of the following sources do you mostly obtain your manipulative materials for teaching mathematics?
    (1). Improvisation by teachers and pupils. [ ] (2). Supply from MOE/GES. [ ] (3). Donations from NGOs and Wa municipal assembly. [ ] (4). PTA and Philanthropist. [ ]

46. If others, specify……

Indicate how frequent you receive/prepare the manipulative materials from the sources identified in question 45.

Sources of supply	Frequency of supply			
	No supply	Termly	Yearly	Once a while
47. Improvisation by teachers and pupils.				
48. Supply from MOE/GES				
49. Donations from NGOs and Wa municipal assembly.				
50. PTA and philanthropist.				
51. Others				

52. If 'No Supply' what limit/prevents you from obtaining these manipulative materials?

SECTION D: TEACHING METHOD JHS TEACHERS USE FOR TEACHING MATHEMATICS WITH MANIPULATIVE IN THE MUNICIPALITY

53. In teaching mathematics with manipulative materials, which teaching methods do you use most?
    (1) Lecture Method [ ] (2) Discussion Method [ ]
    (3) Activity Method [ ] (4) Problem solving method [ ]

If others, please specify ……..

SECTION E: BENEFITS OF USING MANIPULATIVE MATERIALS IN TEACHING MATHEMATICSIN THE MUNICIPALITY

Below is a table identifying the benefits of using manipulative materials in teaching mathematics. For each benefit, there are three options- Agree (1). Disagree (2). Uncertian (3). To what extent do you either Agree (1). Disagree (2). or Uncertain (3), these best reflects your opinion on the benefits of using manipulative materials in teaching mathematics in you classroom. Ticking [√] appropriately.

BENEFITS OF MANIPULATIVE MATERIALS	1	2	3
54. The use of manipulative materials for mathematics lessons improves easy understanding and pupils can construct their own knowledge of the subject easily.			
55. Using manipulative materials for mathematics lessons safe a lot of time and more topics are easily covered.			
56. With the use of manipulative materials all pupils' are motivated and their needs are attended to.			
57. The use of manipulative materials will make pupils not shy away from mathematics.			
58. The use of manipulative materials in teaching mathematics will help pupils learn to relate real world situations to mathematics symbolism.			
59. The use of manipulative materials in teaching mathematics helps pupils to work cooperatively in solving problems, discuss mathematical ideas and concepts.			
60. The use of manipulative materials is a fun and easy way to introduce a mathematical concept.			

61. Are there other benefits for using manipulative materials in teaching and learning mathematics?
    Yes [ ] (2)No [ ]
62. If yes mention them……

SECTION E: CHALLENGES OF USING MANIPULATIVE MATERIALS IN TEACHING MATHEMATICSIN THE MUNICIPALITY

Below is a table identifying the challenges teachers face in using manipulative materials in teaching mathematics in your classroom. For each challenge, there are three options- Agree (1). Disagree (2). Uncertian (3). From the table choose the option by ticking [√] either Agree (1). Disagree (2). orUncertian (3) that best reflects your opinion on the challenges of using manipulative materials in teaching mathematics.

Challenges of using Manipuative Materials	1	2	3
63. I do not have the knowledge as to the use of manipulative materials.			
64. Non- availability and inadequacy of manipulative materials are the reasons why I don't use manipulative materials in teaching mathematics.			
65. There is no continuous professional training for teachers as to the use of manipulative materials			
66. I do not have adequate user guides on the use of manipulative Materials.			
67. My work load prevents me from using manipulative materials to teach mathematics			
68. Large class size is the reason why I don't use manipulative materials in teaching mathematics.			
69. Time allocated for mathematics instruction is too short for me to use manipulative materials			
70. High cost of preparing some manipulative materials prevents teachers from using them in the class			

71. Are there any other(s) challenges for using manipulative materials in teaching and learning mathematics?
    (1)Yes [ ] (2) No [ ]
72. If yes mention them……..

APPENDIX B

INTERVIEW GUIDE QUESTIONS MATHEMATICS COORDINATOR

Section 1: Type of Manipulative materials Often Use By JHS Teachers in Teaching Mathematics

1. What are the types of manipulative materials provided to teachers to use in teaching mathematics?

Section 3: How JHS Teachers Obtain Manipulative materials for Teaching Mathematics

2. What are sources of which your mathematics teachers can obtain manipulative materials?
3. How frequent do schools received manipulative materials from these sources? (Probe to know each source mentioned and the frequency of supply)
4. As a mathematics coordinator, do you encourage your teachers to improvise some manipulative materials for teaching mathematics? And why?

Section 4: The Teaching Methods JHS Teachers Use for Teaching Mathematics with Manipulative Materials

5. Do your mathematics teachers use the right teaching method in teaching mathematics with manipulative materials? Please provide some example.
6. What are some of teaching methods you think are the best method for teaching mathematics with manipulative materials

Section 5: Benefits of Using Manipulative Materials to Teach Mathematics in JHS

7. As a mathematics coordinator, why do you think the used of manipulative materials is important and should be encouraged.

Section 6: Challenges of Using Manipulative materials in Teaching Mathematics

8. In your opinion what are the challenges that prevents your teachers from using manipulative materials in teaching mathematics?

APPENDIX C

INTERVIEW GUIDE QUESTIONS HEADTEACHERS

Section 1: Type of Manipulative materials Often Use By JHS Teachers in Teaching Mathematics

1. What are the types of manipulative materials provided to teachers to use in teaching mathematics?

Section 2: How JHS Teachers Obtain Manipulative materials for Teaching Mathematics

2. What are the sources of which your mathematics teachers can obtain manipulative materials?
3. How frequent do your school received manipulative materials from these sources?

   (Probe to know each source mentioned and the frequency of supply)
4. As a head teacher, do you encourage your teachers to improvise some manipulative materials for teaching mathematics? And why?

Section 3: The Teaching Methods JHS Teachers Use for Teaching Mathematics with Manipulatives

5. Do your mathematics teachers use the right teaching method in teaching mathematics with manipulative materials? Please provide some example.
6. What are some of teaching methods you think are the best method for teaching mathematics with manipulative materials

Section 4: Benefits of Using Manipulation to Teach Mathematics in JHS

7. As a mathematics coordinator, why do you think the used of manipulative materials is important and should be encouraged.

Section 5: Challenges of Using Manipulative materials in Teaching Mathematics

8. In your opinion what are the challenges that prevents your teachers from using manipulative materials in teaching mathematics?

APPENDIX D

INTERVIEW GUIDE QUESTIONS MATHEMATICS TEACHERS

Section 1: Type of Manipulative materials Often Use By JHS Teachers in Teaching Mathematics

1. What are the types of manipulative materials use in teaching mathematics? (provide some examples)

Section 2: How JHS Teachers Obtain Manipulative materials for Teaching Mathematics

2. What are some of the sources you do obtain manipulative materials?
3. How frequent do your schools received manipulative materials from these sources?

   (Probe to know each source mentioned and the frequency of supply)

Section 3: The Teaching Methods JHS Teachers Use for Teaching Mathematics with Manipulatives

4. Do you use the right teaching methods in teaching mathematics with manipulative materials? (Please provide some example).
5. What are some of teaching methods you think are the best method for teaching mathematics with manipulative materials

Section 4: Benefits of Using Manipulation to Teach Mathematics in JHS

6. As a mathematics teacher, why do you think the used of manipulative materials is important and should be encouraged.

Section 5: Challenges of Using Manipulative materials in Teaching Mathematics

7. In your opinion what are the challenges that prevents you from using manipulative materials in teaching mathematics?

APPENDIX E

OBSERVATION FOR JHS TEACHERS

1. Name of School:……...…….……...
2. Location of School: ……...……
3. Class: ..... No. On roll: .....Date: .....
4. Topic. .....……
5. Duration of lesson……

SECTION B

Type of manipulative materials used in teaching mathematics.

6. What are the manipulative materials used in teaching the topic ..……
7. Were manipulative materials relates to the topic being taught?
   i) Yes [ ] ii) No [ ]

JHS Teachers Obtain Manipulative materials for Teaching Mathematics

8. Kinds of manipulative materials used in teaching the topic.
   I. improvisation. ii. Purchased package

The Teaching Methods JHS Teachers Use for Teaching Mathematics with Manipulatiives

9. Teaching method used by the teacher.....……

Benefits of using manipulative materials in teaching mathematics

10. Did pupils understand the topic when manipulative materials were used…….. ……..……

What were the challenges teachers face when manipulative materials were used?

11. What were some of the challenges teacher face in trying to teach mathematics with manipulative materials……