UNIVERSITY OF EDUCATION WINNEBA

TEACHERS' USE OF MANIPULATIVES IN TEACHING NUMERACY AT EARLY CHILDHOOD CENTRES IN THE NKORANZA NORTH DISTRICT

ABDUL GAFAR ABUBAKAR SUBEINI

MASTER OF PHILOSOPHY

2021

UNIVERSITY OF EDUCATION, WINNEBA

TEACHERS' USE OF MANIPULATIVES IN TEACHING NUMERACY AT EARLY CHILDHOOD CENTRES IN THE NKORANZA NORTH DISTRICT

ABDUL GAFAR ABUBAKAR SUBEINI
(200003398)

A thesis in the Department of Early Childhood Education, Faculty of Educational Studies, submitted to the School of Graduate Studies, in partial fulfilment of the requirements for the award of the degree of Master of Philosophy (Early Childhood Education) in the University of Education, Winneba

NOVEMBER, 2021

DECLARATION

Student's Declaration

I, Abdul Gafar Abubakar Subeini, hereby declare that this thesis is my own original work. With the exception of specific references to other people's works and publications which have been duly acknowledged, this thesis is the result of my own independent research work. I also declare that, this work had not been presented, either wholly or in part for any degree or other academic honors anywhere else.

Signature: ………….…………………….

Date: ………………………………..…

Supervisor's Declaration

I hear by declare that the preparation and presentation of this work was supervised in accordance with the guidelines on supervision of thesis /dissertation/project as laid down by the University of Education, Winneba.

Dr. Praise Salome Otami (Supervisor)

Signature: ………….…………………….

Date: ………………………………..…

DEDICATION

To my lovely wife, children, and my entire family.

ACKNOWLEDGEMENTS

I am grateful to my academic supervisor, Dr. Salomey Praise Otami, for his guidance, suggestions, and constructive criticisms, which have greatly contributed to the success of this work. I am grateful to my wife, Ms Hafiza, for her unwavering support, as well as my family, for their dedication, encouragement, and endurance while I was away. May Allah, the Almighty, richly bless you.

I am also grateful to the Department of Early Childhood Education's lecturers. I would like to express my gratitude to the Nkoranza North District Director of Education, the School Improvement Support Officers, and the Early Childhood Education Coordinator. Also, thank you to my Headmaster and colleague staff, as well as all of the teachers in Nkoranza North District, for your tremendous support.

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

Table **Page**

LIST OF FIGURES

ABSTRACT

The purpose of this study was to investigate teachers' use of manipulatives in teaching numeracy at early childhood education centres in Nkoranza North District. Mixed methods research design based on sequential explanatory research was used in this study. The sample size was forty-five (45), which comprised of forty kindergarten teachers, four School Improvement Support Officers, and one early childhood education coordinator. Purposive and simple random sampling techniques were used in this study. A questionnaire, an observational guide, and a semi-structured interview guide were used to collect data. Quantitative data was analysed using frequency tables, percentage, simple count, mean and standard derivation and the qualitative data was analysed using themes. The study discovered that counters, bundle of sticks, bottle tops and number cards are manipulative materials available at the early childhood centres. Again, the study discovered that geoboard, Cuisenaire rods, multi-base blocks, Abacus and dice are types of manipulatives teachers often used in teaching numeracy in their classroom. Child centred method, demonstration method, grouping method and role play were methods exhibited by teachers when using manipulative in teaching numeracy. However, teachers were faced with challenges such as limited classroom time, insufficient budget for manipulatives, and inadequate pedagogical and technological knowledge when using manipulative in teaching numeracy. The study recommended that the Nkoranza North Education Office, in collaboration with the Ghana Education Service should make appropriate manipulative materials available and ready for use in teaching numeracy. The study also recommended that kindergarten teachers should attend continuous professional development workshops every term on how to use appropriate manipulative materials to improve their teaching skills in numeracy in order to eliminate abstract learning.

CHAPTER ONE

INTRODUCTION

1.0. Background to the Study

Teaching is an art and science that encompasses knowledge, presentation, dissemination, and, most importantly, all aspects of communication. Teaching necessitates a broad knowledge of subject matter across all horizons, a completed curriculum with standards position, a caring attitude with enthusiasm, a desire for learning and teaching classroom management, and a desire to make a difference in the lives of young people (Burns & Hamm, 2011). Manipulative materials are any concrete objects that allow students to actively explore an idea through a hands-on approach. Manipulatives can be mathematics resource, such as blocks, shapes, spinners, or even cut or folded paper that supports numeracy concepts development. Manipulatives can also be used to help students solve problems (Baggan et al., 2010).

Manipulatives are any of various objects or materials that students can touch and move around in order to help them learn mathematical and other concepts (Jones & Tiller, 2017). Mathematics has traditionally been a subject that many students struggle with and dislike as they progress through the grades. According to Golafshani (2013), on average, students like mathematics and science in elementary school, but they dislike both subjects more in junior high and high school. She also stated that mathematics is her least favourite subject. The focus should then be on how teachers can change this perception and bring some acceptance to mathematics. Teachers should always try to find ways to actively engage their students in order to not only understand concepts but also to create elements of fun and excitement in order to pique students' interest. Using manipulative materials has become one method of engaging students in fun learning that encourages student motivation. Manipulatives have also been helpful in making abstract ideas concrete for students, resulting in conceptual understanding (Golafshani, 2013).

A mathematics manipulative material is an object that can be handled by an individual in a sensory manner in order to foster both conscious and unconscious mathematical thinking (Bartolini-Bussi & Boni 2009). Manipulatives are effective, according to Holmes (2013), for the following reasons: They are multisensory, they represent ideas in more than one way, they promote communication among students, and they increase confidence, resulting in less confusion and deeper understanding. In the context of education, manipulatives are physical teaching tools that engage students visually and physically with objects such as coins, blocks, puzzles, markers, and so on. Because students are actively engaged in discovery during the learning process, the use of manipulatives is constructivist.

The materials are provided by the teacher, along with some basic guidance, but students should be allowed to explore the materials and ask questions before and during the lesson. Bartolini-Bussi and Boni (2009) indicates that certain groups of students, such as learning-disabled students and students with limited English skills, benefit from using manipulatives. A manipulative object is one that is designed to allow a learner to perceive a mathematical concept by manipulating it, hence the name. Manipulatives allow children to learn concepts through developmentally appropriate hands-on experience (Bartolini-Bussi & Boni 2009).

Manipulative materials are defined as objects that learners can touch and move to introduce or reinforce a mathematical concept (Hartshorn & Boren, 1990). In addition, Underhill (2001) explains Mathematical manipulatives as artefacts used in mathematics education which provide a hands-on learning experience in which physical objects are manipulated to develop meaningful understanding of the symbols they represent. Learners use manipulative materials to explore, acquire, or investigate mathematical concepts or processes, as well as to perform problem-solving activities based on perceptual (visual, tactile, or, more broadly, sensory) evidence. Tangrams, interlocking cubes, Pattern blocks, Fraction bars, Probability spinners, Protractors, and Applications are examples of manipulatives for mathematics instruction (National Centre for Educational Achievement, 2009).

What motivated me to choose manipulatives as my research topic was that, during my brief time as a kindergarten teacher, I observed that children learn best when they are provided with manipulative materials. The use of manipulatives materials with different colors captures the children's attention, causing the pupil to develop a lot of interest during the lesson delivery, and helps the pupil understand the concept very easily. There is a widespread fear of learning mathematics (Ojose, 2009). It is an understatement to say that even adults dislike mathematics. To put it into perspective, much of the problem of students disliking mathematics will be mitigated if students are given the necessary tools from the start to make mathematical concepts less abstract. That is the inherent problem here: If students are exposed to manipulative materials to help them better connect with mathematics, we will most likely have a less-phobic mathematics consumer (Ojose, 2009).

Adults and children alike would then express how much they enjoy mathematics, and this attitude would have a positive ripple effect from generation to generation. Another issue is student performance in mathematics, particularly as it relates to high stakes tests. It should be noted that students may not perform well in tests for a variety of reasons. One such reasons is that they are unlikely to learn the material to the level of conceptual understanding. As a result, a lack of understanding manifests itself in poor performance (Reeve & Gray, 2014).

1.1. Statement of the Problem

Interaction with manipulatives in the early grades can lead to a deeper understanding of abstract mathematics as learners' progress to higher-level mathematics (McNeil & Jarvin, 2007). Different manipulatives serve different functions at different grade level, the availability and use of concrete mathematical manipulatives should be matched by, a good understanding of how and when these manipulatives should be used (Mtetwa 2005). Hence, teachers are sceptical of the benefits of using manipulatives to assist learners during numeracy lesson. However, most teachers often struggle to use certain manipulative materials to teach numeracy as required by the national curriculum and also most teachers believe that manipulatives are just item that could add to their workload with little promise of success (Golafshani, 2013).

The use of systemic tests and Annual National Assessments (ANA) to measure learners' performance in Mathematics has put teachers under pressure to reflect on their teaching strategies and look for ways to ensure that all of their students are taught effectively (Mntunjani et al., 2018). Several years ago, the researcher was assigned to teach at a school in Nkoranza North, and I discovered that most teachers do not use manipulatives. As a result, the majority of students in the Nkoranza North District's schools perform poorly in the Numeracy terminal examinations. The majority of the head teachers' reports indicated that the majority of the pupils failed in Numeracy more than any other subject as a result of the teacher's inability to use teaching and learning materials such as selected manipulatives such as bottle tops, seeds, sticks, blocks, sea shells, colours, and so on in the delivery of the concept to the pupil. They stated unequivocally that some kindergarten teachers teach numeracy in an abstract manner that hinders students' understanding of numeracy concepts.

According to a 2020 report obtained from the Nkoranza North District Education office, the majority of the KG teachers in the District teach numeracy without manipulative materials, approximately 82 teachers out of 112 teachers, or 73.5% of the KG teachers in the District. The KG Co-ordinator report and report from the Nkoranza North District education office for the year (2020) shows that, approximately 90 teachers out of 112 teachers, or 82.6% of the KG teachers in the District, do not use manipulative materials during numeracy lessons. Personal observation by the researcher reveals that some learners struggle to match numeracy to numbers; others struggle with place values. It was observed that the majority of teachers in the study area teach numeracy at early childhood centres with little manipulatives.

A careful internet search by the researcher reveals that not much research has been done in Nkoronza North District on the use of specific manipulatives in teaching numeracy. Thus, this study intends to fill the knowledge gap by identifying the types of manipulative materials teachers use in teaching numeracy, finding out the availability of manipulatives used by the teachers in teaching numeracy, methods teachers use in teaching numeracy using manipulatives and challenges faced by teachers in teaching numeracy at the early childhood education centres in the study area. Investigating teachers' use of manipulative materials in numeracy instruction could expose students to hands-on materials that lead to conceptual understanding and thus improve children's cognitive development.

1.2. Purpose of the Study

The purpose for this study was to investigate teachers' use of manipulatives in teaching numeracy at early childhood education centres in Nkoranza North District.

1.3 Research Objectives

1. To find out manipulative materials available at the early childhood education centres in the Nkoranza North District.
2. To identify the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres in Nkoranza North District.
3. Determine the methods teachers use in teaching numeracy using manipulatives at early childhood education centres in the Nkoranza North District.
4. To identify the challenges faced by teachers when using manipulatives in teaching numeracy at early childhood education centres in the Nkoranza North District.

1.4 Research Questions

1. What manipulative materials are available at the early childhood education centres in Nkoranza North District?
2. What type of manipulatives do teachers use in teaching numeracy at the early childhood education centre in the Nkoranza North District?

3. What methods do teachers exhibit in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District?
4. What challenges do teachers face when using manipulatives in teaching numeracy in the Nkoranza North District?

1.5. Significance of the Study

The study's findings may shed light on how to achieve quality education in the district. The study's findings would provide insight into problems whose resolution could help inform specific actions to be taken to address children's performance in an efficient and effective manner. Other researchers will benefit from the findings of this study, which will provide information on manipulatives used to teach numeracy in the early grades. The findings of this study may provide learners and teachers with additional experience in how to use manipulative materials effectively. The study's findings could also be used as a reference document at the District libraries.

1.6. Delimitations of the Study

The study was restricted to selected public kindergarten schools in the Nkoranza North District. The study focused on public kindergarten schools due to accessibility and convenience of participants. Again, manipulatives are very broad area of research that has been widely studied. The focus of study was on teachers' use of manipulatives in teaching numeracy at early childhood education centres in the study setting. Also, the study focused on public kindergarten teachers at the early childhood centres only. Thus, the study is limited because the sample consisted only of public kindergarten teachers who participated in it; thus its findings cannot be generalized to the whole population of kindergarten teachers in the Bono East region of Ghana.

1.7. Limitations of the Study

A limitation of this study was the challenge of unwillingness on the part of some of the respondents to provide the information for fear of the outcome of the research. However, the respondents were assured of their confidentiality. They were also briefed on the purpose of the research and that the results were to be used for research only. In this regard, they willingly provided the information.

1.8. Organization of the Study

This research work has been divided into five chapters, which are as follows: The first chapter discusses the background of the study, problem statement, and purpose of the study, research objectives, and questions, significance of the study, limitations, and organization of the study. The second chapter is a review of the related literature. The methodology used in the study is described in Chapter three. The data collected for the study is analyzed in chapter four, followed by discussions of the findings. The fifth chapter contains the study's summary, conclusions, and recommendations. The chapter also includes suggestions for further research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0. Overview

This chapter of the study focuses on a review of related literature with the following subheadings: theoretical framework, conceptual framework, concept of manipulative, types of manipulatives used by teachers in teaching numeracy, availability of manipulatives used by teachers in teaching numeracy, skills teachers use in teaching numeracy using manipulatives, and challenges faced by teachers in teaching numeracy.

2.1 Theoretical Framework

The theoretical underpinning for this study was Piaget Cognitive Constructivism theory. Jean Piaget (1896-1980) contributed to the establishment of cognitive psychology in the 1950s. Jean Piaget studied the sensorimotor, preoperational, concrete operational, and formal operational stages of the sequential process to demonstrate how children think by observing their interactions with stimuli in the environment (Aliakbari et al., 2015; Alicia & Dusing, 2020). Cognitive abilities have focused on fact processing, thought pattern description, and action control in recent years, and it is clearly described as the technique of gathering, organizing, and establishing information (Govindaraju, 2021).

Piaget's Cognitive Constructivism states that, ideas are constructed in individuals through a personal process. According to Piaget, a human uses both these processes simultaneously throughout his life for developing understanding of his environment (Sehar et al., 2021). Language employed in mathematical discussion to use these symbols and operations requires a cognitive process to articulate preexisting concepts and thoughts (Schoenfeld, 1987). This prompted the inclusion of mathematical knowledge and enhanced problem-based learning skills as a major priority on the agenda of early generations of cognitive science (Stoilescu, 2016).

Piaget (1970) talks about three different types of mathematics abstraction depending on where one directs his/her focus of attention; empirical abstraction on objects, pseudo-empirical abstraction on properties and reflective abstraction on interrelationship among actions. Mathematical ideas are classified by deep structure rather than by visible appearance or known functions like everyday objects (Durmus & Karakirik, 2006). Durmus and Karakirik (2006) extracts three main features associated with mathematical abstraction within the cognitivist constructivism: (1) generalisation arising from the recognition of commonalities isolated in a large number of specific instances; (2) an ascent from lower concrete levels to higher levels of abstract thinking; and (3) a process of decontextualisation. Abstraction is described as the extraction of what is common to a number of different situations. Abstraction is a process of discovering the same type of patterns among different situations which embody the same concept, i.e., formation of an isomorphism, for example, by constructing rectangles from a given set of unit squares (Durmus & Karakirik, 2006).

Hence, a concrete experience in mathematics context is defined not by its physical or real-world characteristics but rather by how meaningful connections it could make with other mathematical ideas and situations. For instance, a student might create the meaning of the concept 'four' by building a representation of the number and connecting it with either real or pictured blocks (Durmus & Karakirik, 2006). Sfard (1991) argues that abstract mathematical notions can be conceived in two different ways; operationally as processes and structurally as objects. Learners firstly get familiar with mathematical concepts by using the processes or operations, manipulatives in this case, and their conception later is detached from the process and seen as a new object belonging to a particular category of concepts through reflection on these actions. Hence, it is very important to encourage learners to reflect on actions they make in order to be able to perceive mathematical processes as objects (Durmus & Karakirik, 2006).

Manipulative materials are concrete models that involve mathematical concepts, appealing to several senses including the socio-cultural needs that can be touched and moved around by the learners (Heddens, 2005). Manipulatives are physical objects, such as base-ten blocks, algebra tiles, Unifix Cubes, Cuisienaire rods, fraction pieces, pattern blocks and geometric solids that can make abstract ideas and symbols more meaningful and understandable to students. New concepts should be introduced with appropriate manipulatives at the elementary and secondary levels (Heddens, 2005). While it is virtually impossible to demonstrate a mathematical concept directly by the help of manipulatives, it is likely for a learner to construct a concept or discover a mathematical relationship through appropriate use of manipulatives with an adequate task. It is suggested that manipulative materials can be used as an intermediary between the real world and the mathematical world (Heddens, 2005).

Using manipulatives benefits students across grade level, ability level, and topics which using manipulative makes sense for that topic (Durmus & Karakirik, 2006). A simplistic design that enables easy manipulation should be chosen while creating manipulatives and motivational concerns should be addressed. Every student should be given an opportunity to play with manipulatives. Just a demonstration by a teacher is not sufficient to realize their full potential and not in line with the theoretical rationale of their usage since they are meaningful to the extent they involve interactive activities. Furthermore, manipulatives should be carefully chosen with the levels of intended audience and the realistic models, such as 1 stick for the digit 1 and 10 stick together as digit 10 for base blocks, should be used in order not to mislead learners by causing misconceptions (Durmus & Karakirik, 2006). Suydam and Higgins (1976) believe that lessons involving manipulative materials, if employed properly, will produce greater mathematical achievement than will lessons in which manipulative materials are not used. In fact, their meta-analysis of the studies using manipulatives verified them

The use of Piaget Cognitive Constructivism in this study lies in fact that, it informs the researcher on how kindergarten teachers develop numeracy lessons with predefined objectives in mind and presentation skills and knowledge in a predefined sequence, while learners' functions are to passively attain teacher-specified knowledge and skills. It also helps to understand why early grade teachers incorporate learners in planning when creating learning environments, accept their ideas, and provide them autonomy and choice to interact with others to actively participate in investigations and problem-solving activities. Moreover, this theory informs that using manipulative materials in teaching numeracy could help learners learn to work together cooperatively in solving problems, verbalise their numeracy thinking, discuss their numeracy ideas and concept and finally solve numeracy problems without just following teachers' direction.

2.2. Concept of Manipulative Materials

2.2.1. Manipulative Materials Philosophy

Mathematics manipulatives are physical objects designed to represent abstract mathematical ideas explicitly and concretely (Moyer, 2001). Mathematics manipulatives have been around for a long time. Montessori schools have long advocated for teaching with concrete objects, as well as Piaget's emphasis on teaching from the concrete to the representational, and finally to the abstract, to help young learners make sense of their mathematics understanding.

George Cuisenaire (1891-1975), a Belgian educator, is best known for inventing the Cuisenaire Rods, which are still used today to teach fraction concepts and other math concepts; these were created in the 1950s. Many other mathematics didactics grew out of these ideas, eventually leading to the Cuisenaire Mathematics Manipulative Company. Many commercially manufactured math manipulatives now adorn the shelves of most school classrooms. According to Moyer (2004), some teachers use manipulatives to reform their mathematics instruction without considering how the use of representations may change their own mathematics instruction. According to Baroody (1989), Piagetian theory does not require students to operate on something concrete in order to construct meaning, but it does suggest that they manipulate something familiar and reflect on these physical or mental actions.

Actively engaged thinking is a necessary component of student learning. According to Ball (1992), manipulative use is widely accepted as an effective way to teach mathematics, but little effort is made to assist teachers in ensuring their students make the correct connections between the materials and the underlying mathematics.

Mathematics manipulatives are physical objects that are intended to represent abstract mathematical ideas explicitly and concretely (Moyer, 2001).

Mathematics manipulatives have been around for a long time. Montessori schools have long advocated for teaching with concrete objects, as well as Piaget's emphasis on teaching from the concrete to the representational, and finally to the abstract, to help young learners make sense of their mathematics understanding. For many years, the availability of concrete and virtual manipulatives has had an impact on mathematics teaching strategies. Previous research has demonstrated the efficacy of using manipulatives to promote academic achievement in students, as well as the reasons for using those manipulatives (Swan & Marshall, 2010). Other studies, however, raise some concerns about the use of manipulatives in mathematics instruction. According to Nickson's (2000) research, when children are assisted in mastering mathematical concepts using manipulatives, they are not always able to apply these concepts in problem-solving situations. Linder, Powers-Costello, and Stegelin (2011) explain why children require concrete manipulatives and opportunities to represent their own thinking when exploring mathematics.

They look into effective, meaningful, and developmentally appropriate strategies for teaching mathematical skills to young children in a variety of learning environments. The use of manipulatives has inspired many instructional and curricular methods. The approaches include math strategies such as project work, the integration of play in mathematics, and developmentally appropriate strategies for developing number sense (Linder et al., 2011). Meaningful mathematical experiences and strategies involving manipulatives can improve student achievement.

Domino (2010) explains how the use of manipulatives during mathematics instruction serves to connect students' progress from a concrete to an abstract stage of development. If students are exposed to manipulatives at an early stage of their mathematical development, it may be easier for them to make connections to more difficult, abstract mathematical ideas. Manipulatives help to strengthen multiple representations, to help students understand mathematics, to increase student achievement, and to provide students with additional resources to help them understand mathematics.

Because there are differing perspectives on the use of manipulatives in mathematics instruction, it is critical that this type of research be conducted in a variety of forms in order to bridge this gap. Using multiple modes of representation that integrate children's prior experiences and interest in solving mathematical problems or engaging learners in multiple solution tasks is one way of meeting the mathematical learning needs in a diverse classroom setting (Nabie et al., 2016). Explicitly using manipulatives provides students with multiple strategies for solving problems in various ways, as well as assisting students in mathematical conversations. Manipulatives and meaningful conversations assist learners in solving mathematical problems in a variety of ways to reach the same solution, which contributes to academic achievement.

2.2.2. History of Manipulatives

Manipulatives are concrete objects that students can view and physically manipulate to demonstrate or model abstract concepts. They are a type of mathematical tool that is mentioned in mathematics standards such as the Mathematics Process Standards in Principles and Standards for School Mathematics

(NCTM, 2000) or the Standards for Mathematical Practice in Common Core State Standards for Mathematics (National Governors Association et al, 2010). A mathematical tool, according to John van de Walle and colleagues (2013), is any object, picture, or drawing that represents a concept or onto which the relationship for that concept can be imposed." Manipulatives are physical objects that students and teachers can use to illustrate and discover mathematical concepts, whether they were designed specifically for mathematics (e.g., connecting cubes) or for other purposes (e.g., buttons). Virtual manipulative tools, which have recently become available for use in the classroom, are also covered in this document as a tool for teacher modelling and demonstration.

Manipulatives for teaching mathematics have been used for at least two centuries. Maria Montessori (1870-1952), Jean Piaget (1896-1980), ZoltanDienes (1916), and Jerome Bruner are more recent significant influences (1915). Each of these historians and innovators has emphasized the importance of authentic learning experiences and the use of concrete tools as a critical stage in the development of history. Manipulatives not only enable students to build their own cognitive models for abstract mathematical ideas and processes, but they also provide a common language through which these models can be communicated to the teacher and other students.

In addition to directly assisting in the cognitive process, manipulatives have the added benefit of engaging students and increasing both interest in and enjoyment of mathematics. Students who have the opportunity to use manipulatives report being more interested in mathematics. Long-term mathematical interest leads to increased mathematical ability (Sutton & Krueger, 2002). The National Council of Supervisors of Mathematics (NCSM) issued a position statement on manipulatives in classroom instruction to improve student achievement in 2013. 'In order to develop mathematical proficiency in all students, leaders, and teachers must systematically integrate the use of concrete and virtual manipulatives into classroom instruction at all grade levels' (NCSM, 2013).

This viewpoint is supported by research that supports the use of manipulatives in classroom instruction. For example, Ruzic and O'Connell (2001) discovered that long-term use of manipulatives improves student achievement by allowing students to observe, model, and internalize abstract concepts using concrete objects. According to Piaget (1952), children only begin to understand symbols and abstract concepts after first experiencing them on a concrete level. Dienes (1960) expanded on this, arguing that children whose mathematical learning is firmly grounded in manipulative experiences are more likely to bridge the gap between their everyday world and the abstract world of mathematics. Their pioneering work has spawned numerous studies on the value of manipulatives in student learning in mathematics.

2.2.3. Benefits Derived from Using Manipulative Materials

Since ancient times, people of many different civilizations have used physical objects to help them solve everyday math problems. The ancient civilizations of Southwest Asia (the Middle East) used counting boards. These were wooden or clay trays covered with a thin layer of sand. The user would draw symbols in the sand to tally, for example, an account or take an inventory. The ancient Romans modified counting boards to create the world's first abacus. The Chinese abacus, which came into use centuries later, may have been an adaptation of the Roman abacus. Similar devices were developed in the Americas.

The Mayans and the Aztecs both had counting devices that featured corn kernels strung on string or wires that were stretched across a wooden frame. The Incas had their own unique counting tool—knotted strings called quipu. The late 1800s saw the invention of the first true manipulatives manoeuvrable objects that appeal to several different senses and are specifically designed for teaching mathematical concepts. Friedrich Froebel, a German educator who, in 1837, started the world's first kindergarten program, developed different types of objects to help his kindergartners recognize patterns and appreciate geometric forms found in nature. In the early 1900s, Italian-born educator Maria Montessori further advanced the idea that manipulatives are important in education. She designed many materials to help preschool and elementary school students discover and learn basic ideas in math and other subjects. Since the early 1900s, manipulatives have come to be considered essential in teaching mathematics at the elementary-school level. In fact, for decades, the National Council of Teachers of Mathematics (NCTM) (2000) has recommended the use of manipulatives in teaching mathematical concepts at all grade levels.

The NCTM calls for manipulatives to be used in teaching a wide variety of topics in mathematics. They include; **Sorting:** a pre-mathematical skill that aids in comprehension of patterns and functions. **Ordering:** a pre-mathematical skill that enhances number sense and other math-related abilities. **Distinguishing patterns:** the foundation for making mathematical generalizations. **Recognizing geometric:** shapes and understanding relationships among them making measurements, using both nonstandard and standard units with application to both two- and three-dimensional objects understanding the base-ten system of numbers comprehending mathematical operations-addition, subtraction, multiplication, division recognizing relationships among mathematical operations, exploring and describing spatial relationships, identifying and describing different types of symmetry, developing and utilizing spatial memory, learning about and experimenting with transformations, engaging in problem-solving, representing mathematical ideas in a variety of ways, connecting different concepts in mathematics, communicating mathematical ideas effectively. Manipulatives should act as a ‘scaffold', which can be removed once independence is achieved. Before using a manipulative, it is important to consider how it can enable students to eventually do the maths without it. When moving away from manipulatives, students may find it helpful to draw diagrams or imagine using the manipulatives.

Different states across the nation have also mandated the use of manipulatives for teaching math. These have included California, North Carolina, Texas, and Tennessee, among others. In addition, many local school districts mandate or strongly suggest manipulatives be used in teaching math especially for mathematics teaching at the elementary level. Manipulative use is recommended theory and educational research in the classroom.

Concrete Stage: A mathematical concept is introduced with manipulatives; students explore the concept using the manipulatives in purposeful activity.

Representational Stage: A mathematical concept is represented using pictures of some sort to stand for the concrete objects (the manipulatives) of the previous stage; students demonstrate how they can both visualize and communicate the concept at a pictorial level.

Abstract Stage: Mathematical symbols (numerals, operation signs, etc.) are used to express the concept in symbolic language; students demonstrate their understanding of the mathematical concept using the language of mathematics

2.2.4. Manipulative in Teaching Mathematics

Manipulatives 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 (Heddens, 1986). Also, constructivism advances the idea that the individual begins to develop understanding through personal experiences and personal connections. The interlacing of content, context and understanding, the individual negotiation of meaning, and the construction of knowledge are promoted in a learning environment that promote constructivism (Land & Hannafin, 2006).

Furthermore, collaboration, real or virtual, which brings about new ways of conceiving concepts that might not be visualized by individual alone are considered integral (Abrami, 2001). The use of manipulative in teaching mathematics has become almost commonplace as the use of textbooks. And with good reasons, as both Sowell (1989) and Ruzic and O'Connell (2001) found that the long –term use of manipulatives has a positive effect on student achievement by allowing students to use concrete objects to observe, model, and internalize abstract concepts.

Manipulatives not only allow student to construct their own cognitive models for abstract mathematical ideas and processes, it also provides a common language with which to communicate these models to the teacher and other students. In addition to the ability of manipulatives to aid directly in the cognitive process, manipulatives have additional advantage of engaging students and increasing both interest in and enjoyment of mathematics. And, long-term interest in mathematics translates to increased mathematical ability (Sutton & Krueger, 2002); Bobby Ojose (2003) and Lindsey, Moyer and Jones (2004) stated that manipulatives are designed to represent explicitly and concretely abstract mathematical ideas, that are often hard for students to understand. As a result, they can become valid resources to use in the classroom when teaching complex ideas to a class.

Research studies have also shown that in lessons whereby manipulatives were used, students appeared to be interested, active, and involved in their learning, seeing math as a fun activity (e.g., Moyer, 2002). It is interesting now to see the changes in perspective regarding the subject with students who are given the opportunity to use manipulatives in their classrooms. The lessons become interactive, engaging, and student driven. Some researchers had even reported students becoming more independent when they were given the opportunity, or choice, to use manipulatives provided for them by their teacher (e.g., Moyer & Jones, 2004). They also pointed out that Overall, having the tools available for them to use brought about a greater understanding of the concepts and allowed the students to devise their own solution strategies, promote autonomous thinking, and create confidence in learning math.' Because of empirical and anecdotal evidence that shows higher student achievement when manipulatives are used, districts throughout the country encourages their teachers to attend workshops that acquaints them with how to properly use manipulatives as instructional tools.

Also, the production of manipulatives with technological interaction has started. These kinds of manipulatives allow students to directly interact with a computer that reinforces the same concepts being taught in class, allowing for accommodations and differentiations for students at various levels of learning. Overall each individual is able to work at their own pace making it possible for students to correctly complete more tasks at their specific levels (Reimer & Moyer, 2005). As Drickey (2006) reported when doing a similar project on the effectiveness of manipulatives (both physical and technological), she found many students who said they enjoyed working with manipulatives and they made them "want to learn more. Research indicates that manipulatives have been used by mathematics teachers in elementary schools for years and with varying degrees of success" (Ross & Kurtz, 1993). Gilbert and Bush (1988) surveyed a group of elementary teachers and found that primary grade teachers were familiar with manipulatives and that various manipulatives were available to them. The teachers also revealed that as the grade level increased the use of manipulatives decreased.

In a similar study by Hatfield (1994, p. 304), a questionnaire was sent to 106 kindergartens through sixth grade teachers who were serving as cooperative teachers for student teachers from a large university in the southwestern United States. Thirteen manipulative devices were listed and teachers were instructed to check which manipulative(s) they were familiar with, used for mathematics instruction, and the number of times per week/month each device was used. In comparing the grade level to the manipulative use, Hatfield concluded that manipulative use declined as the grade level increased from kindergarten through sixth grade.

Gilbert and Bush (1988) conducted a two-part study to ascertain through teacher's self-reporting the degree to which primary grade teachers were using manipulative devices to teach mathematics. The first part of the study involved compiling a list of recommended manipulative devices and the second part of the study involved teachers of grades one to three, from eleven different states to complete a survey to report their familiarity, use, and availability of a particular set of manipulative devices. The teachers who responded to the study had an average of 13.2 years of experience in teaching elementary school mathematics, approximately 86% of the teachers taught one class of mathematics per day, 10% taught two classes, and the remaining teachers taught three to four mathematics classes daily. The results of the study revealed, the use of manipulative devices was low given the current availability of information and materials." The conclusion of the study revealed that teachers were familiar with selected manipulatives and that most of the materials were available to them but that the teacher simply do not use them as often as is recommended (Bush, 1988, p. 467). The use of manipulatives in teaching mathematics has a long tradition and solid research history. Manipulatives not only allow students to construct their own cognitive models for abstract mathematical ideas and processes, they also provide a common language with which to communicate these models to the teacher and other students.

In addition to the ability of manipulatives to aid directly in the cognitive process, manipulatives have the additional advantage of engaging students and increasing both interest in and enjoyment of mathematics. Students who are presented with the opportunity to use manipulatives report that they are more interested in mathematics. Long-term interest in mathematics translates to increased mathematical ability (Sutton & Krueger, 2002). In 2013, the National Council of Supervisors of Mathematics (NCSM) issued a position statement on the use of manipulatives in classroom instruction to improve student achievement. “In order to develop every student’s mathematical proficiency, leaders and teachers must systematically integrate the use of concrete and virtual manipulatives into classroom instruction at all grade levels (NCSM, 2013). This position is based on research supporting the use of manipulatives in classroom instruction. For example, Ruzic & O’Connell (2001) found that long-term use of manipulatives has a positive effect on student achievement by allowing students to use concrete objects to observe, model, and internalize abstract concepts.

2.3. Use of Manipulatives with Students

Students are provided with multiple opportunities to access language when they can use concrete materials to show their mathematical thinking. Use of manipulatives enhances the teaching and learning of because it provides teachers with a variety of teaching strategies and approaches that allow students to access the language (Ghamrawi, 2013).

There are various methods and strategies to promote effective mathematics instruction for students. It is essential for teachers to share content-area knowledge, ideas, and experiences in order to ensure optimal opportunities for students to achieve academic success in mathematics (Becker, 2001; Witzel & Little, 2015). Teachers can learn ways of introducing and developing new concepts in mathematics so that the language is being supported. Some effective classroom strategies that can be incorporated in mathematics lessons for students are repetition, pauses, reduction in speed, and introducing one manipulative at a time (Becker, 2001).

Mathematical understanding does not mean that students simply display what they have been taught, but that they can link what they are learning to previous mathematical concepts that they have already been taught. This information is important especially when considering students. Teaching mathematics to students' needs to be strategic. Teachers need to ensure that they cover the content of their math lessons, but also be certain it transfers properly to students whose first language may be something other than English (Secada & Carey, 1990). A method used to ensure that this happens is using manipulatives as a concrete representation of student's mathematical thinking. Students should be exposed to and be able to examine a variety of situations in which mathematics is useful and makes sense to them in order to become assertive in their ability to perform mathematic operations, become a mathematical problem solver, learn to communicate their mathematical thinking, and learn to purposefully reason mathematically (Secada & Carey, 1990).

According to Hamayan and Freeman (2006), it usually takes between one to two years for students, whose first language is one other than English, to become sensibly fluent in conversational English. What better way to support these students in their mathematical skills than providing them with concrete objects that can be manipulated to communicate their understanding of mathematics concepts? Hamayan and Freeman (2006) state that teachers have to ensure that English language learners students are given ample opportunities and encouragement to experience academic language using manipulatives. Various research studies have proven that the use of manipulatives during mathematics instruction is beneficial for not only English language learners, but also for all students learning math concepts. Mathematics and Low Socio-Economic Students Wang (2010) recognizes that if there is a well-established opportunity for students to learn mathematics, it can support student's mathematical achievement. This can prove to be difficult for students who are products of low socio-economic families. If students have, greater opportunity to learn mathematics through use of manipulatives it is predicted that they will have higher mathematic achievement (Wang, 2010). Educators should provide students with opportunities to learn high quality, challenging, and accessible mathematics especially for students who are members of low-income families.

Wang (2010) clearly documents the presence of mathematics score distinctions by socio-economic status and substantial disparities in scores by socio-economic status. These studies show the importance of investigating achievement difference with students from low socio-economic status and their academic achievement of the students'. According to Heddens, using manipulative materials in teaching can help students learn how to relate real world situations to mathematics symbolism and work together cooperatively in solving problems. He further states that manipulatives allow students to discuss mathematical ideas, concepts, and verbalize their mathematical thinking (Heddens, 2007). Students who use manipulatives in their mathematics courses usually outperform those who do not, although the benefits may be slight (Clements, 1999). Manipulative usage can also improve students' attitude toward mathematics, and give instruction that uses concrete materials to help students retain information and increase scores on test (Sowell, 1989). In order for mathematics to engage students interactively and entertaining for learning, teachers must involve students physically in hands-on experiences. Although some research states that students learned the material no matter which way it was taught; there were definite differences in student enjoyment (Rust, 1999). Student enjoyment in school is directly related to their overall academic success because it has been proven that students will retain the information if it enjoyable to them. (McClung, 1998) states that using manipulative aids and devices make the classroom a more interesting and engaging place for both teachers and students.

2.4. Conceptual framework

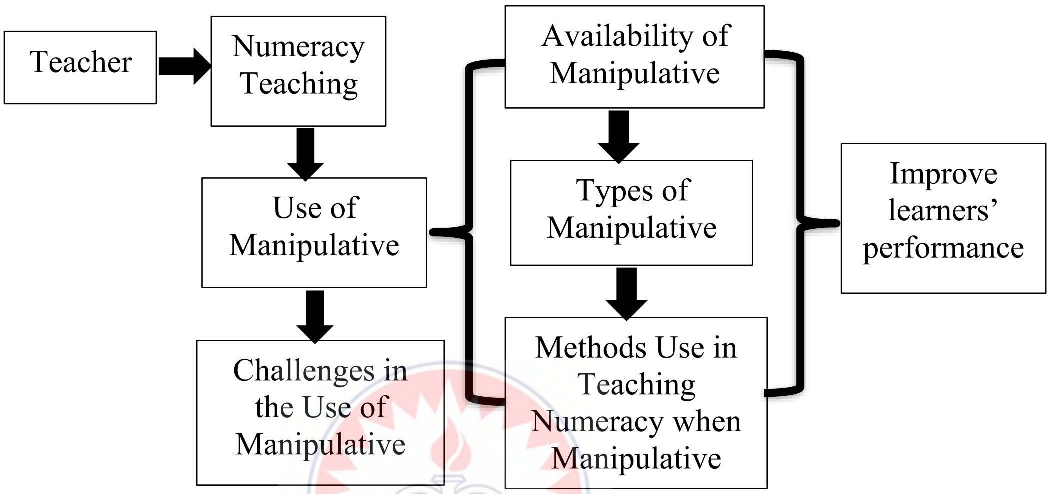


Figure 2.1. Conceptual Framework

Source: Researcher Construct (2021)

Figure 2.1 depicts the conceptual framework of the study. The figure 2.1 shows that, in numeracy teaching teachers use manipulative materials. In using manipulative materials to teach numeracy, teachers must be aware of the manipulative materials available, its types and the methods to use when using those manipulative materials. This could help improve learners' performance in numeracy. However, in using manipulative materials to teach numeracy, teachers often encounter challenges which could hinder their teaching performance in numeracy.

2.5. Availability of Manipulative Materials

Manipulative materials like counters, Danes blocks, grain seeds, and abacus are used to teach numeracy at the kindergarten level. Using simple physical objects that students can visualize, touch, and move to express their thoughts is a cheap and effective way to explore mathematical concepts and encourage learning in the classroom. No single strategy or tool will improve a student's mathematical proficiency in isolation. We are taking about the availability of the teaching and learning materials are. Are there manipulative materials to be used to meet the needs of the learners? Teacher can use selected manipulative materials to teach numeracy when the manipulative materials are in abundant and save for them to use. When there are available manipulative materials it will help the teachers to select the best materials for the pupils' numeracy learning effectively which led the teacher to be able to meet the developmental appropriate level of the pupil (Thomson et al., 2013).

When there are not available, manipulative materials the authorities can make provision for the schools, some non- Governmental organization too can also assist them, and some other means of getting them can be like. Examples of manipulatives in the classrooms are base ten blocks and Cuisenaire rods, but no matter the example we should think about these as tools to learning – the purpose of the use, therefore, becomes key. They may be store-bought, brought from home, or teacher- or student-made. They can be used in all areas of math instruction-teaching number and operations, algebra, geometry, measurement, and so on-and across all grade levels. The following are a few manipulatives that might be used at the elementary level (NCTM, 2000).

Manipulative materials must be used at the right time and in the right way, if they are to be effective (Suydam, 1985). The materials must be selected with the mathematical purpose in mind. Suydam claims that it is important that the child is focused on the objective, and encouraged to think along as they use the manipulative materials. Bohan and Shawaker (1994) recommend using the manipulatives in the context of transfer of learning. This means that studying topic A will help in understanding topic B. Bohan and Shawaker (1994) state that two important conditions have to be met in order for the transfer to occur, common elements must exist between two topics, and the learner must be aware of the existence of the common elements. The manipulatives chosen should support the lesson's objective and involve participation of each student. A system of evaluation must be developed that reflects an emphasis on the development of reasoning skills, organize students into groups of four to reduce the amount of materials on the table which allows for less clutter and maximum learning (Ross & Kurtz, 1993).

Suydam (1984) suggests that teachers practice using the materials before the lesson to become familiar with them. There should be sufficient material, in good working order, for each student to use; provide ample time for using the material; encourage the students to think for themselves-do not provide all the answers for the students; allow for and encourage group interaction, and provide follow-up question and answer time. One example of success with manipulatives is from Ross and Kurtz (1993) article Making Manipulatives Work: A Strategy for Success. A group of second-graders was taught mathematics, with much success, using manipulatives. The class consisted of twenty-four students with varying abilities and backgrounds. Their teacher created various centres and stations in which the children were free to choose which station they wanted to work; each station was directed towards achieving classroom objectives.

There were many baskets, bags, and boxes filled with mathematics manipulatives on countertops and tables so that they were easily accessible to the students when counting, classifying, patterning, constructing, and exploring. The teacher had been teaching place value and used base-ten blocks in a game called "get to a hundred". The students were divided into groups of four and the materials needed for the game were the base-ten blocks, place-value board, and die.

The object of the game was to reach 100 by trading, and the first player to get a flat (10 longs) would win. Using an overhead projector to model the game, the teacher played against the class until he was satisfied that all the students understood the rules and time was allowed for the students to ask questions before students proceeded. As the students played, the teacher walked around the room, watching and listening to the interaction among the students. He also used the time to evaluate students' progress from the comments the students made as well as the strategies used to reach the goal. The teacher found that time spent re-teaching and remediating is greatly reduced when he allows his students the time to build and reflect on their own personal knowledge. The teacher spent time at the end of the lesson to discuss some of his observations with the students, and then asked students to use pencil and paper to write answers to one of his questions. In this, he was assessing which students needed further conceptual development, which students reflected an understanding of concept, and which others indicated advanced development.

The assessment of students' writings, oral comments, and teacher's observations allows the teacher to address the needs of individuals by directly questioning during class...or by working with a small group to facilitate understanding (Driscoll, 1993). When planning lessons in which manipulatives will be used, Driscoll (1993) lists some suggestions: (1) manipulatives chosen will support the lesson's objectives; (2) significant plans have been made to orient students to the manipulatives and corresponding classroom procedures; (3) the lesson involves the active participation of each student; and (4) the lesson plan includes procedures for evaluation that reflect an emphasis on the development of reasoning skills. The effective use of manipulatives, according to Driscoll, also depends on the adequate preparation of the students and the materials. In addition, every student must be kept actively involved in order to achieve success with manipulatives. In order for this to happened students should: (1) work in pairs, (2) have a mental objective at the beginning of the lesson, (3) use visual signals, such as thumbs up or thumbs down, to promote active participation, and (4) ask students to reflect on the mathematical thinking involved in their lessons and to respond in writing (Driscoll, 1993). The level of cognitive development varies with each child and their needs must be considered when using manipulatives (Suydam, 1984).

Suydam states, we need to begin with the student, assessing learning styles, interests, and talents, and attempting to pinpoint the mathematical ideas with which difficulty exists. Diagnosis is imperative. In a study by Bryant (1992) at-risk and targeted students in grades four through six were not doing well in identified mathematics objectives. It was noted that the number one reason why at-risk and targeted students were not achieving in mathematics was that the teachers did not use mathematics manipulatives to stimulate critical thinking and/or problem solving solutions. More in-servicing to familiarize teachers on the effectiveness and practicality of the usage of mathematics manipulatives at the intermediate level would be helpful (Bryant, 1992). The Research Advisory Committee of the National Council of Teachers of Mathematics (1989) states that Mathematics has become a critical filter for employment and full participation in our society.

We cannot afford to have the majority of our population mathematically illiterate. Equity has become an economic necessity" (Bryant, 1992, p. 12). In At-Risk Youth Can Succeed, Green (1989) lists several ways that at-risk students can succeed. These include increased parent involvement, in-service training for classroom teachers, and community partnership with schools, a strong emphasis on teaching student's critical thinking/logical reasoning, goal setting, and problem solving techniques. No mention of manipulative usage was made. It was reported in the Phi Delta Kappan that in 1983 the SAT scores were rising for black students (Bryant, 1992). Researchers investigated the data and found that the reasons for the rise in the scores were that black students were taking more mathematics classes, attending more private schools, and the income level of the students' parents was above average, again, manipulative use was not mentioned as a reason.

Garcia (2004) investigated using math manipulatives and visual cues with explicit vocabulary with lower achievers in third- and fourth-grade bilingual class rooms for a 5 weeks' study. The pre-test composed of 10 of the 13 Texas Assessment of Academic Skill objectives was administered to 64 third- and fourth-grade students. Students were divided into three groups (manipulatives-based instruction, visual (drawings) cued instruction and no additional mathematics instruction). Results indicate minimal improvement in the treatment groups. Gradual improvement was made but was not linear. In an analysis of math retention based on this study, Cabonneau, Scott, and Selig (2013) indicate third- and fourth graders taught with manipulatives performed the same as those taught without manipulatives.

Allen (2007) used an action research project approach to investigate the use of math manipulatives in a fifth-grade self-contained math class (22 students) over a three-day period in a program entitled Everyday Math. The students used pattern blocks to understand the relationship of interior angles in polygons. The students were required to take a pre-test and post-test, and results indicated that students' mathematics achievement increased, their understanding of mathematics increased, and their dispositions toward mathematics improved using manipulatives.

Also, Nishida (2007) investigated children's (134 six to-seven-year olds) addition and subtraction of fractions. Children were randomly assigned to three groups (self-manipulative, other-manipulate, and comparison conditions). In Experiment 1, students used concrete manipulatives (fraction circles) to solve basic problems. As a result, there was no difference between actively using manipulatives, watching an experimenter use manipulative, and looking at pictures. Parents also reported that 90% of the children had used manipulatives previously in school. The remaining 5% to 10% had not used manipulatives in previous lessons. Experiment 2 consisted of higher achieving math students, who also used concrete manipulatives (fraction circles). Students who used the manipulatives scored higher than those who watched manipulatives being used and looked at pictures of fractions. All students were excited and interested and enjoyed working with math manipulatives. In an analysis of mathematics retention based on this study, Cabonneau, Scott, and Selig (2013) indicate retention was the same for both groups.

Battle (2007) used a quantitative research study to determine if manipulatives would
increase math grades for 16 low-achieving students in self-contained classes during a one-week study. One class was a control group (8 students), and the other was a treatment group (8 students). Both groups were learning addition and subtraction. The treatment group used counter blocks for counting and subtracting numbers from 1 through 20. Each student was given a pre-test and a post-test. Results indicate that students taught addition and subtraction with counters performed better than those taught without manipulatives do. However, in an analysis of mathematics retention based on this study, Cabonneau, Scott, and Selig (2013) indicate the students scored lower on a measure of retention than those taught without manipulatives.

Ogg (2010) investigated the impact of math manipulatives on 12 fifth-grade students using calculators, protractors, rulers, money, counting, base-ten blocks and tangrams, candy, cereal, straws, and computers for math games and geometric transformations. The students were required to take pre-tests and post-tests with and without the use of manipulatives. In addition, the students completed a survey to determine their perceptions of the manipulatives. The results of 20 teacher surveys indicate that 9 of the 12 students increased their scores using manipulatives to solve mathematics problems. All surveyed teachers indicated that they used rulers, protractors, calculators, counters, and coins.

In a study relating to probability, Gurbuz (2010) used quasi-experimental investigation on the effects of activity-based instruction and traditional based instruction on fifth-grade students (50 students, 25 treatments, and 25 control). Open-ended questions were administered before and after learning about probability. The results indicated that activity-based instruction was more effective than traditional in students' learning about probability.

Reneau (2012) used a single-case multiple-baseline across participants to investigate the use of the concrete-to- representation-to-abstract sequence, applying virtual manipulatives to solve equations and word problems with fractions. He investigated five fifth-grade students receiving special education services who had been diagnosed with a specific learning disability. The results indicate that all students gained in performing mathematically when using the concrete-to-representation-to-abstract sequence. Results of this study may be applicable to early grade learners and their use of manipulatives when using the concrete to-representation – to-abstract sequence. Graham (2013) investigated the use of manipulatives in upper elementary classrooms, exploring third-, fourth- and fifth-grade teacher perceptions. This case study assisted leaders in understanding the association between teachers' perceptions and the problems associated with concrete math manipulatives' disuse. Observations, interviews, and documents from three teachers were analysed and coded. The results indicate concrete math manipulatives enhance student learning. However, teachers need training (professional development) to use concrete mathematics manipulatives as components of the state standards.

Morris (2014) investigated the impact of virtual manipulatives on 12 fourth-grade

students' mathematics performance in adding and subtracting three- to six-digit whole numbers. One treatment group used virtual manipulatives, and of the two control groups, one used pencil, paper, and worksheets, and the other used concrete manipulatives. The results indicate that the three groups showed improvement between the pre-test and post-test. However, significant improvement exists for those students who participated in the virtual manipulative group. Dahl (2011) studied the impact manipulatives have in elementary and middle school mathematics classrooms, in addition to the impact manipulatives have on students' understanding and enjoyment for learning mathematics. The research also identified struggles, concerns, and the needed increase in professional development for teachers in using math manipulatives.

2.6. Types of Manipulative Used in Teaching Numeracy

There are vast varieties of manipulatives that can be used during mathematics lessons. Teachers need to know what types of manipulatives are available so they can access them for their own classrooms. Manipulatives should foster children's concepts in specific areas such as numbers and operations, patterns, geometry, measurement, probability, reasoning, and more (Boggan, et al., 2010). There are certain manipulatives used in each of these areas. Base-ten blocks are popular manipulatives that come in a set and used to teach numbers and operations (Boggan, et al., 2010). The complete set, seen in *Figure 2.1* includes a "cube" *(Figure 2.1 (a))* representing one thousand, a "flat" *(Figure 2.1 (b))* representing one hundred, a "long" *(Figure 2.1 (c))* (sometimes called a "rod") representing ten, and "units"

(Figure 2.1 (d)) representing ones (sometimes called "minis" or "ones"). Base-ten blocks can also be printed from a template and laminated if purchasing the set is not feasible. They are vastly used in early elementary classrooms and often used to teach place value as well (Loong, 2014). Students frequently mix up the value for each digit in a number, which leads to confusion. Place value mats and base 10 blocks are jointly used to help students overcome this. *Figure 2.1(e)* shows a place value mat with the four columns, each representing a different place value with a picture of the respective base 10 block. For example, the column labelled "flats" is where students would place any number of flats to represent the hundreds place. Flats, longs, and units can be seen on the students' desks as they work on modelling different numbers.

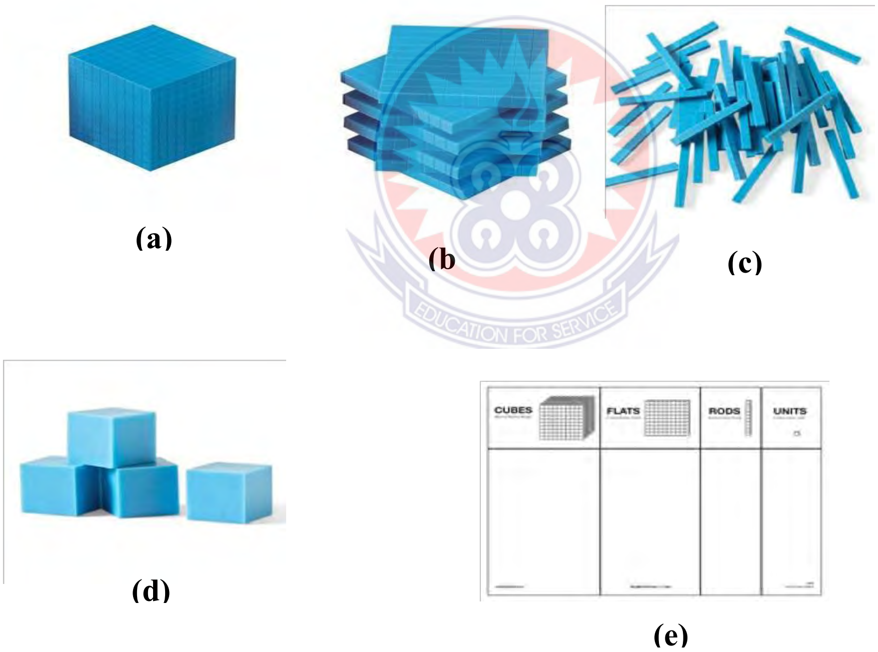


***Figure 2.2*: (a) A Cube, (b) A Flat, (c) A long, (d) A Unit, (e) Place Value Mat**

It is vital that students first understand place value before they move on to number and operations. Students can easily mix up digits when performing addition, subtraction, multiplication, and/or division if they do not understand place value. For example, if a teacher asked a student to illustrate the number 341 using the base-ten blocks, the student would need to understand there would be three flats, four longs, and 1 unit. Once students understand place value, they can use the base-ten blocks and place value mat to guide them when solving problems. Base-ten blocks are a great tool to use to teach addition, especially when digits must be carried over. They are also helpful to teach subtraction when regrouping must be carried out (Loong, 2014). To summarize, a set of base-ten blocks is a valuable resource for students in the classroom to learn numbers and operations.

A geoboard is a manipulative used to assist in the learning of geometry. A geoboard is a board with nails or pegs lined up in rows and columns (Loong, 2014). They can come in different sizes and colours. Geoboards are used by wrapping rubber bands around the nails or pegs to create shapes and learn geometry. *Figure 2.2(a)* displays yellow geoboards with common shapes. Geoboard templates can also be printed, but the aspect of making shapes with the rubber bands would not be possible. This takes away the point of physically handling a manipulative. Geoboards are helpful when trying to identify simple geometric shapes such as squares, rectangles, circles, and triangles (Boggan, et al., 2010). They also develop problem-solving and teach patterning, perimeter, and symmetry (Goonen & Pittman-Shetler, n.d.).

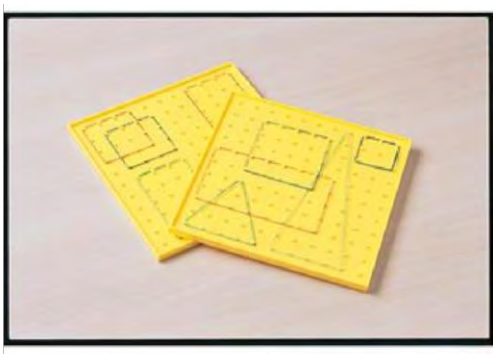
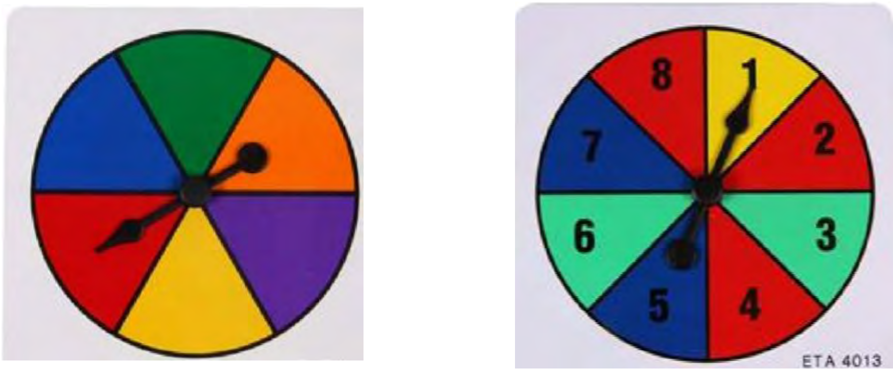


***Figure 2.3*: (a) Geoboards**

Other concepts geoboards can illustrate are area, perimeter, and rational number concepts (Monte, 2021). Students often confuse the terms area and perimeter. Sometimes they use the two interchangeably and the units are wrongly attributed. A geoboard is an effective tool to help students overcome misconceptions about area and perimeter as described below. One of the most common misconceptions students have is they think shapes with the same perimeter have the same area. By counting the number of squares or the lengths of the sides, area and perimeter can be differentiated. A geoboard is also an ideal tool to explore how the area of a shape changes with the perimeter. Geoboards promote critical thinking as students investigate the relationships among shapes, area, and perimeter (Loong, 2014). To summarize, geoboards are tremendously useful for students to learn about different concepts in geometry.

Spinners are manipulatives used in probability. Spinners are used to find the probability of landing on a designated area (Boggan, et al., 2010). Seen in *Figure 2.3*, a spinner is a circle with an arrow in the middle that gets spun around a central point. They can be split up into any number of parts, and the parts can represent anything. The most common parts that spinners are split into are colours, numbers, words, and pictures. For example, the spinner below in *Figure 2.3(a)* has six different colours (blue, green, orange, red, yellow, and purple). If a student spins it once, they have a one out of six (1/6) chance of landing on blue since there is only one blue section out of the six-total number of sections. The spinner in *Figure 2.3(b)* differs from *2.3(a)* because it has four different colors (red, blue, green, and yellow), and is divided into eight parts instead of six. Spinners can also be used to test multiple possibilities by spinning more than once.



(a) **(b)**

Dice are manipulatives also used in probability. They are used to find the probability of rolling a certain number or combination of numbers (Boggan, et al., 2010). Seen in *Figure 2.4*, dice are cubes with a certain number of dots on each side to represent a number that ranges from one to six. For example, if a student rolls a die and wants to roll a five, they have a one out of six (1/6) chance because a die has one five out of six possible outcomes. They come in variety of sizes, colours, and used in many games. There are dice templates that can be printed out and assembled, but may rip easily since paper and tape is not completely sturdy. Most dice are made from plastic, but some are also made from foam.

Figure 2.4: Dice. Teacher Created Resources.

Playing cards are a third type of manipulative used in probability. They are used to find the probability of picking a certain number, suit, or combination of the two. They are also used in many different games. Playing cards come in decks of fifty-two cards each that contain four different suits: spades, hearts, clubs, and diamonds. *Figure 2.5(a)* shows a ten and ace of spades, a jack of hearts, a queen of clubs, and a king of diamonds. *Figure 2.5(b)* shows multiple decks of cards with a storage bin that can be used in a classroom. These are inexpensive and easily accessible manipulatives for teachers to have in their classrooms.

(a)

(b)

***Figure 2.5*: (a) Playing Cards and (b) Playing Cards with Storage Tote**

Pouw, VanGog, & Paas (2014) indicate that when students interact with manipulatives their reasoning resources are focused on those objects. Students use the interaction with manipulatives to learn more and to gain a better understanding of mathematical concepts. According to Hurrell (2018), using manipulatives is a prerequisite for students learning and being able to physically manipulate the materials is beneficial to the learner. Hurrell (2018) conducted a quantitative research study examining how Kindergarten students utilized manipulatives. Hurrell (2018) investigated how the Kindergarten students physically handled the materials and had discussions with the students to gain a better understanding of how using the manipulatives in mathematics helped with concept development. The students were given the individual Popsicle sticks. Once they had ten of them, they traded it in for a bundle, which had ten sticks. The students gained a better understanding of place value by using manipulatives.

Thirey and Wooster (2014) conducted a quantitative research study in a freshman calculus course that took place at West Point Military Base exploring the effects of using construction paper as a manipulative while learning calculus math skills. Of the 18 students in the calculus mathematics class, all of the students reported that the use of construction paper as a manipulative gave them a better understanding when learning the properties of calculus. The findings of this research study encouraged further use of manipulatives in teaching calculus. Similarly, a study by Hurst and Linsell (2020) agreed with Thirey and Wooster's (2014) findings that manipulatives increase student's learning. Hurst and Linsell (2020) conducted a quantitative research study where they required 32 students to use bundling sticks as manipulatives to demonstrate their understanding and reasoning skills in multiplication, division, and place value mathematics skills.

From this study, Hurst and Linsell (2020) found that when the students used the manipulatives their math assessment scores and conceptual understanding of math skills improved. In this study, it was noted the importance of teachers physically modelling the use of the manipulatives so students grasped a better understanding of the concrete material use (manipulative) in terms of math skill development. Much like Thirey and Wooster (2014) findings, that construction paper used as manipulatives gave the calculus students a better approach to the properties in learning math skills, Hurst, and Linsell (2020) findings showed increase in math understanding and reasoning skills by the use of manipulatives. The research shown in Thirey and Wooster (2014) and Hurst and Linsell (2020) showed that manipulatives are beneficial to a learner at any age with a variety of concepts.

In a qualitative research study by Presser, Vahey and Dominguez (2015), the use of manipulatives and online games were used in a preschool classroom to examine the effect on skill development. Sixteen teachers with 8-10 students in each class were given the use of manipulatives and online games. The students were given a pre and post standardized assessment to assess the impact of the manipulatives and online game use. During the study, the findings revealed that the preschool students struggled with having time in the day to use manipulatives or online games for skill development. The teachers in this study found the manipulatives and online games useful and convenient to use with their students and curriculum.

In a similar study, Tucker and Shumway (2021) conducted a qualitative research study with 33 students in second grade who were given virtual manipulatives (VM) when learning about how a number line works in mathematics. The virtual number line had animals that faced left if they were negative and faced right for positive numbers. Student interviews and observations were collected for data. The findings of this study concluded that the students loved using virtual manipulatives and gained a better understanding of the positive and negative number line concepts.

A quantitative research study completed by Loong (2014) confirmed the findings in both Tucker and Shumway (2021) and Presser, Vahey, and Dominguez (2015) research about the positive effects of using virtual manipulatives in the classroom. Loong (2014) completed a quantitative research where students used virtual base-10 blocks and placed them on a computer mat where they were able to manipulate the blocks to work through multiplication and division of fraction math problems. The students in the study had more of an understanding of place value and fractions than before. In comparison, Gecu-Parmaksiz and Delialioglu (2019) conducted a quantitative study with 72 participants at 1 school. The study was conducted over 4 weeks and looked at the influence of the virtual manipulatives with the first graders geometry over concrete manipulatives. Gecu-Paramaksiz and Delialioglu (2019) found virtual manipulatives to be more impactful for the students than the concrete manipulatives that they used. Students struggled identifying the difference between a square and a rectangle, but still showed improvements on identifying the shapes that were taught.

This section explored different types of manipulatives that are applicable for numbers and operations, geometry, and probability. There are many more manipulatives. Monte (2021) observed that students using manipulatives in specific areas are more likely to achieve success than students who do not have the opportunity to work with manipulatives. They are found to provide a strong foundation for students to master concepts in specific areas. In closing, teachers can integrate these manipulatives into lessons to assist students on their way to success.

2.7. Methods Teachers Use in Teaching Numeracy Using Manipulatives

We are talking about the methods that we can use in teaching numeracy using manipulative materials at the kindergarten level such as grouping method, discussion method, role play method discovery method etc. The method using should meet the developmental level of the pupil and should meet their learning needs. However, there are a lot of teaching methods that can be used in teaching numeracy but the teacher should try and consider the children developmental level (NTCM, 2000).

The grouping method can be used during sorting lesson in numeracy with a lot of bottle tops, blocks, seeds etc., and the sorting can be done according to colours, shapes, size, texture, use etc. The discussion method too can be used by matching objects according to colours, shapes, size, use and the others. The role play method can also be used to learn ordering according to colours, shapes, sizes, textures, etc. Again, the discovery method also can be used to perform the above mentioned activities like sorting, matching, ordering, etc., with the above listed materials. Teaching methods are changing. One component of the current redevelopment of all subject area curricula is the change in focus of instruction from the transmission curriculum to a transactional curriculum (NTCM, 2000).

In a traditional curriculum, a teacher transmits information to students who passively listen and acquire facts. In a transactional curriculum, students are actively involved in their learning to reach new understandings. Constructivist teaching fosters critical thinking and creates active and motivated learners. Zemelman, Daniels, and Hyde (1993) tell us that learning in all subject areas involves inventing and constructing new ideas. They suggest that constructivist theory be incorporated into the curriculum, and advocate that teachers create environments in which children can construct their own understandings.

According to Hamzeh (2014), there are several teaching strategies that can be used by teachers to improve the academic performance of the students in mathematics. Those teaching strategies are accounted for in different time periods and applied inside the classroom. The most common one is lecture type. It is an instructional method where the teacher who possesses the knowledge on a given topic delivers all relevant information to students verbally. The person presenting the lecture was called a reader because the information in the book was read to students who would then copy the information all down (Goffe & Kauper, 2014). Cooperative learning is a simple strategy that allows students to work and solve a problem with a pair or a group (Razak, 2016). When a teacher has provided the basic instruction, s/he will then split the class into pairs or groups to work on problems (Chan & Idris, 2017). Since the pairs are working as a team, the students can discuss the problems and work together to solve them. The goal of cooperative learning is to teach students critical thinking skills that are necessary for future math problems and real life (Sari, Mulyono, & Asih, 2019; Zakaria, Solfitri, Daud & Abidin, 2013).

A simple strategy teacher can use to improve mathematics skills is repetition or repetitive exercise. By repeating and reviewing previous formulas, lessons, and information, students are better able to comprehend concepts at a faster rate (Bates, 2020). According to Wilson (1999), the core concepts of basic mathematics must be mastered before students are able to move into a more advanced study. Repetition is a simple tool that makes it easier for students to master concepts without wasting time. A strategy which connects other subject matter in other subject area is called integrative approach. This is another way of organizing those learnings that came from another subject area and making an instructional design be interesting and integrative (Panicker, 2014). In this strategy, all the factors that can contribute to the teaching-learning process are considered (Adunola, 2011).

Demonstration method of teaching is another form of traditional classroom strategy that requires step by step process of solving math problems (Ramadhan & Surya, 2017). It focuses on achieving psychomotor and cognitive objectives. Another approach that teaches the students to learn how to learn rather than what to learn is induction. This is an effective approach for helping students to understand concepts and generalizations and for developing their higher-order thinking skills (Rahmah, 2017). The inductive approach is a much more student-centred approach that makes use of a strategy known as 'noticing.' Here, various facts and examples are presented to the learners from where they have to find out rules or establish a general formula. Therefore, it is a method of constructing a formula with the help of an adequate number of concrete examples (Singh & Yadav, 2017). Meanwhile, the deductive approach is the opposite of the inductive approach, where the teacher conducts lessons by introducing and explaining concepts to students and then expecting students to complete tasks to practice the concepts. In this approach, all the general ideas or information are given to the students and the specific ideas or information are discussed later (Singh & Yadav, 2017; Adunola, 2011)

2.8. Challenges Teachers Face in Using Manipulative.

Many teachers admit that they do not use manipulatives because they are not readily available (Hatfield, 1994). Hatfield discovered that manipulative availability was a factor considered by 81% of the teachers who responded to her survey, and availability ranked first on the list of factors to consider when deciding whether to use manipulatives in their classroom. Eighty percent of teachers reported that another factor they consider is teacher competency in teaching mathematics using manipulatives.

Jones, Burton, and Davenport (1984) discovered that many causes were cited as to why certain students do not do well in mathematics: parental contribution, low expectations of minorities, and the courses to which minorities are assigned but there is nothing mentioned about the use of manipulatives. In Bryant's (1992) study it is concluded that an "effective in-service for teachers on the appropriate use of manipulatives, peer tutoring, collaborative teaching methods, and computer use, were successful solutions to improving mathematics achievement for at-risk and targeted students.

In a survey by Scott (1987), teachers were asked whether they wanted in-service training on the use of mathematics materials. The majority responded that they would like to have training on the use of manipulatives. Workshops and other assistance programs at many schools were then dedicated to helping the teachers learn how to effectively use mathematics manipulatives and courses at many universities were offered (p. 21). In Gilbert and Bush's (1988) study, over three-fourths of the teachers participating in the study reported availability of manipulative devices, expect for fraction bars and math balances, as a factor for hindering the use of manipulatives.

It was also revealed that experienced teachers tend to use manipulative devices less often than inexperienced teachers do. Tooke et al. (1992) interviewed thirty teachers of the 4th through 8th grades about their attitudes towards manipulatives and the confidence they had when using manipulatives to teach mathematics. Their findings were in direct opposition to the ones by Scott (1987). The participating teachers in Tooke's study stated that the reason for their refusal to use manipulative instruction was that many of them did not know how to use manipulatives; much less what concepts, skills, or abilities the manipulatives were to be used to teach. However, not one teacher was willing to learn the use and purpose of manipulatives if they had to spend their own money and time, and definitely had no interest in enrolling in a university course to learn (Tooke et al, 1992).

Many of the negative attitudes towards the use of manipulatives by teachers of mathematics are because teachers feel that: (1) manipulative instruction is inappropriate for students above the fourth grade; (2) the students are confused by manipulatives and, (3) many teachers say that manipulatives are not worth the expense (Tooke, et al, 1992).Teachers also claim that there is not enough time to use manipulatives, using manipulatives is too much like playing games, and they are difficult to manage with large numbers of students (Herbert, 1989).Prospective teachers resist using manipulatives in the classroom for two reasons: (1) lack of confidence in their ability to use manipulative materials correctly and, (2) the general belief that children will become too dependent on these materials and as a result, will not master basic computational algorithms and related concepts (Trueblood, 1986).

According to Monte (2021), there are several possible reasons why mathematics teachers do not use manipulatives in their lessons. One reason is because of the lack of funds to purchase manipulatives or the shortage of time to develop the hands-on materials. Depending on the school district and their budget, teachers may not have the funds to pay for manipulatives. This is unfortunate, since manipulatives are made to help students learn mathematics. As the research has shown, students benefit from having the opportunity to work with manipulatives in meaningful ways. The less funding a school has, the less resources they can provide for their students.

If teachers do not have access to purchase manipulatives, they could print or make their own. Teachers can print out and cut manipulative templates as described in the "Types of Manipulatives" section, or they could make their own with other materials. For example, a teacher could glue ten beans on a Popsicle stick to make a rod, and glue ten of them together to make a flat to represent base 10 blocks. However, this is time consuming, which means teachers lose a great chunk of their time due to the lack of funding when they could be doing something else to better benefit their students (Monte, 2021).

A second reason why teachers may not use manipulatives is because they fear a breakdown in classroom management. Using manipulatives works nicely in a cooperative learning setting. However, lessons using manipulatives may be noisier and messier. Manipulatives also require a great deal of planning and organizing. These aspects of manipulative use may push teachers away from the chance of using them in their lessons. Teachers may cut out the idea of using manipulatives when they think about the prep work and clean-up. Although classroom management may be a potential hurdle when using manipulatives, there are tactics teachers can use to diminish the chance? Possibilities include planning and organizing during prep periods, having a teacher's aid to help set up and monitor students, setting up when students are at lunch and recess, having a student teacher help, or having students who complete their work early help. These possibilities make it more manageable for a teacher to use manipulatives without a fear of breakdown in classroom management (Monte, 2021).

A study by DeLoache (2000) illustrates how children's knowledge of an object as a toy can hinder their ability to use it symbolically. In the study, children's goal was to use a scale model of a room to locate an object hidden in a larger room. Children were randomly assigned either to an experimental condition, in which they played with the scale model before using it to locate the object in the larger room, or to a control condition, in which they did not play with the model beforehand. Children who played with the model beforehand performed much worse on the search task than did children in the control condition. This result suggests that children's knowledge of the scale model as a toy interfered with their ability to use it symbolically as a representation of the larger room. This implies that researchers need to consider children's established knowledge when hypothesizing about the effects of various manipulatives.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter spells out the methodology of the study. It describes the procedures at data collection and analyses. It presents the research method chosen for this study and justifies its fitness for the objectives of this study. This chapter covers the research design, study area, population of the study, sample and sampling technique, research instruments, pre-testing of instrument, validity and reliability of instruments, data collection procedure, data analysis procedure and ethical considerations.

3.1. Research Philosophy

Creswell (2008) indicate that in conducting a research, the researcher needs to think about the philosophical worldviews. The strategy of enquiry related to the worldviews and the methods and procedures of the research. Thus, this research was founded on pragmatist philosophy. Pragmatist philosophy was chosen because it allowed the researcher to use mixed method approach to find out teachers use of manipulatives in teaching numeracy at early childhood centre in the Nkoranza North District. Pragmatist philosophy holds that human actions can never be separated from the experiences and from the beliefs that have originated from those experiences (Goldkuhl 2012). A major underpinning of pragmatist epistemology is that knowledge is always based on experience. Human thoughts are thus intrinsically linked to action. People take actions based on the possible consequences of their action, and they use the results of their actions to predict the consequences of similar actions in the future (Morgan 2014a).

3.2. Research Approach

The study was based on mixed method approach. Mixed methods approach was used in this study because it helped to provide more evidence for studying the research problem than either quantitative or qualitative study alone. With mixed methods, the researcher was able to use all of the tools of data collection available rather than being restricted to the type of data collection typically associated with quantitative or qualitative research. Thus, mixed methods helped in using questionnaire, interview, and observe some of the characteristics investigated. Mixed methods research also, helped in answering questions that could not be answered by quantitative or qualitative approach alone. The core assumption of the mixed research approach is that mixing quantitative and qualitative methods provides a complete understanding of the research problem than using only one type of methods (Creswell, 2014). For example, Mitchell (2018) found out that using mixed method approach provides both quantitative and qualitative reasoning that lead to best data explanation and best understanding for the studied research phenomena.

3.3. Research Design

An explanatory sequential mixed method design was used in the study. The explanatory sequential mixed method design was used because it assisted the researcher in collecting and analysing quantitative (numeric) data first, followed by qualitative data that helped to explain or elaborate on the quantitative results obtained. Furthermore, the rationale for this design is that the quantitative data and subsequent analysis provided a general understanding of the research results by in-depth exploration of participants' perspectives. According to Creswell (2014), an explanatory sequential mixed method design is a research design in which a researcher conducts quantitative research first, followed by qualitative research. The qualitative research is carried out by the researcher in order to provide additional explanation for the quantitative research findings (Creswell, 2014).

3.4. Study Area

This study was conducted at Nkoranza North in the Bono East Region. Nkoranza North has a population size of 78,446 inhabitants, the District was carved from the then Nkoranza District which is the District capital in 2007 and was inaugurated in February 2008. Nkoranza North is located between Kintampo South and Nkoranza South in the Bono East Region. This district shares boundaries with Kintampo South to the North, Nkoranza South district to the South, Atebubu Amantin district to the East and Techiman North to the West. Farming is the major occupation of the people in the district, about 97.5% of the inhabitants were farms, and the remaining 22.2% of the inhabitants too were engaged in some small trading. The economy of the district was mainly agricultural activities. The crop sub-sector dominates the agricultural sector and employs a percentage of 97.5 of the labour force employed in the sector. Maize is the major crop produced in the district. Others include cassava, yam, cocoyam, plantain, groundnut, cowpea, tomato, beans, sorghum, etc. The major cash crop is cashew.

The district currently has Fifty-six (56) public Kindergarten (KGs), Fifty-Four (54) public primary schools, Forty-Three (43) JHS and two (2) SHS. There are One hundred and Twelve (112) classrooms for Kindergartens (KGs), One hundred and Twenty-Nine (129) for JHS and Seventeen (17) for SHS. There are Three Private Schools in the district, which are located in Busunya in the district capital, Dromankese, and Yefri. The private schools in Busunya and Dromankese have K.G, primary and JHS whiles the one in Yefri has only K.G and primary. Sixteen of the Fifty-Six (56) schools are under trees. But this study is focuses on only kindergarten levels in Nkoranza North District.

3.5. Population of the Study

According to Agyedu, Donkor and Obeng (2011), population in research is the complete set of individuals (subjects), objects or events with common observable features for which a researcher is interested in studying. It is also regarded as the larger group from which individuals are selected to participate in a study. Target population is the large group of people, which has one or more characteristics in common on which the research study will be focused (Kothari 2004) whiles accessible population is the research participants who are available for participation in a given research (Johnson & Christensen 2012).

The target population of this study were all early grade teachers, School Improvement Support Officers (SISOs), and early childhood coordinators in the district. However, the accessible population for this study were kindergarten teachers, School Improvement Support Officers, and early childhood coordinator. Information obtained from the district indicates that there were one hundred and eighty early grade teachers, sixty-five kindergarten teachers, eight School Improvement Support Officers, and two early childhood coordinators.

3.6. Sample and Sampling Technique

Neuman (2006) reiterated that a sample is a smaller set of cases a researcher selects from a larger pool and generalizes to the population. For Agyedu et al. (2011), a sample consists of individuals, objects, or events that form part of the population.

Thus, a sample is a collection of a part or subset of the objects or individuals of a given population which is selected for representing the population of interest. Hence, the sample size for this study comprised of forty kindergarten teachers, four School Improvement Support Officers, and one early childhood coordinator.

Sampling, according to Bless and Higson-Smith (2000) is a process of selecting the units of the target population which are to be included in the study. Osuala (2003) posited that sampling in itself is not a technique for data collection but it makes sure that any technique used will help collect data from a smaller group, which could accurately represent the whole group. He further explained sampling as a way of selecting from a larger population, a group about which a generalized conclusion can be made. Also according to Osuala (2003) and Fink (2004), sampling is efficient and precise in that those resources that might go into collecting an unnecessary number of individuals or items can be spent on other activities of the research. It helps focus the survey on precisely the characteristics of interest samples which are expected to be representative of the population. Samples are therefore chosen by means of sound methodological principles. Purposive and simple random techniques were used in this study.

Simple random technique was used to select the kindergarten teachers from the 56 kindergarten schools to respond to the questionnaire. Crossman (2013) stated that simple random sampling technique is the basic sampling technique assumed in statistical methods and computations. The simple random sampling technique is where sample units are drawn directly from the population by some procedure. Mostly, a random sample table or a mathematical random process such as lottery method designed to meet the essential criterion of randomness, thereby, giving all elements in the population an equal chance of being selected from the population is used (Crossman, 2013).

Knowing the number of kindergarten schools to be fifty-six and their location in the district, the researcher wrote Yes and No on pieces of papers together with blank papers. The pieces of paper were folded and put in a box. The box was turned repeatedly to ensure that the pieces of paper were well mixed to guarantee that each kindergarten teacher had an equal opportunity of being selected. In each kindergarten school visited, kindergarten teachers were required to pick the pieces of paper at random. Kindergarten teacher who picks a piece of paper with Yes response was enrolled as the study participant for the stud. In all, forty (40) kindergarten teachers were selected. Random sampling was used here because the researcher wanted the sample method to be free from preconception and unfairness just as (Creswell, 2014) asserted. According to Showkat and Parveen (2017) and Saunders et al (2012), the method of lottery is the most primitive and mechanical example of random sampling where you have to number each member of population in a consequent manner, writing numbers in separate pieces of paper. This activity is straightforward and helps the researcher to avoid being biased.

Purposive sampling technique was used to select School Improvement Support Officers and an Early Childhood Coordinator. Purposive/Judgemental sampling technique is a technique where the selection of the sample is based on the researcher's knowledge of the population and the purpose of the study (Crossman, 2013). This technique was used to select four School Improvement Support Officers and one early childhood coordinator. This was done with the help of the criteria given, thus the researcher hand-picked them to be included in the study. The criterion was that the

School Improvement Support Officers must be supervising in the schools within the district and the Early Childhood Coordinator must be working in the district. Participants who met this criterion were 4 School Improvement Support Officers, and 1 Early Childhood Coordinator. Therefore, the study had a sample size of 45 participants. Creswell (2014) states that purposive or judgemental sampling technique is the process whereby the researcher selects a sample based on experience or knowledge of the group to be sampled.

3.7. Data Collection Instruments

Questionnaire, interview guide, and observation guide were the instruments used to collect data for the study.

3.7.1. Questionnaire

A questionnaire is a type of research instrument that consists of a series of questions and other prompts designed to elicit information from respondents (Creswell, 2012). Questionnaires were used in this study because it was less expensive and helped the researcher to collect data from respondents on a larger scale. According to Creswell (2012), a questionnaire has the advantage of being less expensive than an interview. They produce quick results and provide great assurance of anonymity, typifying that the questionnaire is widely used for data collection in educational research because it was designed to answer research questions; it is very effective for securing information about practices, as well as inquiring into opinions and attitudes of the subject (Creswell, 2012).

A questionnaire that had closed – ended items was administered to the sampled kindergarten teachers. Responses to each of the items was rated using a 5 –

point Likert scale which was coded as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, and 5 = Strongly Agree, in other to obtain their views on a set of given statements. The 5-point scale ranged from 1 to 5. The points were only for identification, and they do not imply that one response is superior to another (Brown, 2001). To understand the mean scores, items/statement on research questions that scored a mean of,

a) 4.00 – 5.00 is regarded as strongly agree which is interpreted as Highly Yes.
b) 3.00 – 3.79 is regarded as agree which is interpreted as Yes.
c) 1.80 – 2.59 is regarded as disagree which is interpreted as No.
d) 1.00– 1.79 is regarded as strongly disagree which is interpreted Highly No.

This interpretation is only applicable to all the research questions. This interpretation helped the researcher to establish whether teachers' use manipulatives in teaching numeracy at early childhood centres. Chang (1994) used a model approach to evaluate 4- and 6-point scales after fitting empirical data and concluded that the scale points had no effect on criterion-related validity. The Likert scale was used because it is relatively easy to construct, it facilitates quantifications of the responses, and enables ranking of items thus tendencies can be identified and improves the response rate at the respondents are more likely to respond to all the statements in the instrument (Kothari & Garg, 2014).

The questionnaire for kindergarten teachers had five main sections, A, B, C, D and E. Section A consisted of seven items eliciting basic information on the respondents' background. These were the respondents' sex, age, academic and professional qualification, rank, teaching experience and present class. Section B had seven items eliciting information about the manipulative materials available at the early childhood centre. Section C of the questionnaire had seven items on the type of manipulative materials teachers use in teaching numeracy at the early childhood centres. Section D of the questionnaire also had seven items on the skills teachers use in teaching numeracy manipulatives at the early childhood centres. The last section (E) consists of seven items focusing on the challenges faced by teachers when using manipulatives in teaching numeracy at the early childhood centres. This can be seen in Appendix A.

3.7.2. Interview Guide

The second phase of the data collection for this study was done by using interviews. As reported by Zohrabi (2013) and Burns (2009) an interview is a popular and widely used means of collecting qualitative data. By using an interview for data collection, the researcher gets first-hand information directly from targeted respondents. Flick (2006) adds that an interview reveals exiting knowledge on an issue in a way that can be expressed in the form of answers and so become accessible to interpretation. In his view, Zohrabi (2013) said an interview can be conducted in two forms: person-to-person and group or collective formats. According to Merriam (2014), both forms of interview are a kind of goal oriented conversation. Structured, semi-structured, unstructured, and focused group interviews are the different types of interviews. However, semi-structured interviews were used in this study.

Semi-structured interviews were chosen because it allowed the interviewees to freely express their thoughts, feelings, and experiences, and also allowed the interviewer not to deviate from items or questions on the schedule to seek clarification during the interview process. According to O'Leary (2014), semi-structured interviews are neither fully fixed nor fully free, and are perhaps best viewed as flexible. Interviews typically begin with a predefined questioning plan, but a more casual and conversational style of interview may result in questions being answered in an order that is natural to the flow of the conservation (O'Leary, 2014, p.164).

According to Wragg (2002), semi-structured interview guide allows the interviewer to ask initial questions followed by probes to seek clarification on issues raised. Making the interview process as adaptable as possible. This knowledge, according to Flick (2006), contains both explicit and implicit assumptions, which are expressed when interviewees are given the opportunity to respond to open questions. The qualitative researcher believes that because participants have lived in their communities or socio-cultural contexts, they have extensive knowledge about the phenomenon under investigation. Using a semi-structured interview guide allows participants to create their own world. Semi-structured interview guide was used in this study because it allows participants to express themselves freely and also provides enough structure to prevent aimless rambling.

The semi-structured interview (Appendix B) focused on three themes. The first theme was on the manipulative materials available at early childhood centres. The second theme was on the skills teachers exhibit in teaching numeracy using manipulatives at early childhood centre and the third theme focused on the challenges faced by teachers when using manipulatives in teaching numeracy at early childhood centres.

3.7.3. Observation Guide

The researcher used an observation guide (Appendix C) to collect data. According to Cohen, Manion and Morrison (2007), observation method implies the collection of information by way of observing without interviewing the respondents. They further explained that the information obtained relates to what is currently happening and is not complicated by either the past behaviour or future intentions or attitudes of respondents. Observation as a research tool is pre-planned and carried out purposefully to answer research questions (Zhrabi, 2013).

The researcher employing this method observed classroom interactions and events as they actually occurred (Burns, 2009). Flirk (2006) also contends that observation is an attempt to observe events as they naturally occur. To end this, Merriam (2014) believes that observation is a kind of data triangulation in order to substantiate the finding. This method was used to collect information on the type of manipulative materials in the classroom and those used during numeracy lessons and what teachers do when manipulative materials were not promptly supplied. It gave first-hand information on the state of the manipulative materials in the classroom and the centre as a whole. The classroom observation (Appendix D) also consisted of one section which focused on the type of manipulative materials teachers often use in teaching numeracy at early childhood centres.

3.8. Pilot-Testing of Instruments

To establish validity and reliability of the instruments applied, the researcher conducted a pilot testing prior to the actual data collection. The pilot testing helped the researcher to detect early warning about where the main research questions will fail, where research protocols may not be followed, or whether proposed methods or instruments are inappropriate or overly complicated. The instruments were administered to two School Improvement Support Officers, one early Childhood Coordinator, twelve Kindergarten teachers at early childhood centres in Kintampo district schools. This district was chosen because its characteristics are similar to those involved in the main study. The researcher explained the instruments to them and their feedbacks helped the researcher to make changes and reframed some of the statements.

3.9. Validity and Reliability of Instruments

3.9.1. Quantitative (Questionnaire)

Validity was ensured by assessing the questionnaire items during their construction using content and face validity. Validity is the extent to which research instruments measure what they are intended to measure (Oso & Onen, 2005). For face validity, the instruments were given to colleague Master of Philosophy students of the Department of Early Childhood Education in the University of Education, Winneba for scrutiny and peer review. For content validity, the instruments were given the supervisor and early childhood coordinators for expert review. They scrutinised the items for their suitability before pre-test. Content validity is a measuring instrument which gauges whether there has been adequate coverage of the investigative questions guiding the study (Creswell, 2003). It indicates that the technique assesses or measures what it is supposed to measure (Creswell, 2009). It is a judgmental assessment on how the content of a scale represents the measures.

In this study, reliability of the questionnaire was tested using Cronbach Alpha that is the most common means of testing internal consistency of the items, using the SPSS software package version 26.0, through a pilot test that was conducted with 12 public kindergarten teachers that was not part of the main work. In this study, internal consistency was tested on the questionnaire by means of Cronbach alpha statistics with the help of SPSS software version 26. The analysis yielded a Cronbach's alpha coefficient (α) of 0.89 which is deemed as an acceptable measure of reliability because this is above the 0.70, the threshold value of acceptability as a measure of reliability as noted by Dörnyei and Taguchi (2010). According to Mugenda and Mugenda (2003), an instrument is judged highly reliable for a research if its reliability coefficient is above 0.5. This result implies that the instrument was reliable; hence, it was used for the study.

3.9.2. Qualitative (Interview guide and Observation guide)

In order to make the research findings convincing and trustworthy, the researcher considered the issues of credibility, transferability, dependability, and confirmability (Lincoln and Guba, 1985). To ensure credibility, which can replace internal validity, the researcher recorded the interviews and classroom activities for accurate interpretations and used member checks techniques as suggested by Teddie and Tashakkori (1998) and Singh (2007). After transcribing the interviews, the researcher provided each interviewee with the transcribed version and the corresponding recorded interview to check that the transcriptions are identical to what they said in their interviews.

Transferability, which should replace external validity, was addressed by providing thick description of the situation studied and documenting all steps of research. The explicit description of the research process, methods of data collection, analysis, and interpretation highlights the detailed steps of my research and provides a thick description of the whole research process. Dependability or reliability was increased in this study in two different ways. First, the researcher used the same interview and observation guides that has been carefully designed, worded, and piloted while conducting interviews and observing. Second, the researcher transcribed the interviews accurately and provided interviewees with the transcribed versions for verification.

Finally, confirmability, which should replace objectivity, was achieved by auditing and triangulation. Two external audits (my supervisor and one head teacher) examined both the process and product of the research study. In addition to reviewing questionnaires, interview and observation guides before and after piloting, they helped with evaluating whether or not the findings, interpretations, and conclusions are supported by data. While acknowledging the subjective nature of interpretive research, the researcher tried to present a detailed, accurate, and non-biased account of participants' views.

3.10. Data Collection Procedure

The researcher obtained an introductory letter from the Department of Early Childhood Education in the University of Education, Winneba to facilitate the process of data collection. Research permit from the Nkoranza North District Education Office was sought before embarking on data collection. The administration of the questionnaire lasted for five school weeks. A maximum of eight (8) schools were covered each day for the field work. In each school, the researcher personally distributed the questionnaire to the respondents. The respondents were given instructions by the researcher on how to complete the questionnaire. Forty (40) minutes was used for the distribution and answering of the questionnaire. The various sub-headings of the questionnaire were discussed with the respondents. All items in the questionnaire were duly filled up by the respondents and returned for final analysis.

The interview was personally conducted on the selected School Improvement Supervise Officers and the Early Childhood Coordinator. The interview took the form of face-to-face interaction with the participants. The interview focused on the content specified by the research objectives for a systematic description, prediction, or explanation of the phenomenon under study as stated by Bryman (2006). Interviewing was employed as a data collection technique because the researcher values contact with key players who can provide privileged information. Though the interview was time consuming, it helped both the researcher and the respondents to clarify issues. Finally, the researcher personally observed the type of manipulative materials teachers use in teaching numeracy in their classrooms.

3.8. Data Analysis Procedure

Data analysis is a process of inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, informing, conclusion, and supporting decision-making (Creswell, 2012). The researcher examined all returned questionnaires for completeness and accuracy of response. This helped to detect all defective questionnaires for an appropriate action to be taken. Bell (1999) gave three stages which data collected should be taken through. These include, data coding, data input and cleaning and analysis of data. The study employed the three stages. All data was analysed using the Statistical Package for Social Science (SPSS) software version 26.0.

Descriptive statistics such as frequency tables, percentages, mean, and standard derivation was used to describe participants' responses on the manipulatives materials available at early childhood centres, types of manipulative teachers use in teaching numeracy, skills teachers exhibit in teaching numeracy using manipulatives, and challenges faced by teachers when using manipulatives in teaching numeracy at early childhood centres in the Nkoranza North District.

Qualitative data was analysed using thematic approach. Thematic approach helped the researcher to systematically search and arrange the interview transcripts or other non-textual materials that accumulates to increase the understanding of the phenomena. Thematic approach involves the identification, examination, and interpretation of patterns and themes in textual data and determines how these patterns and themes help answer the research questions at hand. Thematic analysis is a method of identifying, analysing, and reporting patterns within data (Creswell, 2014). The researcher analysed qualitative data using thematic approach because of its flexibility.

3.8. Ethical Considerations

The researcher was guided by ethical considerations which included voluntary participation, no harm to respondents, anonymity, and confidentiality, identifying purpose and sponsor, and analysis and reporting. To conduct the study, the researcher was equipped with knowledge, expertise, and due diligence, and ensured the process observed honesty and integrity. Also, the participants' informed consent was used when sampling the participants. The participants were given the freedom to choose to participate or not to in the study. Confidentiality and anonymity were achieved by not asking participants to write their names on the questionnaires. Participants' identity was not tied to the information given nor disclosed to the public. The instruments were destroyed when the research work was completed to ensure confidentiality.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0. Overview

This study investigated teachers use of selected manipulative in teaching numeracy at the early childhood centres in the Nkoranza North District. This chapter presents the results of the data collected from the respondents. The results have been organised, presented, and discussed under the following questions:

i. What are the manipulatives materials available at the early childhood education centres in Nkoranza North District?

ii. What type of manipulatives do teachers often use in teaching numeracy at the early childhood education centre in the Nkoranza North District?

iii. What skills do teachers exhibit in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District?

iv. What challenges do teachers face when using manipulatives in teaching numeracy in the Nkoranza North District?

4.1. Background Information on Kindergarten Teachers

This section considers the background information of the respondents focusing on the sex, age range, present class, academic qualification, teaching experience, rank in Ghana Education Service, and professional qualification. The result is presented in Table 4.1.

Table 4.1: Background Information of the respondents

Variable	Frequency	Percent (%)
Gender:		
Male	11	24.4
Female	34	75.5
Total	45	100.0
Age:		
26-35yrs	13	28.8
36-45yrs	19	42.2
46-55yrs	10	22.2
66 years and above	2	4.4
Total	45	100.0
Present class:		
ECE Coordinator	1	2.2
KG1	18	40
KG2	22	48.8
SISO	4	8.8
Total	45	100.0
Teaching experience:		
Less than 5 years	4	8.8
6-10 years	14	31.1
11-15 years	10	22.2
16-20 years	4	8.8
More than 20years	13	28.8
Total	45	100.0
Academic qualification:		
O' Level	2	4.4
Diploma in Basic Education (DBE)	27	60
Higher National Diploma (HND)	2	4.4
First degree	14	31.1

Total	45	100.0
Rank in GES		
Teacher	2	4.4
Senior sup II	18	40
Senior sup I	9	20
Principal superintendent	9	20
Assistant director II	7	15.5
Total	45	100.0
Professional qualification		
Graduates Professional	17	37.7
Graduate non-Professional	7	15.5
Diploma Professional	18	40
Diploma non-Professional	3	6.6
Total	45	100.0

Source; Field data, (2021)

Regarding gender of the respondents in Table 4.1., 11 (24.4%) of the respondents were males whilst 34 (75.5%) of the respondents were females. This indicate that majority of the respondents in this study were females. In addition, 13 (28.8%) of the respondents were within the age range of 26 – 35 years; 10 (22.2%) of the respondents were within 36 – 45 years; 8 (20.0%) of the respondents were within the age range of 66 years and above. This implies that majority of the respondents were within the age range of 36 – 45 years which signifies a youthful population for this study.

Concerning the present class of respondents, majority (22; 48.8%) of the respondents were kindergarten two teachers whiles minority (18; 45%) of the respondents were kindergarten one teachers. School improvement support officers 4 (8.8), ECE Coordinator 1 (2.2%), however, 4 (8.8%) of the respondents had less than

5 years teaching experience; also 14 (31.1%) of the respondents had 6 – 10 years teaching experience; 10 (22.2%) of the respondents had 11 – 15 years teaching experience; 4 (8.8%) of the respondents had 16 – 20 years teaching experience; and 10 (28.8%) of the respondents had more 20 years of teaching experience. This indicate that majority of the respondents in this study had 6 to 10 years of teaching experience.

In terms of academic qualification, 2(4.4%) of the respondents had O' Level certificate; 27 (60%) of the respondents had DBE certificate; 2 (4.4%) of the respondents had HND certificate; and 14 (31.1%) of the respondents had first degree certificate. This indicate that majority of respondents in this study had DBE certificates. With regard to the rank in Ghana Education Service, 2(4.4%) of the respondents were teachers; 18 (40%) of the respondents were senior superintendent II; 9 (20%) of the respondents were senior superintendent I; 9 (20%) of the respondents were principal superintendent; and 7 (15.5%) of the respondents were assistant director II. This indicate majority of respondents rank in Ghana Education Service senior superintendent II. Finally, 17 (37.7%) of the respondents were graduate professionals; 7 (17.5%) of the respondents were graduate non-professionals; 18 (40%) of the respondents were diploma professional; and 3 (6.6%) of the respondents were diploma non-professionals.

4.2. Data Presentation, Analysis, and Discussion of Findings

This section present, analyse and discuss findings in line with the research questions of the study. The quantitative data was first presented, analysed and discussed, then followed by the qualitative data.

Research Question 1: What manipulative materials are available at the early childhood education centres in Nkoranza North District?

The first research question sought to find out manipulative materials available at the early childhood education centres in the Nkoranza North District. The result is presented in table 4.2.

Table 4.2: Manipulative Materials Available at The Early Childhood Education Centres in The Nkoranza North District.

Statement/Item	**M**	**SD**	**Interpretation**
Counters	3.82	1.35	Highly Yes
Bundle of sticks	4.15	1.18	Highly Yes
Playing cards	3.75	1.40	Yes
Bottle tops	3.74	1.37	Yes
Number cards	4.32	1.02	Highly Yes
Clock	3.32	1.52	Yes
Number charts	4.20	1.20	Highly Yes
Average M and SD Score	**3.90**	**1.29**	**Highly Yes**

Source: Field Data (2021) ***N = 40***

Key: M = Mean, SD = Std. Deviation. Mean score range = 1.00 – 1.79 → strongly disagree (Highly No), 1.80 – 2.59 → disagree (No), 3.00 – 3.79 → agree (Yes) and 3.80 – 5.00 → strongly agree (Highly Yes)

Results presented in table 4.2 reveals an average mean value of 3.90 which implies that respondents were much aware of the manipulative materials available at the early childhood education centres in the Nkoranza North District. The average standard deviation of 1.29 also implies that respondents accept that those manipulative materials indicated in the questionnaire were available at the early childhood education centres in the Nkoranza North District. Specifically, all of the respondents were within the mean score range of 3.00 – 5.0 which shows that all of the respondents were in agreement with the statement or accepted the statement. For example, counters attracted a mean score of 3.82 (SD = 1.35); bundle of sticks also attracted a mean score of 4.15 (SD = 1.18) and playing cards attracted a mean score of 3.75 (SD = 1.40). In addition, bottle tops had a mean score of 3.74 (SD = 1.37); and number cards had a mean score of 4.32 (SD = 1.52). Finally, clock had a mean score of 3.32 (SD = 1.52); and number charts also attracted a mean score of 4.20 (SD = 1.20).

The evidence gathered from the data in Table 4.2 indicates that manipulative materials are available at the early childhood education centres in Nkoranza North district. It emerged from the results that majority of the kindergarten teachers viewed bundle of sticks, number cards and number charts as manipulatives available at the early childhood education centres. This finding implies that the availability of manipulative materials such as bundle of sticks, number cards and charts was used by kindergarten teachers to teach numeracy. These findings are in consistent with that of NCTM (2000) observation, who observed that most manipulatives in the early grade classroom include base-ten blocks, counters, three-dimensional geometric models, tangrams, geoboards, spinners, and fraction rods. According to Shichida (2008), numeral card learning for children is quite popular as a playful means to introduce children to new numbers, images, or concepts which makes it easy to learn and help children in their memorization skills. It emerged from the result that other manipulative materials such counters; bottle tops; and clock were also available at the early childhood education centres. According to Azuka and Kurumeh (2013), the use of counters helps to concretize numbers in the various number bases other than base ten. Hence, teachers are encouraged use manipulatives such counters to introduce numeracy topic like number bases to students in schools.

The findings above were further buttressed by the qualitative data. The researcher interviewed four School Improvement Support Officers and one kindergarten coordinator views on the availability of manipulative materials at the early childhood education centres in the Nkoranza North District.

One of the participants expressed that:

> *Manipulative materials for teaching numeracy are inadequate in supply. Hence, most kindergarten teachers supervised do provide counters, bottle tops and small sticks for learners during numeracy lessons. I can conclude that these are the manipulative materials I mostly see in kindergarten classrooms (School Improvement Support Officer, 1).*

Another participant said,

> *From my supervision, I realised that in most early childhood centre kindergarten teachers barely use enough manipulative materials in teaching numeracy. The ones available are the bottle tops, counters, counters, and sometimes number cards which makes lesson boring to learners (School Improvement Support Officer, 2).*

One of the participants was of the view,

> *I recall that I assisted some school heads to get some manipulative materials from the district education office such as numeral cards, number charts, shells and counters (School Improvement Support Officer, 3).*

Another participant also lamented that,

> *From the early childhood centre visited, I realised that the district education office has provided less manipulative materials for kindergarten teachers to use to teach numeracy. A few manipulative materials such as counters and bottle tops are available now (School Improvement Support Officer, 4).*

Finally, one of the participants said that,

> *Only few of the K.G teachers use manipulative materials such as counter and bottle tops in teaching numeracy (Early Childhood Coordinator 1).*

The interview responses give credence to the finding that School Improvement Support Officers and Kindergarten Coordinator have different views on the availability of manipulative materials at the early childhood centre. The findings indicate that manipulative materials such as counters, number cards, shells, bottle tops, and small sticks are available at the early childhood centres in the Nkoranza North District. These findings corroborate the view of Dondieu (2001), who averred that using teaching and learning materials like bundle of sticks, counters, number charts in teaching mathematics helps to stimulate the interest of the child, make the class lively, involve the child in the lesson, higher participation in the lesson is assured, enhances memory retention and thereby be able to associate concepts and theories. Sowell (1989) and Ruzic & O'Connell (2001) found that availability of manipulative for teacher use have long term positive effect on student achievement by allowing students to use concrete objects to observe, model, and internalize abstract concepts.

Research Question 2: What type of manipulatives do teachers use in teaching numeracy at the early childhood education centre in the Nkoranza North District?

This research question sought to identify the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres in Nkoranza North District. The result is presented in table 4.3.

Table 4.3: Type of Manipulative Materials Teachers Use in Teaching Numeracy at The Early Childhood Education Centres in Nkoranza North District

Statement/Item	M	SD	Interpretation
Geoboard	3.80	1.38	Highly Yes
Cuisenaire rods	4.17	1.17	Highly Yes
Multi-base block	4.27	1.08	Highly Yes
Abacus	4.35	1.02	Highly Yes
Colour and number tiles	4.27	.98	Highly Yes
Dice	4.07	1.14	Highly Yes
Pattern blocks	2.90	1.56	Highly No
Average M and SD Score	**3.97**	**1.19**	**Highly Yes**

Source: Field Data (2021) ***N = 40***

Key: M = Mean, SD = Std. Deviation. Mean score range = 1.00 – 1.79 → strongly disagree (Highly No), 1.80 – 2.59 → disagree (No), 3.00 – 3.79 → agree (Yes) and 3.80 – 5.00 → strongly agree (Highly Yes)

Results presented in table 4.3 reveals an average mean value of 3.97 which implies that respondents were much aware of the type of manipulatives they often use in teaching numeracy at the early childhood education centres in the Nkoranza North

District. The average standard deviation of 1.19 also implies that respondents' views on the type of manipulatives use in teaching numeracy at the early childhood education centres in the Nkoranza North District slightly varies. Specifically, majority of the respondents were within the mean score range of 3.00 – 5.0 which shows that majority of the respondents were in agreement with the statement or accepted the statement. For example, Geoboard attracted a mean score of 3.80 (SD = 1.38); Cuisenaire rods also attracted a mean score of 4.17 (SD = 1.17) and multi-base block attracted a mean score of 4.27 (SD = 1.08). In addition, Abacus had a mean score of 4.35 (SD = 1.02); colour and number tiles had a mean score of 4.27 (SD = .98); and dice had a mean score of 4.07 (SD = 1.14). However, few of the respondents were in disagreement with the statement. For example, pattern blocks attracted a mean score of 2.9 (SD = 1.56).

The evidence gathered from the data in Table 4.3 indicates that Cuisenaire rods, multi-base blocks, Abacus, dice, colour and number tiles are types of manipulatives materials teachers often use in teaching numeracy Nkoranza North district. These findings corroborate with Furner and Worrell (2017) findings, who found that teachers often use manipulatives such as paper money, buttons, blocks, Cuisenaire rods, tangrams, geoboards, pattern blocks, algebra tiles, and base-ten blocks in teaching mathematics. These manipulatives provide teachers with a great potential to use their creativity to do further work on the mathematics concepts instead of merely relying on worksheets. Consequently, students learn numeracy in an enjoyable way, making connections between the concrete and the abstract. Pouw, VanGog, & Paas (2014) indicate that when students interact with these manipulatives their reasoning resources are focused on those objects. Students use the interaction with manipulatives to learn more and to gain a better understanding of mathematical concepts.

In support of the above assertion, the researcher did classroom observation. The researcher observed the type of manipulative materials kindergarten teachers often use while teaching numeracy. The result is presented in table 4.4.

Table 4.4: Observation guide on types of manipulative materials

Type of Manipulative Materials	**Frequency**	**Percentage (%)**
Abacus and bundle of sticks	12	30.0
Geoboard and dice	22	55.0
Multi-base blocks	6	15.0
Total	40	100.0
What teachers do when manipulative materials are not promptly supplied?		
They use materials within their environment	4	10.0
Improvisation	14	35.0
The use of chalk board illustration	22	55.0
Total	40	100.0

Source: Field Data (2021)

During the classroom observation, the researcher observed that one of types of manipulative materials kindergarten teachers often use were Geoboard and dice (22; 55%), Abacus and bundle of sticks (12; 30%), and Multi-base blocks (6; 15%). In the case when manipulative materials are not promptly supplied, 10% of the kindergarten teachers use the materials in the environment, 35% of the kindergarten teachers improvise whilst 55% of the kindergarten teachers use chalk board illustration. As Jones (2017) indicate that popular manipulatives used in mathematical instruction include: blocks, Popsicle sticks, Abacus, toothpicks, Styrofoam cups, containers, Geoboards, candies, and various other counting objects. In addition, Kalejaiye (2004) argued that, the selection of a variety of manipulatives often follows the choice of methods of teaching mathematics in primary schools. This is because primary school children are at the concrete operational stage – the stage when they learn working with physical objects. The manipulatives will enable them understand better the basic principles of mathematics, such as number relationships, the idea of Abacus and Bundle of sticks among many others.

Moreover, it was observed that majority of the teachers often use Geoboard and dice in teaching numeracy. According to Boggan, et al., (2010), geoboards are helpful when trying to identify simple geometric shapes such as squares, rectangles, circles, and triangles. Similarly, Loong (2014) found that a geoboard is also an ideal tool to explore how the area of a shape changes with the perimeter. Geoboards promote critical thinking as students investigate the relationships among shapes, area, and perimeter.

Research Question 3: What methods do teachers exhibit in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District?

This research question sought to determine the methods teachers use in teaching numeracy using manipulatives at early childhood education centres in the Nkoranza North District. The result is presented in table 4.5.

Table 4.5: Methods Teachers Use in Teaching Numeracy Using Manipulatives at Early Childhood Education Centres in The Nkoranza North District

Statement/Item	M	SD	Interpretation
Child centred	4.32	.91	Highly Yes
Demonstration method	3.77	1.40	Yes
Discussion method	4.12	1.11	Highly Yes
Brainstorming	2.82	1.56	Highly No
Group method	4.37	.83	Highly Yes
Question and answers	3.87	1.32	Highly Yes
Role play	4.15	1.29	Highly No
Average M and SD Score	**3.91**	**1.20**	**Highly Yes**

Source: Field Data (2021) ***N = 40***

Key: M = Mean, SD = Std. Deviation. Mean score range = 1.00 – 1.79 → strongly disagree (Highly No), 1.80 – 2.59 → disagree (No), 3.00 – 3.79 → agree (Yes) and 3.80 – 5.00 → strongly agree (Highly Yes)

Results presented in table 4.5 reveals an average mean value of 3.91 which implies that respondents know the methods to use in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District. The average standard deviation of 1.20 also implies that respondents' views with regards to the skills they use in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District are similar. Specifically, majority of the respondents were within the mean score range of 3.00 – 5.0 which shows that majority of the respondents were in agreement with the statement or accepted the statement. For example, child centred attracted a mean score of 4.32 (SD

= 0.91); demonstration method also attracted a mean score of 3.77 (SD = 1.40) and discussion method attracted a mean score of 4.12 (SD = 1.11). In addition, group method had a mean score of 4.37 (SD = .83); questions and answers had a mean score of 3.87 (SD = 1.32); and role play had a mean score of 4.15 (SD = 1.29). However, few of the respondents were in disagreement with the statement. For example, brainstorming attracted a mean score of 2.82 (SD = 1.56).

The evidence gathered from the data in Table 4.5 indicates that in teaching numeracy using manipulatives at the early childhood education centres in Nkoranza North district, teachers' different skills. It emerged from the results that, in teaching numeracy using manipulatives kindergarten teachers use skills such as child centred method, discussion method, grouping method, question and answer method, and role play at the early childhood education centres in the Nkoranza North district. These findings echo the view of Odum (2022) who found that most mathematics teachers use activity method, discussion and group method, deductive method, role play method, lecture and problem solving to teach mathematics.

Hence, Madu (2014) cautioned that, Mathematics teachers should be free to use methods they consider suitable for their particular students under particular conditions. To be effective, the mathematics teacher must have a thorough understanding of a number of methods, their strengths, weaknesses and particular conditions under which they operate best. A number of different teaching methods can be used in the classroom setting. The method selected will depend on the learning objectives, the technological resources available, the overall course design and the instructor's training.

The findings above were further buttressed by the qualitative data. The researcher interviewed four School Improvement Support Officers and one kindergarten coordinator views on the skills teachers use in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District. The following were their responses.

> *The teachers use the demonstration method to teach them (School Improvement Support Officer, 1).*
>
> *Teachers use demonstration method in teaching numeracy which involves both the learner and the teacher (School Improvement Support Officer, 2).*
>
> *Teachers always use role play method of teaching in numeracy (Early Childhood Coordinator, 1).*
>
> *Teachers often use demonstration method which encourage learners' active participation and makes them feel free to explore new ideas (School Improvement Support Officer, 3)*
>
> *Teachers often use discussion and group method which helps learners to explain their ideas (School Improvement Support Officer, 4)*

The interview responses give credence to the finding that School Improvement Support Officers and Kindergarten Coordinator have similar views on the skills teachers use in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District. The findings indicate that teachers often use skills such as demonstration method, discussion and group method, and role play method in teaching numeracy using manipulatives at the early childhood centres in the Nkoranza North District. It is true that in teaching numeracy there must be a demonstration before letting the learners to do their own. Such demonstrations are so-called examples. According to Ramadhan and Surya (2017), the use of demonstration methods is effective in increasing students' mathematical ability, especially in mastering mathematical concepts on the matter of multiplication operations. The demonstration method increases the students' activeness and helps them in understanding the material, thus enhances their overall learning outcomes in mathematics.

Also, NCTM (2000) indicate that the grouping method can be used during sorting lesson in numeracy with a lot of bottle tops, blocks, seeds etc., and the sorting can be done according to colours, shapes, size, texture, use etc. The discussion method too can be used by matching objects according to colours, shapes, size, use and the others. The role play method can also be used to learn ordering according to colours, shapes, sizes, and textures (NCTM, 2000). Hence, Piaget constructivist theory cautioned that in order for a child to understand numeracy well, he or she should interact with fellow peers. Therefore, the early grade classroom should allow interaction, pose some features such as teachers having a dialogue with pupils, and help the pupils to construct their own knowledge and pupils should work primarily in groups and collaborate (Hanley, 1994).

Research Question 4: What challenges do teachers face when using manipulatives in teaching numeracy in the Nkoranza North District?

This research question sought to identify the challenges faced by teachers when using manipulative in teaching numeracy at early childhood education centres in the Nkoranza North District. The result is presented in table 4.6.

Table 4.6: Challenges Faced by Teachers when Using Manipulatives in Teaching Numeracy at Early Childhood Education Centres in the Nkoranza North District

Statement/Item	M	SD	Interpretation
Limited classroom time	4.30	.91	Highly Yes
Inadequate pedagogical knowledge	3.52	1.43	Yes
Inadequate technological knowledge	3.02	1.51	Highly Yes
Insufficient budget for manipulatives	4.35	1.09	Highly No
Lack of administrative support	4.20	1.04	Highly Yes
Poor attitude of learners	3.57	1.28	Highly Yes
Lack of availability of kits	3.40	1.31	Highly No
Average M and SD Score	**3.33**	**1.22**	**Yes**

Source: Field Data (2021) ***N = 40***

Key: M = Mean, SD = Std. Deviation. Mean score range = 1.00 – 1.79 → strongly disagree (Highly No), 1.80 – 2.59 → disagree (No), 3.00 – 3.79 → agree (Yes) and 3.80 – 5.00 → strongly agree (Highly Yes)

Results presented in table 4.6 reveals an average mean value of 3.33 which implies that respondents could easily identify the challenges they faced when using manipulatives in teaching numeracy at the early childhood education centres in the Nkoranza North District. The average standard deviation of 1.22 also implies that respondents' views with regards to the challenges they faced when using manipulatives in teaching numeracy at the early childhood education centres in the Nkoranza North District looks alike. Specifically, majority of the respondents were within the mean score range of 3.00 – 5.0 which shows that all of the respondents were in agreement with the statement or accepted the statement. For example, limited classroom time attracted a mean score of 4.30 (SD = 0.91); inadequate pedagogical knowledge also attracted a mean score of 3.52 (SD = 1.43) and inadequate technological knowledge attracted a mean score of 3.02 (SD = 1.51). In addition, insufficient budget for manipulatives had a mean score of 4.35 (SD = 1.09); lack of administrative support had a mean score of 4.20 (SD = 1.04); poor attitude of learners had a mean score of 3.57 (SD = 1.28) and lack of availability of kits attracted a mean score of 3.40 (SD = 1.31).

The evidence gathered from the data in Table 4.5 indicates that in teaching numeracy at the early childhood education centres in Nkoranza North district, teachers are faced with challenges when using manipulatives. It emerged from the results that, limited classroom time, inadequate pedagogical knowledge, inadequate technological knowledge, and insufficient budget for manipulatives are the challenges faced by teachers when using manipulatives in teaching numeracy at early childhood education centres in the Nkoranza North district. These findings align with the findings of Moch (2008), found in her study that one of the most common problems teachers face when using manipulatives is that they do not have time to include manipulatives as part of their lessons. There are many underlying factors affecting this including lack of availability of kits, insufficient budgets for manipulatives, lack of administrative support, and being overwhelmed with other classroom responsibilities. Additionally, the need to cover a large amount of curriculum quickly, limited classroom time, and the pressure imposed by standardized testing inhibits teachers from using manipulatives. Some teachers also claim that they do not have time to stay up-to-date on the latest findings, and this is what restricts them from utilizing manipulatives in their classrooms. (McNeil & Jarvin, 2007).

The findings above were further buttressed by the qualitative data. The researcher interviewed four School Improvement Support Officers and one kindergarten coordinator views on the skills teachers use in teaching numeracy using manipulatives at the early childhood education centres in the Nkoranza North District. The following were their responses.

> *I think time allocated for numeracy instruction is too short for teachers to use manipulative materials (School Improvement Support Officer, 1).*
>
> *Teachers do not have enough knowledge of manipulative materials (School Improvement Support Officer, 2).*
>
> *There is no continuous professional training for teachers as to the use of manipulative materials (Early Childhood Coordinator, 1).*
>
> *Teachers work load prevents them from using manipulative materials to teach numeracy (School Improvement Support Officer, 3)*
>
> *High cost of preparing some manipulative materials prevents teachers from using them in class (School Improvement Support Officer, 4)*

The interview responses give credence to the finding that School Improvement Support Officers and Kindergarten Coordinator share similar views on the challenges teachers face when using manipulatives in teaching numeracy at the early childhood education centres in the Nkoranza North District. The findings indicate that limited time allocation in class, high cost of preparing manipulative materials; teachers' workload prevents them from using manipulative materials, teachers do not have the knowledge as to how to use manipulative materials to teach numeracy were the challenges faced when using manipulative materials in teaching numeracy. These findings are also in tandem with the views of other researchers (Odum, 2022; Larkin, 2016; Petersen & McNeil, 2014; West, 2018) who found that teachers knew the benefits of manipulative materials in learning; two factors challenged their use in the classroom: non-availability and inadequate supply of manipulative materials, and the high cost of preparing some manipulative materials. Larkin (2016) added that although the students loved the physical manipulative the best, the cost of the balancing beams was a huge factor.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.0 Overview

This chapter presents an overview of the entire work. It contains the summary of the study, key findings, and the recommendations made. It also presents some suggested topics that could serve as based for further research.

5.1. Summary

The study examined the teachers' use of selected appropriate manipulative materials in teaching numeracy at early childhood centres in the Nkoranza North District of the Bono East Region. It attempted to find out manipulatives materials available at the early childhood education centres in the Nkoranza North District. identify the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres in Nkoranza North District, Determine the skills teachers use in teaching numeracy using manipulatives at early childhood education centres in the Nkoranza North District, and identify the challenges faced by teachers when using manipulatives in teaching numeracy at early childhood education centres in the Nkoranza North District. Questionnaires, interview guide, and observational guide were used to collect data for the study. The sample size for study was forty-five (45) including forty (40) kindergarten teachers, four (4) School improvement support officers and one (1) early childhood coordinator. Purposive sampling and simple random sampling techniques was used in this study. Descriptive statistical tools such as frequencies and percentages were employed to analyse the quantitative data while thematic approach was used analyse the qualitative data.

5.2 Key Findings

The following were the major findings that emerged from the study:

1. The study findings reveal that counters, bundle of sticks, bottle tops, number cards and number charts were the manipulatives materials available at the early childhood education centres in the Nkoranza North District.
2. Again, the study findings reveal that geoboard, Cuisenaire rods, base-10 blocks, abacus, dice, colour and number tiles were the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres in Nkoranza North District,
3. Moreover, child centred method, discussion method, grouping method, question and answer and question method, and role play were the methods teachers use in teaching numeracy using manipulatives at early childhood education centres in the Nkoranza North District
4. Finally, limited classroom time, inadequate of pedagogical knowledge, inadequate technological knowledge and insufficient budget for manipulative were the challenges faced by teachers when using manipulatives in teaching numeracy at early childhood education centres in the Nkoranza North District.

5.3 Conclusion

This study discovered that many kindergarten teachers' ignorance resulted in their inability to use appropriate manipulative materials during numeracy lessons. The majority of them lacked knowledge of manipulative materials and were unwilling to learn and improve themselves. Indeed, the younger kindergarten teachers were expected to keep up to date and to make numerous inquiries from their colleagues in other places regarding the teaching of numeracy at the kindergarten. Because kindergarten class involves a variety of activities, and we now live in a modernized world where things are constantly changing. Availability and adequacy of appropriate and need manipulative materials including counters, bottle tops, colours, shapes, dines block, casiniarrodes, number cut-out shapes, etc., it would enhance the kindergarten teachers to select and use the appropriate manipulative materials. It also gives the kindergarten teachers in depth knowledge about the existence of manipulative materials to be able to use them properly at the appropriate time and appropriate lesson to match the various topics in the kindergarten syllabus, which could cartel abstract learning. This would aid child centred learning which brings about pupil participation in the numeracy lesson and help build children's numeracy skills which will help their future academic progress. The use of appropriate manipulative materials by other K.G teachers who feel lazy or unprepared to use will be compelled or encouraged to improvise themselves and use numeracy lesson which will make the lesson interesting and steal the attention of the pupils and prevent abstract learning. This will improve the children's numeracy skills.

5.4 Recommendations

Based on the findings and conclusion, the following recommendations were made for possible consideration and implementation:

1. Thorough and serious in-service training for kindergarten teachers should be organized by GES on the type of manipulative materials that should be used within the developmental level during numeracy lessons and should match the topic teaching in that particular lesson, and also try to involve School improvement supervise officers, head teachers, and early childhood

coordinators so they can monitor and supervise them on proper and consistent usage to fit the particular lesson.

2. The government and the Ghana Education Service should always try to make appropriate manipulative materials available and ready during the numeracy lesson and to fit the curriculum topics.
3. NGOs, philanthropists, religious organizations, and natives from other countries should try to provide kindergarten schools with the necessary manipulative materials to aid in the wage of manipulative materials in teaching numeracy lessons in order to prevent abstract learning of numeracy.
4. Kindergarten teachers and their coordinators should be engaged in proper and serious workshops every term on how to improvise proper and needed manipulative materials to fit the particular topic and lesson they teach to eradicate abstract learning. School Improvement Support Officers, Early childhood Coordinators, Head teachers and other leaders in District Education Office should be engaged in a well prepared in-service training on how to supervise K.G Teachers numeracy lesson with appropriate manipulative materials.

5.5 Suggestions for Further Research

The study was done in only kindergarten level in Nkoranza North District only; therefore, the researcher is recommending that the scope of the studies should be expanded to include the lower primary, upper primary, JHS, and Senior High Schools. And should be expanded in several Districts. This will help Ghana Education Service and other stakeholders to determine the magnitude of this phenomenon and address it appropriately at the appropriate time.

REFERENCES

Abrami, P. C. (2001). Understanding and promoting complex learning using technology. *Educational Research and Evaluation, 7*(2 & 3), 113136.

Agyedu, G. O., Donkor, F. & Obeng, S. (2011). *Teach yourself research methods.* Kumasi, Ghana: University of Education, Winneba.

Aliakbari, F., Parvin, N., Heidari, M., & Haghani, F. (2015). Learning theories application in nursing education. *Journal of Education and Health Promotion, 4*(2), 2.

Alicia, J., & Dusing, S. (2020). *Encyclopedia of infant and early childhood development*. Elsevier.

Allen, C. (2007). *An action based researched study on how using manipulatives will increase students' achievement in Mathematics*. Marygove College

Amaya, E., Davis, D., Ari-Rouse, D.B. (2007). Alternative diets for the Pacific white shrimp Litopenaeus. *Vannameie Aquaculture*, 262(2-4) 419425

Amaya, M. M., Uttal, D. H., O'Doherty, K. D., Liu, L. L., & DeLoache, J. S. (2013) *Two-digit subtraction: Examining the link between concrete and abstract representations of knowledge.* Manuscript under revision.

Amedahe, F. K., & Atta, E. T. (2005). *Principles and methods of teaching*. Accra, Ghana: Universities Press. Ltd.

Anderson, J. R. (1990). *Cognitive psychology and its implications (3rd ed.)* New York: Freeman.

Anderson, L. W. (1999). The classroom environment study: Teaching for learning. *Comparative Educational Review,* 31, 69 - 87.

Anthon -Van de Walle, J., Karp, K.S. & Williams, J.N.I. (2013). *Elementary School Mathematics* : Tead's $Bay micelle Developmental, (The Professional Development Edition for Mattenstier

Ball, D. L. (1992). Magical Hopes: Manipulatives and the Reform of Math Education. American Educator: *The Professional Journal of the American Federation of Teachers,* 16(2), p14-18,46 47

Bandura, A. (1965). *Behaviour modification through modelling procedures.*

Bandura, A. (1975). *Vicarious processes: A case of no-trial learning*.

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). *Organisational research: Determining appropriate sample size in survey research.*

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organisational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal,* 19(1), 1-8.

Bartolini-Bussi M.G, & Boni M (2009) The early construction of mathematical meanings: learning positional representation of numbers. In: Barbarin OA, Barbarin O, Wasik B (eds) *Handbook of child development and early education: research to practice. Guilford,* New York, pp 455–477

Battle, T. S. (2007). *Infusing math manipulatives: The key to an increase in academic achievement in the mathematics classroom*. (ERIC Document Reproduction Service No. ED498579)

Becker, H. (2001). *Teaching ESL K-12: Views from the Classroom*. Boston, MA:

Bernard, H.R. (2002). *Research Methods in Anthropology: Qualitative and quantitative methods.* 3rd edition. AltaMira Press, Walnut Creek, California.

Bless, C., & Higson-Smith, C. (2000). *Fundamentals of Social Research Methods: An African Perspective.* Lansdowne: Juta Education Ltd.

Boggan, M., Harper, S., & Whitmire, A. (2010). Using manipulatives to teach elementary mathematics. *Journal of Instructional Pedagogies,* 3.

Boham, H. & Shawake P. (1994) Nemplat Manipulative effectively / A drive down rounding road Arithmetic Teacher (41)5-246. Retrieved January 20, 2006 from the dato Trace database

Bouck, E. C., Satsangi, R., Doughty, T. T. & Courtney, W. T. (2014). Virtual and Concrete Manipulative: A comparison of approaches for solving mathematics problems for students with autism spectrum disorder. *Journal of Autism Development Discord,* 44, 180-193.

Bourdeau, P.F. (1953). A test of random versus systematic ecological sampling. *Ecology* 34:499-512.

Briars, D., & Siegler, R.S. (1984). A feature analysis of preschoolers' counting knowledge. *Developmental Psychology,* 20, 607-618.

Brookfield, S. (1986). Understanding and facilitating adult learning. San Francisco: Jossey -Bass.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.

Bruner, J. S. (1964). The course of cognitive growth. *American Psychologist,* 19(1), 1–15.

Brunner, S. J. (1966). *The Process of Education.* Cambridge: Harvard University Press.

Bryant, D. P., Bryant, B. R., Shin, M. & Pfannenstiel, K. H. (2014). Learning disabilities: Mathematics characteristics and instructional exemplars. In S. Chinn (Ed.), The outledge international handbook of dyscalculia and mathematical learning difficulties (pp. 243-256). London: Routledge.

Bryant, R.L. (1992). Ecology: emerging research agenda in third world studies. *Ecological Geography* 11, 12-36.

Burns, B. A., & Hamm, E. M. (2011). A comparison of concrete and virtual manipulative use in third-and fourth-grade mathematics. *School Science and Mathematics,* 111(6), 256-261.

Cabonneau, K., Scott, M. and Selig, P. (2013). A Meta-Analysis of the Efficacy of Teaching Mathematics with Concrete Manipulatives. *Journal of Education Psychology*, 105(2), 380-400

Cain-Caston, M. (1996). *Manipulative queen.* 23(4): 270–274.

California's Starting Point Toward Goal of Career and College Readiness." California Department of Education. 9 Sept. 2015. <http://www.cde.ca.gov/nr/ne/yr15/yr15rel69.asp#tab1>.

Campbell, D.T. (1955). The informant in quantitative research. The American Journal of Sociology 60:339-342. controlling measurement error in organization analysis. *American Sociological Review* 39:816-831.

Canny, M. E. (1984). *The relationship of manipulative materials to achievement in three areas of fourth-grade mathematics: Computation, concept development, and problem solving.* 45A: 775–776.

Carbanneau, K.J., Marley, S.C., & Selig, J.P. (2013). A Meta-Analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology*, 105(2), 380-400

Carroll, W. M. & Porter, D. (1997). *Invented strategies can develop meaningful mathematical procedures.* 3(7): 370–374.

Cawley, J., Amaya, M. M., Uttal, D. H., O.Doherty, K. D., Liu, L. L., & DeLoache, J. Chappell, M. F. & Strutchens, M. E. (2001). Creating connections: Promoting algebraic thinking with concrete models. Reston, VA: *National Council of Teachers of Mathematics*

Chinn, S. & Ashcroft, J. R. (1998). *Mathematics for Dyslexics.* London: Whurr.

Chinn, S. (2014). The Routledge international handbook of dyscalculia and

Chinn, S. (2014). The Routledge international handbook of dyscalculia and mathematical learning difficulties. London: Routledge.

Chomsky, N. (1959). *Review of Verbal Behaviour* by B. F. Skinner, Language, 35, 26-58. 31-1 662

Chomsky, N., & Miller, G. A. (1958). *Finite-state languages*. Information and Control, 1, 91-112.

Clements, D. H. & Battistia, M. T. (1990). *Constructive learning and teaching*. 38: 34–35.

Clements, D. H. (1999). Concrete manipulatives, concrete ideas. *Contemporary Issues in Early Childhood, 1*, 45-60.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. New York: Lawrence Erlbaum Associates.

Cole, M. (1995). *Socio-cultural historical psychology*: Some general remarks and a proposal for a new kind of cultural-genetic methodology, In J. V

Copley, J.V. (2000). *The young child and mathematics.* Washiton DC: National Association for the Education of young children

Copple, C., & Bredekamp, S. (2009). *Developmentally appropriate practice in early childhood programs*. Washington, DC: National Association for the Education of Young Children.

Creswell, J. W. (2008). Educational research. Planning, conducting, and evaluating quantitative and qualitative research. *American Journal of Sociology* 67:566-576

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches (3rd ed.).* California: SAGE Publications Inc.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage publications.

Creswell, J. W., Plano Clark, V. L., Gutmann, M., & Hanson, W. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209–240). Thousand Oaks, CA: Sage.

Crossman A. (2013). *Types of sampling designs*. Retrieved from About.com.Guide on May 10,, 2015.

Cuisenaire, G. (1961). Historique des recherches concernant les nombres en couleurs [History of research on the numbers in colour], typewritten text reproduced by the Maison de l'Imprimerie in Thuin, 2013.

Cuisenaire, Georges, & Gattegno, Caleb (1954). Numbers in colour: A new method of teaching arithmetic in primary schools. London: Heinemann

Dahl, L. (2011). The impact of manipulatives on learning in the elementary and middle school mathematics classroom. (M.A.) Bemidji State University. Bemidji, Minnesota.

Danz, N.P., R.R. Regal, G.J. Niemi, V.J. Brady, T. Hollenhorst, L.B. Johnson, G.E. Host J.M. Hanowski, C.A. Johnston, T. Brown, J. Kingston & J.R. Kelly. 2005. Environmentally stratified sampling design for the development of Great Lakes environmental indicators. *Environmental Monitoring and Assessment, 102*, 41-65.

Decker, P. J., & Nathan, B. R. (1985). *Behaviour modelling training: Principles and applications*. New York: Praeger.

DeLoache, J. S. (2000). Dual representation and young children's use of scale models. *Child Development, 71,* 329-338.

Department for Education (DfE) (2013). *Mathematics programmes of study: Key stages 1 and 2:* National Curriculum in England. Reference: DFE-00180-2013

Department of Educational and Child Development (2014). *Annual Report.* Accra

Dewey, J. (1938) *Experience and Education*. New York: Collier Books.

Dienes, Z. P. (1960). *Building up mathematics.* London: Hutchinson Education Ltd.

Domino, J. (2010). The Effects of PhysicalM anipulatives on Achievement in Mathematics in Grades k-6: A Meta-Analysis (Doctoral dissertation, State University of New York, 2010) (pp. 1-93). Ann Arbor, MI: ProQuest.

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

Drickey, N. (2006). Learning technologies for enhancing student understanding of mathematics. *International Journal of Learning, 13*(5), 109116.

Driscoll, M. (2000). Psychology of Learning for Instruction. Boston: Allyn& Bacon ecstasy users recruited using purposive sampling strategies. *Drug and Alcohol Dependence, 73*, 33-40.

Driscoll, M.P. (1994). *Psychology of learning for instruction.* Allyn & Bacon. 750 first street NE Washington DC

Fennema, E. (1972). Models and mathematics. *Arithmetic Teacher, 19,* 635640. Individuals with Disabilities Education Act (IDEA) of 1997, 120 U.S.C Ch. 1400 et seq.

Fletcher, D., Boon, R. T., & Cihak, D. F. (2010). Effects of the touch math program compared to a number line strategy to teach addition facts to *Regrouping to Students with Learning Disabilities, 29(*4), 171183.

Flick, U. (2006). *An introduction to qualitative research.* Sage, London.

Flores, M. M., Hinton, V. M., & Schweck, K. B. (2014). *Teaching multiplication with mathematics in grades K-6: A meta-analysis* (Doctoral dissertation). Retrieved from ProQuest. (UMI 3423451).

Fox, R. (2001). Crxonstructivism examined. *Oxford Review of Education, 27*(1), 23 35.

Fraenkel, J. R., & Wallen, W. E. (2000). *How to design and evaluate educational* research. New York: Routledge

Fuson, K. C., & Briars, D. J. (1990). Using a base-ten blocks learning/teaching approach for first-and second-grade place-value and multidigit addition and subtraction. J*ournal for Research in Mathematics Education, 21*, 180206.

Garcia, E. P. (2004). Using manipualtives and visual cues with explicit vocabulary enhancement for mathematics instruction with grade three and four low achievers in bilingual classrooms (Unpublished doctoral dissertation). Texas A&M University, College Station, TX.

Gecu-Parmaksiz, Z., & Delialioglu, O. (2019). *Augmented reality-based virtual manipulatives versus physical manipulatives for teaching geometric shapes to preschool children*. Retrieved February 7, 2021, from https://bera-journals-onlinelibrary-wileycom.ezproxy.nwciowa.edu/doi/pdfdirect/10.1111/bjet.12740

Geneen, J. G. (1991). Number sense as situated knowledge in a conceptual domain. *Journal for Research in Mathematics Education, 22,* 170-218.

Geneen, J. G. (1998). *The situativity of knowing, learning, and research*. American Psychologist, 53, 5-26.

Ghamrawi, Norma. (2013). Multiple Intelligences and ESL Teaching and Learning: An Investigation in KG II Classrooms in One Private School in Beirut, Lebanon. *Journal of Advanced Academics, 25(*1), 25-46

Gibert, R. & Bush, W. (1988). Familiarity, availability and use of manipulative devices in mathematics at the primary school Science and mathematics, 94(6)803-309.

Gilbert, R., & Bush, W. (1988). Familiarity, availability, and the use of manipulative devices in mathematics at the primary level. *School Science and Mathematics, 94*(6), 459 – 469.

Godambe, V.P. 1982. Estimation in survey sampling: robustness and optimality. *Journal of the American Statistical Association 77*, 393-403.

Golafshani, N. (2013). Teachers' beliefs and teaching mathematics with manipulatives. *Canadian Journal for Education,* 36(3), 137-159.

Goldstein A. P., & Sorcher M. Changing managerial behavior by applied learning techniques. *Training and Development Journal,* 1973, 36–39.

Goldstein A. P., Sorcher M. (1974). *Changing supervisory behavior*. New York: Pergamon Press.

Gomez-Beloz, A. (2002). Plant use knowledge of the Winikina Warao: The case for questionnaires in ethnobotany. *Economic Botany, 56*, 231-241.

Gomez-Beloz, A. 2002. Plant use knowledge of the Winikina Warao: the case for questionnaires in ethnobotany. Economic Botany 56:231-241.

Govindaraju, F. V. (2021). A review of social cognitive theory from the perspective of interpersonal communication. *Multicultural Education, 7*(12), 488-492.

Graham, J. M. (2013). Concrete Math Manipulatives in Upper Elementary Classrooms. (Ph.D., Walden University). *ProQuest Dissertations and Theses, 170*

Greeno, J. G. (1991). Number sense as situated knowing in a conceptual domain. Journal for research in mathematics education, 170-218. Brookfield, S. (1993). Self-directed learning, political clarity, and the critical practice of adult education. *Adult Education Quarterly, 43*(4), 227-242.

Gürbüz, R. (2010). The effect of activity-based instruction on conceptual development of seventh grade students in probability. *International Journal of Mathematical Education in Science and Technology, 41*, 743–767.

Hamayan, E., & Freeman, R. (2006). *English language learners at school: A guide for administrators*. Philadelphia, PA: Carlson.

Hamid I. B. & Abdul Rahman Y. (2018). Using constructivists approach to enhance students understanding of logarithmic functions: A care study of Kalpohin Senior High School, Tamale. *International Journal of Engineering and Applied Science (IJEAS) 5.* ISSN: 2394-3661

Hannafin, M.J. & Land, S.M. (2006). Grounded practice and the design of construviimst learning environment and environmental education development, 45)5) 101

Hartshorn, R. & Boren, S. (1990). *Experiential learning of mathematics: Using manipulatives*. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools.

Hartshorn, R. & Boren, S. (1990). *Experiential learning of mathematics: Using manipulatives.* Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools.

Hatfield, M. (1994). Use of manipulative devices: elementary school cooperating teachers self-report. *School Science and Mathematics, 94*(6). 303-309.

Heddens, J. W. (1986). Bridging the Gap between the Concrete and the Abstract. *Arithmetic Teacher, Feb., 33*(6).

Heddens, J. W. (1997). Improving Mathematics teaching by using Manipulatives. Retrieved October 2, 2007, from Kent State Universtiy Website: *http://www.fed.cuhk.edu.hk/~fllee /mathfor/edumath /9706/13hedden. html.*

Heddens, J. W.(2005). *Improving Mathematics Teaching by Using Manipulative*s. Accessed on September 2023 on site http://www.fed.cuhk.edu.hk/~fllee/mathfor/edumath/9706/13hedden.html

Herbert, E. (1989). One Point of View: Manipulatives are Good Mathematics. *Arithmetic Teacher, 32*(6), 4.

Heuser, D. (1999). *Reflections on teacher philosophies and teaching strategies* from low income families: A study on opportunity to learn Mathematics. *Early Childhood Education Journal, 37*, 295-302

Hillsdale, NJ: Erlbaum.State Schools Chief Torlakson Calls First Year of CAASPP Results California's Starting Point Toward Goal of Career and College Readiness. (2015, September 9). *Retrieved from http://www.cde.ca.gov/nr/ne /yr15/yr15rel69.asp#tab1*

Holmes, A. B. (2013). *Effects of manipulative use on PK-12 mathematics achievement: A meta-analysis.* Poster presented at the meeting of Society for Research in Educational Effectiveness, Washington, DC.

Houle, C. O. (1961). *The inquiring mind*. Madison, WI: University of Wisconsin Press.

Hull, C. L. (1929). A functional interpretation of the conditioned reflex. *Psychological Review, 36*, 498-511.

Hull, C. L. (1943). *Principles of behaviour*. New York: Appleton-CenturyCrofts.

Hull, C. L. (1951). *Essentials of behaviour*. New Haven: Yale University Press.

Hurrell, D. (2018). *I'm proud to be a toy teacher: Using CRA to become an effective teacher*. Retrieved February 1, 2021, from https://files.eric.ed.gov/fulltext/EJ1231485.pdf.

Hurst, C., & Linsell, C. (september 7, 2020). Manipulatives and Multiplicative Thinking. *European Journal of STEM Education, 5*(1).

Johnston, T. Brown, J. Kingston & J.R. Kelly. 2005. Environmentally stratified sampling design for the development of Great Lakes environmental indicators. *Environmental Monitoring and Assessment 102*, 41-65.

Jordan, L., Miller, D. & Mercer, C. (1999). The effects of concrete to semi concrete to abstract instruction in the acquisition and retention of fraction concepts and skills. *Learning Disabilities: A Multidisciplinary Journal, 9*(3), 115-12.

Kant, I. (1900). *Critique of pure reason*. New York: Colonial Press (Original work published 1781).

Karmel, T.S. & Jain, M. (1987). Comparison of purposive and random sampling schemes for estimating capital expenditure. *Journal of the American Statistical Association, 82*, 52-57

Kenkel, N.C., P. Juhasz-Nagy & J. Podani. (1989). *On sampling procedures in population and community ecology*.

Koffka, K. (1935). *Principles of Gestalt psychology*. New York: Harcourt.

Kohler, W. (1929). *Gestalt psychology*. New York: Liveright.

Lancey, W. J. (1993). Situated action: A neuropsychological interpretation response to Vera and Simon. *Cognitive Science, 17*, 87-116.

Lashey, K. S. (1929). *Brain mechanisms and intelligence*. Chicago: University of Chicago Press.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2005). *SPSS for intermediate statistics: Use and interpretation*. Psychology Press.

Leedy, J. J. (Ed.). (1985). *Poetry as healer: Mending the troubled mind*. Vanguard Press.

Leedy, P. D. (1993). *Practical research: Planning and design*. New York: Rd

Levine, J. (1990). *Bilingual learners and the mainstream curriculum: Integrated approaches to learning and the teaching and learning of English as a Second language in mainstream classrooms*. Bristol, PA: The Falmer Press.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Linder, S. M., Powers-Costello, B., & Stegelin, D. A. (2011). Mathematics in early childhood research-based rationale and practical strategies. *Early Childhood Education Journal, 39*, 29-37

Locke, E., & Latham, G. P. (1990). *A theory of goal setting and task performance*. Englewood Cliffs, NJ: Prentice-Hall

Locke, J. (1995). *An essay concerning human understanding*. New York: Prometheus. (Original work, 1690).

Loong, E. Y. (2014). *Fostering mathematical understanding through physical and virtual manipulatives*. Retrieved February 10, 2021, from https://gogalecom.ezproxy.nwciowa.edu/ps/retrieve.do?tabID=T002

Lopez, A., S. Atran, J.D. Coley, D.L. Medin & E.E. Smith. 1997. The tree of life: universal and cultural features of folk biological taxonomies and inductions. *Coginitive Psychology, 32,* 251-295.

Maccini, P., & Hughes, C. A. (2000). Effects of a problem-solving strategy on the introductory algebra performance of secondary students with learning disabilities. *Learning Disabilities Research & Practice, 15*, 10–21. Macmillan.

Maria, M. (1870-1952). Women's intellectual contribution to the struly of mind and society. Archived from the original on 25 Dec 2014 Retrieved 12 Dec. 2012. New York New t Libramy.

Marsh, L. G. & Cooke, N. L. (1996). The effects of using manipulatives in teaching math problem solving to students. *Learning Disabilities, 11*(1), 58–65.

Martin, T., & Schwartz, D. L. (2005). Physically distributed learning: Adapting and reinterpreting physical environments in the development of fraction concepts. *Cognitive Science, 29*, 587–625. Mathematical learning difficulties. London: Routledge.

McClelland, J. L., & Rumelhart, D. E. (1988). Explorations in parallel distributed processing: *A handbook of models, programs, and exercises*. Cambridge, MA: MIT Press/Bradford Books.

McClung, L. W. (1998). A *study on the use of manipulatives and their effects on student achievement in a high school Algebra I class*. Master of Arts Thesis. Salem- Teikyo University. 1-50

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=1477

McNeil, N. & Jarvin, L. (2007). When theories do not add up: Disentangling the manipulatives debate. *Theory into Practice,* 46(4), 309-316.

McNeil, N., & Jarvin, L. (2007). When theories don't add up: disentangling he manipulatives debate. *Theory into Practice, 46*(4), 309–316.

Merriam, S. B. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. In S. B. Merriam (Ed.) The new update on adult learning theory. New Directions for Adult and Continuing Education, no. 89, 3-13.

Merriam, S. B. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. In S. B. Merriam (Ed.) *The new update on adult learning theory*. New Directions for Adult and Continuing Education, no. 89, 3-13.

Mezirow, J. (1985). A critical theory of self-directed learning. In S. Brookfield(Ed.). *Self-directed learning from theory to practice.* New Directions for Continuing Education, no. 25, San Francisco: Jossey-Bass.

Mill, J. (1829). *Analysis of the phenomena of the human mind*. London: Baldwin & Cradock. 311- 663

Mitchell, A. (2018). A review of the mixed methods, pragmatism and abduction techniques. *The Electronic Journal of Business Research Methods, 16,* 103-116. Retrieved from http://www.ejbrm.com/volume16/issue3/p103

Mitchell, D. (2010). *Education that fits: Review of instructional trendsin the education of students with special educational need*. Ministry of Education. New Zealand.

Mntunjani, L.M., Adendorff, S.A. & Siyepu, S.W., (2018). 'Foundation phase teachers'
use of manipulatives to teach number concepts: A critical analysis', South African. *Journal of Childhood Education,* 8(1), a495

Moch, P. L. (Fall 2001). *Manipulative work*! Upper Saddle River Pearson.

Monte, Jade. (2021). An Exploration of Manipulatives in Math Education. In BSU Honors Program Theses and Projects. Item 485.

Moore, S. D. (2013).*Teaching with manipulatives: Strategies for effective instruction*." Colorado Mathematics Teacher. Fall Issue. Available at www.cctmath.org.

Morris, J. (2014). The use of virtual manipulatives in fourth grade to improve mathematics performance. (M.A., State University of New York. Fredonia, New York.

Morris, K. A., & Easterday, J. (2008). Amplifying Autonomy and Collective Conversation: Using Video iPods[TM] to Support Mathematics Teacher Learning. *Teacher Education, 17*(2), 47-62.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics, 47,* 175–197.

Moyer, P. S., & Jones, M. G. (2004). Controlling choice: Teachers, students, and manipulatives in mathematics classrooms. School Science and Mathematics, 104(1), 16-31.

Moyer, P.S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics, 47*(2), 175-197.

Moyer, P.S., & Jones, M.G. (2004). Controlling choice: Teachers, students, and manipulatives in mathematics classrooms. *School Science and Mathematics Association, 104*(1), 16-31.

Mtetwa, D.K.J., (2005). 'Some characteristics of mathematics teaching in Zimbabwean infant and primary school classrooms'. *International Journal of Early Years Education,* 13(3), 255–264.

Nabie, M. J., Raheem, K., Agbemaka, J. B., & Sabtiwu, R. (2016). Multiple Solutions Approach (MSA): Conceptions and Practices of Primary School Teachers in Ghana. *International Journal of Research in Education and Science, 2*(2), 333-344.

Nabie, M. J., Raheem, K., Agbemaka, J. B., & Sabtiwu, R. (2016). Multiple National Council of Supervisors of Mathematics (2013). *Improving student achievement in mathematics by using manipulatives with classroom instruction.* Denver, CO: Author.

Nation Council of principle Restor, VA jexcles of mettement (2008) and standards for schort mathemation Author National Council ng Supervisor of mathematics (2013) Improrlig student achievement m mathematics by rung manipulatives with Classroom mistinctiño Denver, Co:

National Center for Educational Achievement. (2009). *Core Practices in Math and Science: An Investigation of Consistently Higher Performing Schools in Five States.* Austin, TX: National Center for Educational Achievement.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics

National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) (2010). Common core state standards initiative. Downey United School District: *http://www.dusd.net/cgi/*

National Numeracy (2014). What is the issue? Low levels of numeracy are a long-term problem for the UK. Retrieved from: *http://www.nationalnumera cy .org.uk/whatissue.*

Neuman. W.L. (2006). *Social research method qualitative and quantitative approach* (6th ed.). Upper Saddle River Pearson.

Nickson, M. (2000). *Teaching and learning mathematics: A teacher's guide to recent research and its application*. New York, NY:

Nishida, T. K. (2007). The use of manipulatives to support children's acquisition of abstract math concepts. (Ph.D., University of Virginia). *ProQuest Dissertations and Theses.*

Nunley, K. F. (1999). *Salt Lake City*, UT: Layered Curriculum.

O'Leary, Z. (2014). *The essential guide to doing your research project* (2nd ed.). London: SAGE.

Ogg, B. (2010). What is the Impact of Math Maniplatives on Student Learning. (MA., Ohio University).

Ojose, B. (2009). *Mathematics education: Perspectives on issues and methods of instruction in K–12 classrooms.* Unpublished Manuscript: University of Redlands, CA.

Organisation for Economic Co-operation and Development. (2013). *PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know* (Volume I). OECD Publishing.

Pavlov, I. (1927). *Conditioned reflexes*. (Trans. G. V. Anrep). New York: Oxford University Press.

Pavlov, I. (1941). *Lectures on conditioned reflexes*, (Vol. I & II,) New York: International Universities Press.

Peterson, S., Mercer, C. D. & O'Shea, L. (1988). Teaching learning disabled students place value using the concrete to abstract sequence. *Learning Disabilities Research, 4*(1), 52-56.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher, 24*(7), 5-12.

Piaget, J. (1896-1980) Piaget's theory of Cognitive and affective development. Openlibrary org. Diener the D. Primerples of Zoltes

Piaget, J. (1952). *The child's Concept of numbers.* New York Humanities Press.

Piaget, J. (1965). *The child's conception of number*. New York: W. W. Norton & Company.

Pouw, W. T., Van Gog, T., & Paas, F. (2014, March). *An Embedded and Embodied Cognition Review of Instructional Manipulatives*. Retrieved February 7, 2021, from https://wwwproquestcom.ezproxy.nwciowa.edu/docview/1501014431/fulltextPDF/E59BD03B120147F7PQ/1?accountid=28306.

Presser, A. L., Vahey, P., & Dominguez, X. (2015). *: Improving Mathematics Learning by Integrating Curricular Activities with Innovative and Developmentally Appropriate Digital Apps: Findings from the Next Generation Preschool Math Evaluation*. Retrieved February 6, 2021, from https://files.eric.ed.gov/fulltext/ED562305.pdf.

Quinlan, P. T. (1991). *Connectionism and psychology: A psychological perspective on new connectionist research*. Chicago: The University of Chicago Press.

Rashid, S., & Brooks, G. (2010). *The levels of attainment in literacy and numeracy of 13-to 19-year-olds in England, 1948-2009*. London: NRDC.

Reeve, R. A. & Gray, S. (2014). Number difficulties in young children. In S. Chinn (Ed.), *The Routledge international handbook of dyscalculia and mathematical learning difficulties (pp. 44-59)*. London: Routledge

Reimer, K. & Moyer, P.S. (2005). Third-graders learn about fractions using virtual manipulatives: A classroom study. *Journal of Computers in Mathematics and Science Teaching, 24*(1), 5–25

Reneau, J. L. (2012). Using the concrete-representational-abstract sequence to connect manipulatives, problem solving schemas, and equations in word problems with fractions. (Ed.D., West Virginia University). *ProQuest Dissertations and Theses.*

Rew, L.J., B.D. Maxwell, F.L. Dougher & R. Aspinall. (2006). Searching for a needle in a haystack: evaluating survey methods for non-indigenous plant species. *Biological Invasions, 8*, 523-539.

Rittle-Johnson, B., & Koedinger,K. R. (2005). Designing knowledge scaffolds to support mathematical problem solving. *Cognition and Instruction, 23*, 313349.

Robinson, J. C. (1982). *Developing managers through behaviour modeling*. San Diego, CA: Learning Concepts.

Ross, R. & Kurtz, R. (1993). Making manipulatives work: a strategy for success. *Arithmetic Teacher, 40*(5), 254-257.

Rumelhart, D. E., & Ortony, A. (1977). The representation of knowledge in Memory, In R. C. Anderson, R. J. Spiro, & W.E. Montague (Eds.), *Schooling and the acquisition of knowledge (pp. 99-136)*. Hillsdale, NJ: Erlbaum.

Rust, A. L. (1999). *A study of the benefits of math manipulatives versus standard curriculum in the comprehension of mathematics concepts*. Master Action.

Ruzic, R. & O Connell, K. (2001). Manipulatives. enhancement literature review. Retrieved June 10, 2009, from: *http://www.cast.org/ncac/Manipulatives1666.cfm*

Schoenfeld, A. H. (1987). *Cognitive science and mathematics education*. Lawrence Erlbaum Associates, Inc

Scott, W.I.R. (1987). The Adolescences of Institutional Theory Administrative science. *Quarterly*, 32, https://doi.org/10.2307

Seaberg, J. R. (1988). Utilizing sampling procedures. *Social Work Research and Evaluation, 3,* 240-257.

Sebesta, L. M. & Martin, S. R. M. (2004). Fractions: building a foundation with concrete manipulatives. 83(2): 3–23.

Secada, W. G., & Carey, D. A. (1990). Teaching mathematics with understanding to limited english proficient students (Master's thesis, University of Wisconsin,

Seidler, J. (1974). On using informants: a technique for collecting quantitative data and Smith, T.M.F. 1983. On the validity of inferences from nonrandom sample. *Journal o the Royal Statistical Society.* Series A (General) 146:394-403.

Seidler, J. 1974. On using informants: a technique for collecting quantitative data and Smith, T.M.F. 1983. On the validity of inferences from nonrandom sample. Journal of the Royal Statistical Society. Series A (General) 146:394-403.

Showkat, N., & Parveen, H. (2017). *Non- Probability and Probability Sampling*. e-PG Pathshala

Skemp, R. R. (1987). (revised American edition). Hillsdale, NJ: Erlbaum.

Skinner, B. F. (1953). Science and human behaviour. New York: Macmillan.

Skinner, B. F. (1957). Verbal behaviour. New York: Appleton-Century-Crofts.

Skinner, B. F. (1968). The technology of teaching. New York: Applet on Century-Crofts.

Skinner, B. F. (1987). Whatever happened to psychology as the science of behaviour? American Psychologist, 42, 780-786.

Slater, Pam. "State Schools Chief Torlakson Calls First Year of CAASPP Results

Smith, J.A., Jarman, M. & Osborn, M. 1999: Doing interpretative phenomenological analysis. In Murray, M. and Chamberlain,

Smith, T.M.F. 1983. On the validity of inferences from nonrandom sample. *Journal of the Royal Statistical Society.* Nkoranza north District 2018 - 2020 budget. Series A (General) 146:394-403.

Solutions Approach (MSA): Conceptions and Practices of Primary School Teachers in Ghana. *International Journal of Research in Education and Science*, 2(2), 333-344. Retrieved January 21, 2017, from http://flles.eric.ed.gov/fulltext/EJn05120.pdf

Sorcher, M., & Goldstein, A. P. (1972) A behaviour modelling approach in training. Personnel Administration, 35, 35-41.

Sowell, E. (1989). Effects of manipulative materials in mathematics instruction. Journal for Research in Mathematics Education. 20: 498-505.

Spiro, R., Bruce, B., & Brewer, W. (Eds.), Theoretical issues in reading comprehension, (pp. 33-58).

Stein, M. N., & Bovalino, J. W., (2001). Manipulatives: One piece of the puzzle. Mathematics Teaching in the Middle School, 6(6), 359

Stellingwerf, B. P., & Lieshout, E. C. D. M. (1999). Manipulatives and number sentences in computer aided arithmetic word problem solving. Instructional Science, 27(6), 459–476.

Sternberg, R. J. & Grigorenko, E. L. (2004). Why cultural psychology is necessary and not just nice. *American Psychology Association.* First Street NE, Washington, DC.

Stoilescu, D. (2016). Aspects of theories, frameworks and paradigms in mathematics education research. *European Journal of Science and Mathematics Education, 4*(2), 140-154.

Stroizer, S., Hinton, V., Flores, M., & Terry, L. (2015). An Investigation of the Effects of Model-Centered Instruction. *Education and Training in Autism and Developmental Disabilities,* 50(2), 223–236.

Sutton, J., & Krueger, A. (Eds.) (2002). EDThoughts: What we know about mathematics teaching and learning. Aurora, CO: Mid-Continent Research for Education and Learning. Learners. New York, NY: Guilford Publications.

Suydam, M. N. (1984). Manipulative Materials and Achievement. Arithmetic Teacher, 33(6), 29 & 32.

Suydam, M. N. (1984). What research says: Helping low-achieving students in mathematics. *School Science and Mathematics,* 84(5), 437-441.

Suydam, M. N. and J. L. fliggins. (1977). Activity-based learning in elementary school mathematics: Recommendations from research. Columbus, Ohio: ERIC Center for Science, Mathematics, and Environmental Education, College of Education, Ohio State University.

Suydam, M. N., & Higgins, J. L.(1976). Review and Synthesis of Studies of Activity-Based Approaches to Mathematics Teaching. Final Report, NIE Contract No. 400-75-0063

Suydam, M.N.(1985).Research on instructional materials for mathematics & environmental education. (ERIC Document Reproduction Service No.ED276 569

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

Swan, P., & Marshall, L. (2010). Revisiting Mathematics Manipulative Materials. Australian Primary M athematics Classroom, 15(2), 13-19.

Tabachnick, B. G., & Fidell, L. S. (2007). Using multivariate statistics. Allyn & Bacon/Pearson Education

Tashakkori, A., & Teddlie, C. (Eds.). (2003). Handbook on mixed methods in the behavioral and social sciences. Thousand Oaks, CA: Sage Publications.

Taylor, P. J., Russ-Eft, D., & Chan, D. (2003, June). The impact of alternative rating sources and retrospective pre-tests on training effect sizes. Paper presented at the Australian Industrial Organizational Psychology conference, Melbourne, Australia.

Thirey, B., & Wooster, R. (2013). The touchy-feely Integral: Using Manipulatives to teach the basic properties of integration. *PRIMUS, 23*(7), 605-616.

Thompson, D. M., & Tulving, E. (1970). Associative encoding and retrieval: Weak and strong cues. Journal of Experimental Psychology, 86, 255-262.

Thompson, P. W. (1992). Notations, conventions, and constraints: Contributions to effective uses of concrete materials in elementary mathematics. Journal for Research in Mathematics Education, 23, 123–147.Thomson Learning.

Thompson, P. W. (1994). Concrete materials and teaching for understanding. Arithmetic Teacher. 41(9), 556-58.

Tooke, D., Hyatt, B., Leigh M., Snyder, B., & Borda, T. (1992). Why aren't manipulatives used in every middle school mathematics classroom? Is Eddle School lommal, 24(3), 61-64.

Topp, L., B. Barker & L. Degenhardt. 2004. The external validity of results tree of life: universal and cultural features of folkbiological taxonomies and inductions. Cognitive Psychology 32:251-295.Snedecor, G.W. 1939. Design of sampling experiments in the social sciences. *Journal of Farm Economics* 21:846-855.

Tremblay, M.-A. 1957. The key informant technique: a none ethnographic application. *American Anthropologist* 59:699-701.

Tremblay, M.-A. 1957. The key informant technique: a nonethnographic application. *American Anthropologist* 59:699-701.

Trueblood, T. (1986). *The relationship of each the three factors of the MARS to the emotionality* factor of the TAI ranges from. 42 (Evaluation) 314.

Tucker, S., Shumway, J. F., Moyer-Packenham, P. S., & Jordan, K. E. (2016). *Zooming in on Children's Thinking*. Retrieved February 6, 2021, from https://files.eric.ed.gov/fulltext/EJ1096470.pdf.

Turner, J. C. (1995). The influence of classroom contexts on young children's motivation for literacy. *Reading Research Quarterly,* 30, 410-441.

Turner, J. C., & Meyer, D. K. (2000). Studying and understanding the instructional contexts of classrooms: Using our past to forge our future. *Educational Psychologist,* 35(2), 69-85.

Underhill, B. (1981). Teaching elementary school mathematics (3rd ed.). Columbus, OH: Merril.

Underhill, B. (1981). *Teaching elementary school mathematics* (3rd ed.). Columbus, OH: Merril.

University of Maryland, 1990) (pp. 1-48). New York: ERIC Clearing House on Urban Education.

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1979). Consciousness as a problem in the psychology of behaviour. *Soviet Psychology*, 17(4), 3-35

Wang, A. H. (2010). Optimizing Early Mathematics Experiences for Children from Low Income Families: A Study on Opportunity to Learn Mathematics. *Early Childhood Education Journal,* 37, 295-302.

Wang, A. H. (2010). Optimizing Early Mathematics Experiences for Children upon children's cognitive structure development—reflection II; Pennsylvania

Watson, J. B. (1913). Psychology as a behaviourist views it. *Psychological Review, 23*, 89-116

Wenglinsky, H. (2000). How teaching matters: Bringing the classroom back into discussions of teacher quality. Princeton, NJ: Educational Testing Service.

Wertsch, J. V., Rio, P., & Alverez, A. (1995). Sociocultural studies of mind, New York: Cambridge University Press

Wittgenstein, L., (1953/1968). Philosophical Investigations, trans. G. E. M. Anscombe, Oxford: Basil Blackwell.

Witzel, B. S. (2005). Using CRA to Teach Algebra to Students with Math Difficulties in Inclusive Settings. Learning Disabilities: *A Contemporary Journal,* 3(2), 49-60.

Witzel, B. S., & Little, M. E. (2015). *Teaching Elementary Mathematics to Struggling*

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching Algebra to Students with Learning Difficulties: An Investigation of an Explicit Instruction Model. *Learning Disabilities Research and Practice,* 18(2), 121–131.

Wragg E.C. (2002). *An Introduction to Classroom Observation.* Second edition. Second edition. London and New York: Routledge

Zelditch, M.Jr. (1962). Some methodological problems of field studies. *The America Journal of Sociology* 67:566-576

Zemelman, S., Daniels, H., & Hyde, A. (1993). *Best practice: New standards for teaching and learning in America's schools.* Portsmouth, NH: Heinemann.

Zoltam, D. (1916). Mathematics through the senses, games, dance and art. Windsor, UK: *The National Foundation for Educational Research.*

APPENDIX: 1

APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF EARLY CHILDHOOD EDUCATION

QUESTIONNAIRE FOR KINDERGARTEN TEACHERS

I am Mphil student at the University of Education, Winneba (North Campus), researching the topic: ***Teachers' use of manipulatives in teaching numeracy at early childhood centre in the nkoranza north district of bono east, Ghana.*** I am gathering information for the aforementioned study. As a kindergarten teacher, you have been chosen as one of the favourable respondents. The questionnaire is in five parts. The first part seeks basic information about you, the second part also seeks your views on manipulatives materials available at the early childhood education centres, the third section seeks your views on type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres, the fourth part seeks your views on the skills teachers use in teaching numeracy using manipulatives at early childhood education centres and the fifth part also seeks your views on the challenges faced by teachers in teaching numeracy at early childhood education centres. Your cooperation and objective responses will provide the study with the necessary data. All information will be kept strictly confidential and used solely for the purposes of this study.

SECTION A
BACKGROUND INFORMATION OF RESPONDENTS

Kindly tick (√) where appropriate

1. Sex **(select as appropriate)**

Male	
Female	

2. Age Range **(select as appropriate)**

Age Range/Years	26 – 35	36 – 45	46 – 55	56 years and above
Select				

3. Academic Qualification **(select as appropriate)**

Academic Qualification	First Degree	HND	DBE	O'Level
Select				

4. What is your rank in your teaching profession? **(select as appropriate)**

Rank	Assistant Director II	Principal Superintendent	Senior Superintendent I	Senior Superintendent II	Teacher
Select					

5. What class do you teach? **(select as appropriate)**

Present class	Kindergarten 1	Kindergarten 2
Select		

6. How many years have you been teaching at the kindergarten level? **(select as appropriate)**

Duration Served	Less than 5 years	6 – 10 years	11 – 15 years	16 – 20 years	More than 21 years
Select					

7. Professional Qualification **(select as appropriate)**

Professional Qualification	Graduate professional	Graduate non-professional	Diploma professional	Diploma non-professional
Select				

SECTION B

MANIPULATIVES MATERIALS AVAILABLE AT THE EARLY CHILDHOOD EDUCATION CENTRES IN THE NKORANZA NORTH DISTRICT.

In this section, you are required to give your ratings on the manipulatives materials available at the early childhood education centres. The scale given in Table 1 indicates the weighting assigned to the responses.

Table 1

5	4	3	2	1
Strongly Agree	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**

For each of the statement in Table 2, tick (√) as appropriate to indicate the degree to which you rate the manipulatives materials available at the early childhood education centres.

Table 2

#	***Statement***	***5***	***4***	***3***	***2***	***1***
1	Counters					
2	Bundle of sticks					
3	Playing cards					
4	Bottle tops					
5	Number cards					
6	Clock					
7	Number charts					

SECTION C

TYPE OF MANIPULATIVE MATERIALS TEACHERS OFTEN USE IN TEACHING NUMERACY AT THE EARLY CHILDHOOD EDUCATION CENTRES IN NKORANZA NORTH DISTRICT

In this section, you are required to give your ratings on the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres. The scale given in Table 3 indicates the weighting assigned to the responses.

Table 3

5	4	3	2	1
Always	**Frequently**	**Sometimes**	**Seldom**	**Never**

For each of the statement in Table 4, tick (√) as appropriate to indicate the degree to which you rate the type of manipulative materials teachers often use in teaching numeracy at the early childhood education centres.

Table 4

#	***Statement***	***5***	***4***	***3***	***2***	***1***
1	Geoboard					
2	Cuisenaire rods					
3	Base – 10 blocks					
4	Abacus					
5	Colour and number tiles					
6	Dice					
7	Pattern blocks					

SECTION D

SKILLS TEACHERS USE IN TEACHING NUMERACY USING MANIPULATIVES AT EARLY CHILDHOOD EDUCATION CENTRES IN THE NKORANZA NORTH DISTRICT

In this section, you are required to give your ratings on the skills teachers use in teaching numeracy using manipulatives at early childhood education centres. The scale given in Table 5 indicates the weighting assigned to the responses.

Table 5

5	4	3	2	1
Strongly Agree	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**

For each of the statement in Table 6, tick (√) as appropriate to indicate the degree to which you rate the skills teachers use in teaching numeracy using manipulatives at early childhood education centres.

Table 6

#	***Statement***	***5***	***4***	***3***	***2***	***1***
1	Child centred method					
2	Demonstration method					
3	Discussion method					
4	Brainstorming					
5	Grouping method					
6	Question and answer method					
7	Role play					

SECTION E

CHALLENGES TEACHERS FACE WHEN USING MANIPULATIVES IN TEACHING NUMERACY AT EARLY CHILDHOOD EDUCATION CENTRES IN THE NKORANZA NORTH DISTRICT

In this section, you are required to give your ratings on the challenges teachers face when using manipulatives in teaching numeracy at early childhood education centres. The scale given in Table 7 indicates the weighting assigned to the responses.

Table 7

5	4	3	2	1
Strongly Agree	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**

For each of the statement in Table 8, tick (√) as appropriate to indicate the degree to which you rate the challenges teachers face when using manipulatives in teaching numeracy at early childhood education centres.

Table 6

#	***Statement***	***5***	***4***	***3***	***2***	***1***
1	Limited classroom time					
2	Inadequate of pedagogical knowledge					
3	Inadequate technological knowledge					
4	Insufficient budgets for manipulatives					
5	Lack of administrative support					
6	Poor attitude of learners					
7	Lack of availability of kits					

APPENDIX B

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF EARLY CHILDHOOD EDUCATION

Interview Guide for School Improvement Support Officers and Kindergarten Coordinators

1. During your supervision, what manipulative materials are available at the early childhood education centres in the Nkoranza district?
2. In using the available manipulative materials, what skills or methods do teachers often use in teaching numeracy at the early childhood education centres in the Nkoranza district?
3. What challenges do you think teachers face when using those available manipulative materials in your district?

APPENDIX C

OBSERVATIONAL GUIDE

School…………………. Name of observer…………………..

Class…………………………

The purpose of this form is to provide information about the type of manipulative materials use in teaching numeracy at the Kindergarten level.

N/O	Types	Frequently	Sometimes	Not at all
1.	Abacus			
2.	Bundle of Sticks			
3.	Dice			
4.	Multi-base block			
	What teachers do when manipulative materials are not promptly supplied			
5.	Improvisation			
6.	Use materials in the environment			
7.	Use chalk board illustration			