THE INFLUENCE OF MODELS ON THE LEARNING OUTCOMES IN MATHEMATICAL ACTIVITIES IN PRESCHOOLS IN KAKAMEGA MUNICIPALITY.

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DECLARATION

This research project is my original work and has not been presented for a degree award in any other university.

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DEDICATION

This work is dedicated to the Almighty God who has given me the wisdom and the zeal to study. To my loving and caring parents for the sacrifice and full support they have offered to me in ensuring that I have a bright future. Also special thanks to my supervisor Dr. S. Mwanda of the Department of Educational Communication and Technology for his guidance and patience throughout my entire project.

Finally to all people in one way or another who have contributed in making my work a success. I love you all.

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ABSTRACT

The purpose of the study was to find out the influence of models on the learning outcomes in Mathematical Activities in preschools in Kakamega municipality. The study sought to achieve the following objectives:-

To determine the learning outcomes when models are used in the teaching of classification and number concepts in mathematics activities in preschools in Kakamega municipality, to find out the learning outcomes when models are used in the teaching of measurement and geometry in mathematics activities and to evaluate the impact of the use of models on learner performance in mathematics in preschools in Kakamega municipality.

The significance of the study was to add to the growth of knowledge of the factors affecting effective learning and teaching of mathematical activities in pre-schools. The study adopted a correlational research design to describe the statistical association between the variables.

The study used only public pre-schools in Kakamega municipality because of their standardized curriculum and supervision.

The sample comprised of 5 head teachers and 5 teachers. Data was gathered by use of questionnaires, observation schedule and interview guides and it was analyzed by using descriptive statistics by use of frequencies and percentages.

The study found out that various models were used by teachers in the teaching of mathematics in preschools and children learn best by engaging in manipulative activities.

Based on the findings it was recommended that there is need to strengthen facilities and teacher capacity in teaching maths at pre-school. This can be done through capacity building and training of pre-school teachers. Also there is need to encourage closer participation of stakeholders in enhancing performance of preschool children in mathematics.

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LIST OF ABBREVIATIONS

D.E.C.E.C.E:- District Centers for Early Childhood Education.

E.C.E- Early Child hood education

N.A.C.E.C.E- National Centre for Early Childhood Education

K.I.E. - Kenya Institute of Education.

M.O.E- Ministry of Education.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Problem

Mathematics provides a powerful means for understanding and analyzing the world. Mathematical ways of describing and representing quantities, shapes, space, and patterns help to organize people's insights and ideas about the world in systematic ways. Some of these mathematical systems have become such a fundamental part of people's everyday lives—for example, counting systems and methods of measurement—that they may not recognize the complexity of the ideas underpinning them. The mathematical ideas that are suitable for preschool and the early grades reveal a surprising intricacy and complexity when they are examined in depth (Dodge and Colker, 2001).

There is evidence that most children bring foundational resources and knowledge about mathematics to school (Starkey and Klein, 2008). Most children bring core number sense (interconnected knowledge of numbers and operations) or number competencies to school. Although preverbal number sense begins in infancy and appears to be universal, preschool and kindergarten number sense involves understanding of number words and symbols, which is heavily influenced by experience and instruction. The number sense children bring to kindergarten is highly predictive of their later mathematics achievement (Gersten, Jordan, and Flojo, 2005).

Mathematics equips the children with knowledge and skills which assist in developing logical thinking, ability to apply the knowledge acquired, analyze situations and make rational decisions. In the learning of mathematics, children naturally look for patterns and shapes, make comparisons and explore relationships within their environment (Dodge and Colker 2001).

They develop and acquire mathematical concepts and skills at early age. It is therefore important for the teacher to build the fundamental mathematical concepts and skills in children at an early age.

The significances of ECE lie in the fact that the curriculum provides a foundation upon which mastery of formal learning skills is planted. The successful transition and completion of subsequent levels is dependent on the foundation laid in early schooling (Sifuna, Chege and Oamda, 2006). Understanding math concepts opens many doors for children, from being able to tell time to grasping the value of money. Starting at age 3, children should be learning to count, recognize numbers and manage basic addition and subtraction. Children need concrete objects in order to make sense of new math concepts or abstract ideas. Only after children have had ample opportunities to learn a new concept with real objects are they ready to connect their learning to abstract symbols such as numbers and math symbols. In this study, the focus will be on the use of models as an instructional resource in the teaching of mathematics in preschools in Kakamega Municipality.

Instructional resources are tools used for teaching and learning they support the teacher in the delivery of knowledge or help to emphasize specific knowledge. All good instructional resources should meet the needs of children, fulfill the requirements of the subjects and facilitate the teaching and learning process (Thungu et al 2008). Piaget (1967) in his theory of constructivism argues that children generate knowledge and meaning from an interaction between their experiences and their ideas. He associated his theory with pedagogic approaches that promote active learning.

Merely using instructional resources does not guarantee effective teaching. To make teaching and learning effective, the resources must be appropriately selected and used. It is important to note that the primary function of instructional resources as a communication device is to serve as a more concrete reference to meaning than spoken or written word. Moreover, instructional resources serve functions of enhancing retention which makes learning more permanent; stimulate and sustain interest in learning by providing firsthand experience with the realities of the physical and social environment and help to overcome the limitations of the classrooms and make what may be inaccessible in class available. In addition, they encourage active participation especially those that can be handled and manipulated by children; they discourage rote learning and make abstract ideas more concrete (Thungu et al 2008).

Early childhood activities should be practical with plenty of manipulatives such as models that include stones, blocks, bottle tops, and flash cards among others (Mwangi 2010). These activities should enable children to expand their understanding of number, shape, size and patterns as they have a meaning in the world around them. Models are three dimensional simplified representation of a real object. When used in the teaching of mathematics activities, being three dimensional models give a feeling of substance and depth of the real object and can be manipulated by children thus motivating and stimulating them in the teaching and learning process. Models also promote active participation of children during classroom instruction of mathematics activities thus making the concepts and special features being explained easy to understand. More so models can be assembled or disassembled as need arises to give meaning to what is being explained in the classroom.

The major aspects taught in preschool include: classification that involves children picking objects which look the same in one way or the other in a given group comprising different types of objects. This is aimed at developing in the child skills of discriminating and estimating sizes, mathematical vocabulary and reasoning and thinking logical thinking. In this case models such as wooden blocks of different shapes and sizes, paper cut outs of different shapes, will be the most appropriate teaching resource because it gives the child an opportunity to differentiate objects practically, Therefore a wider range of materials must be provided in Pre School to enable the children to engage in various learning activities. This should be joint effort involving the teacher, children and the local community especially parents. (Kenya Pre School Teachers Activities Guide Series Book 3, 2006).

It should be noted that, mathematics for young children lays the foundations of the concepts and skills on which further learning are built upon. These concepts and skills are developed through concrete experiences such as exploration of objects and gradual understanding of their properties and their relationships. Throughout the early years of life, children notice and explore mathematical dimensions of the world. Based on the Kakamega Municipality education survey carried out in 2006, the poor performance of mathematics at Kenya Certificate of Primary Education and Kenya Certificate of Secondary Education was linked to poor background traced down to ECE. This concurs with assertions made through different study findings with regard to the impact of early childhood education on progressive learning outcomes at advanced stages of learning (Brosnan, 1998; Ehrlich, Levine, and Goldin-Meadow, 2006; Jordan et al., 2006; Levine et al., 1999; Rosser et al., 1984). These studies assert, among other things, that the teaching approaches and the pedagogical strategies adopted by preschool teachers influence the performance of preschool learners. It is with this in mind that this study examines the use of models as a teaching approach in preschool mathematics.

1.2 Statement of Problem

Early childhood Education plays a crucial role in laying a foundation for further education and character formation. This applies critically to the acquisition of numerical literacy that is learnt in preschool math. The performance in mathematics depends heavily on the pedagogic strategies that are employed by the preschool teacher. These strategies must bear in mind the needs of the learner as well as the intended learning outcomes of the instructional procedure adopted by the teacher.

It is with regard to these issues that this study pursues modeling as a teaching and learning strategy for preschool mathematics. The study examined the use of models as a pedagogical strategy and learner outcomes as a consequence of the use of this strategy.

1.3Purpose of the Study

The purpose of the study was to assess the influence of using models on the learning outcomes of mathematics activities among preschool children in Kakamega Municipality.

1.4Objectives of the Study

The study sought to achieve the following objectives:

i. To determine the learning outcomes when models are used in the teaching of classification in mathematics activities in preschools in Kakamega municipality.

ii. To determine the learning outcomes when models are used in the teaching of number concepts in mathematics activities in preschools in Kakamega municipality.

iii. To find out the learning outcomes when models are used in the teaching of measurement and geometry in mathematics activities in preschools in Kakamega municipality.

iv. Evaluate the impact of the use of models on learner performance in mathematics in preschools in Kakamega municipality.

1.5Research Questions

The study sought to answer the following questions:

i) What are the learning outcomes when models are used in the teaching of classification in mathematics activities in preschools in Kakamega municipality?

ii) What are the learning outcomes when models are used in the teaching of number concepts in mathematics activities in preschools in Kakamega municipality?

iii) What are the learning outcomes when models are used in the teaching of measurement and geometry in mathematics activities in preschools in Kakamega municipality?

iv) To what extent does the use of models in teaching mathematics at preschool impact on their performance?

1.6 Significant of the study

The findings of this study may add to the growth of the knowledge of the factors affecting effective learning and teaching in ECE. Preschool teachers may gain new knowledge which they can implement to improve their teaching skills, Head teachers and Managers of schools may use the information to improve on the way of providing instructional resources used in the teaching of mathematics activities in their schools. The school inspectors and education officers may use the information to correct an area of weakness in preschool education.

Moreover, the study will serve as a feedback to the education sector especially the department of teacher training and curriculum development and evaluation. Finally the findings may also be an inspiration for further research on the theory of knowledge on impact of instructional resources on learning outcomes of preschool children.

1.7 Limitations of the Study

The study was limited in scope and in methodology. The study limited itself to only to the use of models as a teaching methodology for preschool math teachers. This was done in the knowledge that there exist other learning resources available to maths teachers in preschool. In addition, the study was limited to the aspects of learner performance related to the use of models in the learning of math. This was regardless of the fat that such performance may be, to a certain extent, influenced by the use of other teaching strategies. Moreover, the study was limited in its examination of the use of models in a sample of preschools in Kakamega municipality.

1.8 Delimitation of the Study

The research was delimited to preschools in Kakamega Municipality and to the teachers and children in these schools. These were preschool head teachers, preschool teachers and the pupils involved in the study.

1.9 Basic Assumption

This study assumed that mathematics activities are taught in all preschools in Kakamega Municipality and that all teachers make use of models as an instructional resource during the teaching and learning process.

1.10 Definition of Key terms

Achievement: - refers to extent to which a leaner has attained the goals as indicated by his or her grade.

Early Childhood Education: - refers to education of children from two to five years.

Instructional Resources: - refers to materials used for teaching and learning.

Learning outcomes: refer to change or modification of behavior or response as a result of a form of experience.

Models: refers to three dimensional simplified representation of a real object.

Performance; refers to the improvement in understanding of activities taught using adequate instructional resources.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The literature review is an extended examination of views and opinions regarding aspects media influence on youth. Literature review surveys scholarly articles, books and other sources relevant to a particular issue, area of research, or theory, providing a description, summary, and critical evaluation of each work (Cooper, 2010). The purpose is to offer an overview of significant literature published on a topic. The review makes a critical examination of theories related to learning. Therefore the reviewed literature on the influence of using models in teaching classification, number concepts, and measurement and geometry. Further the review will examine literature related to the use of models and learner performance.

2.1 Using Learning Resources

According to Feshbach (1973) preschool teaching materials must be available in preschool most of the days. These include housekeeping materials, puppets, puzzles books science materials and trucks. Furthermore, Feshbach (1973) also reports on preschool, education in Israel .He says that the Ministry of Education and the culture employ preschool supervisors, construct class rooms and equips classrooms with a variety of teaching materials.

Cass(1990) conducted a research with 400 preschool teachers in London on their role in schools to provide the child with a live day where he can be living ,learning and growing al the time .From the preschool teachers responses , they all agreed that the children benefit , greatly from the active methods found in the child centered teaching methods. Teachers responded that children have the opportunity to develop at their own rate , gain confidence independence and prepared for all round development .

Usuala (1984) reiterates these facts on the usefulness of learning resources. In a study on Education Technology in Africa, he reiterated the effectiveness of teaching materials in preschool in Africa. For instance charts, flash cards, realia and toys. He also expressed the recognition of the importance of these instructional aids by a number of African countries .This has led to the establishment of educational technology centres in a number of African countries.

Allen and Hart (1996) states that beside using touching materials the teacher must ensure that variety of the same are available in class for effective teaching and learning. They say that the materials and equipment presented in early childhood setting should be chosen to provide many and varied opportunities for children are offered many opportunities to practice and master familiar skills through a variety of materials. By having a variety of materials, teachers can readily adapt the setting to individual as well as group learning needs. The more skills a particular material prompts a child to learn the better the material is. For example, showing a picture of a cow to preschool children will make them understand it much better than explaining what it is.

2.2 Learning Outcomes in Teaching Classification

Dennis et al (1999) studied use of games to teach simple classification and seriation constructs to 3-1/2-year-old children. They found substantial and maintained improvement on classification and seriation. Children generalized their new understanding of classification and seriation to different problems, and found that evidence for a more general cognitive gain that extended to other cognitive abilities was equivocal. There is considerable variability in the age at which children do particular numerical tasks (Clements and Sarama, 2008). However, a considerable amount of this variability comes from differences in the opportunities to learn these tasks and the opportunity to practice them with occasional feedback to correct errors and extend the learning.

Once started along these numerical learning paths, children become interested in consolidating and extending their knowledge, practicing by themselves and seeking out additional information by asking questions and giving themselves new tasks. Preschool and school environments need to support children in this process of becoming a self-initiating and self-guiding learner and facilitate the carrying out of such learning. Targeted learning path time is also needed—time at home or in an early childhood learning center—that will support children in consolidating thinking at one step and moving along the learning path to the next step.

Although we consider the mathematics goals foundational and achievable for all children in the designated age range for that step, we recognize that some children's learning will be advanced while others' functioning will be significantly behind (Benson and Baroody, 2002). Children at particular ages/grades may be able to work correctly with larger numbers or more complex geometric ideas than those we specify in the various tables and text. Each subsequent step assumes that children have had sufficient experiences with the topics in the previous step to learn the earlier content well. However, many children can still learn the content at a given step without having fully mastered the previous content if they have sufficient time to learn and practice the more challenging content (Mix, Sanhofer, and Baroody, 2005). Of course, some children have difficulty in learning certain kinds of mathematical concepts, and a few have really significant difficulties. But most children are capable of learning the foundational and achievable mathematics content specified in the learning steps outlined here.

In both the number and operations and the geometry and measurement core areas, children learn about the basic numerical or geometric concepts and objects (numbers, shapes), and they also relate those objects and compose/decompose (operate on) them. Therefore, each core area begins by discussing the basic objects and then moves to the relations and operations on them. In all of these, it is important to consider how children perceive, say, describe/discuss, and construct these objects, relations, and operations.

According to Lipton and Spelke, (2006), the development of the elements of the number core across ages is described first, and then the development of the relations and operations core is summarized. These cores are quite related, and their relationships are discussed. As children move from age 2 through kindergarten, they learn to work with larger and more complicated numbers, make connections across the mathematical contents of the core areas, learn more complex strategies, and move from working only with objects to using mental representations(Mix, Sanhofer, and Baroody, 2005). This journey is full of interesting discoveries and patterns that can be supported at home and at care and education centers.

2.3 Studies on Teaching Number Concepts

The four mathematical aspects of the number core involve culturally specific ways that children learn to perceive, say, describe/discuss, and construct numbers. These involve: i) Cardinality: Children's knowledge of cardinality (how many are in a set) increases as they learn specific number words for sets of objects they see (*I want two crackers*); ii)Number word list: Children begin to learn the ordered list of number words as a sort of chant separate from any use of that list in counting objects; iii) 1-to-1 counting correspondences: When children do begin counting, they must use one-to-one counting correspondences so that each object is paired with exactly one number word; and iv) Written number symbols: Children learn written number symbols through having such symbols around them named by their number word (*That is a two*)(Lipton and Spelke, 2006).

Initially these four aspects are separate, and then children make vital connections. They first connect saying the number word list with 1-to-1 correspondences to begin counting objects (Spelke, 2003; also see Baroody, Lai, and Mix, 2006). Initially this counting is just an activity without an understanding of the total amount (cardinality). If asked the question *How many are there?* after counting, children may count again (repeatedly) or give a number word different from the last counted word. According to Benson and Baroody, (2002), connecting counting and cardinality is a milestone in children's numerical learning path that coordinates the first three aspects of the number core. As noted, we divide the teaching-learning path into four broad steps.

In Step 1, for 2- and 3-year-olds, children learn about the separate aspects of number and then begin to coordinate them. In Step 2, for approximately 4-year-olds/prekindergartners, children extend their understanding to larger numbers. In Step 3, for approximately 5-year-olds/kindergartners, children integrate the aspects of number and begin to use a ten and some ones in teen numbers. In Step 4, approximately Grade 1, children see, count, write, and work with tens-units and ones-units from 1 to at least 100(Benson and Baroody, 2002).

The process of identifying the number of items in a small set (cardinality) has been called *subitizing*. We will call it *perceptual subitizing* to differentiate it from the more advanced form we discuss later for larger numbers called *conceptual subitizing* (Clements, 1999). For humans, the process of such verbal labeling can begin even before age 2. It first involves objects that are physically present and then extends to nonpresent objects visualized mentally (Benson and Baroody, 2002). This is an extremely important conceptual step for attaching a number word to the perceived cardinality of the set. In fact, there is growing evidence that the number words are critical to toddlers' construction of cardinal concepts of even small sets, like three and four and possibly one and two.

Children generally learn the first 10 number words by rote first and do not recognize their relation to quantity (Fuson, 1988; Ginsburg, 1977;; Wynn, 1990). They do, however, begin to learn sets of fingers that show small amounts (cardinalities). This is an important process, because these finger numbers will become tools for adding and subtracting (see research literature summarized in Clements and Sarama, 2007; Fuson, 1992a, 1992b). Interestingly, the conventions for counting on fingers vary across cultures.

In order to fully understand cardinality, children need to be able to both generalize and extend the idea. That is, they need to generalize from a specific example of two things (two crackers), to grasp the "two-ness" in any set of two things. They also need to *extend* their knowledge to larger and larger groups—from one and two to three, four, and five, although these are more difficult to see and label (Baroody, Lai, and Mix, 2006; Ginsburg, 1989). Children's early notions of cardinality and how and when they learn to label small sets with number words are an active area of research at present. The timing of these insights seems to be related to the grammatical structure of the child's native language (e.g., see the research summarized in Sarnecka et al., 2007).

Later on, children can learn to quickly see the quantity in larger sets if these can be decomposed into smaller subitized numbers (e.g., *I see two and three, and I know that makes five*). Following Clements (1999), we call such a process *conceptual subitizing* because it is based on visually apprehending the pair of small numbers rather than on counting them. Conceptual subitizing requires relating the two smaller numbers as addends within the conceptually subitized total.

With experience, the move from seeing the smaller sets to seeing and knowing their total becomes so rapid that one can experience this as seeing 5 (rather than as seeing 2 and 3). Children may also learn particular patterns, such as the 5 pattern on a die.

The importance of facilitating subitizing is underscored by a series of studies, which first found that children's spontaneous tendency to focus on numerosity was related to counting and arithmetic skills, then showed that it is possible to enhance such spontaneous focusing, and then found that doing so led to better competence in cardinality tasks (Hannula, 2005). Increasing spontaneous focusing on numerosity is an example of helping children mathematizes their environment (seek out and use the mathematical information in it). Such tendencies can stimulate children's self-initiated practice in numerical skills because they notice those features and are interested in them.

A common activity in many families and early childhood settings is helping a child learn the list of number words. Children initially may say numbers in the number word list in any order, but rapidly the errors take on a typical form. Children typically say the first part of the list correctly, and then may omit some numbers in the next portion of the list, or they say a lot of numbers out of order, often repeating them (e.g., one, two, three, four, five, eight, nine, four, five, two, six) (Fuson, 1988; Fuson, Richards. and Briars, 1982; Miller and Stigler, 1987; Siegler and Robinson, 1982). Children need to continue to hear a correct number list to begin to include the missing numbers and to extend the list.

Children can learn and practice the number word list by hearing and saying it without doing anything else, or it can be heard or said in coordination with another activity. Saying it alone allows the child to concentrate on the words, and later on the patterns in the words. However, it is also helpful to practice in other ways to link the number words to other aspects of the number core. Saying the words with actions (e.g., jumping, pointing, shaking a finger) can add interest and facilitate the 1-to-1 correspondences in counting objects. Raising a finger with each new word can help in learning how many fingers make certain numbers, and flashing ten fingers at each decade word can help to emphasize these words as made from tens.

In order to count a group of objects the person counting must use some kind of action that matches each word to an object. This often involves moving, touching or pointing to each object as each word is said. Four factors strongly affect counting correspondence accuracy: (1) amount of counting experience (more experience leads to fewer errors), (2) size of set (children become accurate on small sets first), (3) arrangement of objects (objects in a line make it easier to keep track of what has been counted and what has not), and (4) effort (see research reviewed in Clements and Sarama, 2007, and in Fuson, 1988). Small sets (initially up to three and later also four and five) can be counted in any arrangement, but larger sets are easier to count when they are arranged in a line. Children ages 2 and 3 who have been given opportunities to learn to count objects accurately can count objects in any arrangement up to 5 and count objects in linear arrangements up to 10 or more (Clements and Sarama, 2007; Fuson, 1988).

In groundbreaking research, Gelman and Gallistel (1978) identified five counting principles that stimulated a great deal of research about aspects of counting. Her three how-to-count principles are the three mathematical aspects we have just discussed: (1) the *stable order principle* says that the number word list must be used in its usual order, (2) the *one-one principle* says that each item in a set must be tagged by a unique count word, and (3) the *cardinality principle* says that the last number word in the count list represents the number of objects in the set. Her two what-to-count principles are mathematical aspects we have also discussed: (1) the *abstraction principle* states that any combination of discrete entities can be counted (e.g., heterogeneous versus homogeneous sets, abstract entities, such as the number of days in a week) and (2) the *order irrelevance principle* states that a set can be counted in any order and yield the same cardinal number (e.g., counting from right to left versus left to right).

Gelman took a strong position that children understand these counting principles very early in counting and use them in guiding their counting activity. Others have argued that at least some of these principles are understood only after accurate counting is in place (e.g., Briars and Siegler, 1984). Still others, taking a middle ground between the "principles before" view and the "principles after" view, suggest that there is a mutual (e.g., iterative) relation between understanding the count principles and counting skill (e.g., Baroody, 1992; Baroody and Ginsburg, 1986; Fuson, 1988; Miller, 1992; Rittle-Johnson and Siegler, 1998).

Children may initially produce the first several number words and not even separate them into distinct words (Fuson, Richards, and Briars, 1982). They may think that they need to say the number word list in order as they count, but early on they cannot realize the implication that they need a unique last counted word, or they would not repeat words so frequently as they say the number word list.

The what-to-count principles also cover a range of different understandings. It takes some time for children to learn to count parts of a thing (Shipley and Shepperson, 1990; Sophian and Kailihiwa, 1998), a later use of the abstraction principle. And the order irrelevance principle (counting in any order will give the same result) seems to be subject to expectations about what is conventional "acceptable" counting (e.g., starting at one end of a row rather than in the middle) as well as involving, later on, a deeper understanding of what is really involved in 1-to-1 correspondence:

2.4 Teaching Measurement and Geometry

The Dutch mathematician Hans Freudenthal stated that geometry and spatial thinking are important because "Geometry is grasping space. And since it is about the education of children, it is grasping that space in which the child lives, breathes, and moves. The space that the child must learn to know, explore, and conquer, in order to live, breath and move better in it. Are we so accustomed to this space that we cannot imagine how important it is for us and for those we are educating?" (Freudenthal, 1973, p. 403). This section describes the two major ways children understand that space, starting with smaller scale perspectives on geometric shape, including composition and transformation of shapes, and then turning to larger spaces in which they live. Although the research on these topics is far less developed than in number, it does provide guidelines for developing young children's learning of both geometric and spatial abilities.

Shape is a fundamental idea in mathematics and in development. Beyond mathematics, shape is the basic way children learn names of objects, and attending to the objects' shapes facilitates that learning (Jones and Smith, 2002).Children tend to move through different levels in thinking as they learn about geometric shapes (Clements and Battista, 1992; van Hiele, 1986). They have an innate, implicit ability to recognize and match shapes. But at the earliest, prerecognition level, they are not explicitly able to reliably distinguish circles, triangles, and squares from other shapes. Children at this level are just starting to form unconscious visual schemes for the shapes, drawing on some basic competencies. An example is pattern matching through some type of feature analysis (Anderson, 2000; Gibson et al., 1962) that is conducted after the visual image of the shape is analyzed by the visual system (Palmer, 1989).

At the next level, children think visually or holistically about shapes (i.e., syncretic thought, a fusion of differing systems; see Clements, Battista, and Sarama, 2001; Clements and Sarama, 2007b) and have formed schemes, or mental patterns, for shape categories. When first built, such schemes are holistic, unanalyzed, and visual. At this visual/holistic step, children can recognize shapes as wholes but may have difficulty forming separate mental images that are not supported by perceptual input. A given figure is a rectangle, for example, because "it looks like a door." They do not think about shapes in terms of their attributes, or properties. Children at this level of geometric thinking can construct shapes from parts, but they have difficulty integrating those parts into a coherent whole.

Next, children learn to describe, then analyze, geometric figures. The culmination of learning at this descriptive/analytic level is the ability to recognize and characterize shapes by their properties. Initially, they learn about the parts of shapes—for example, the boundaries of two-dimensional (2-D) and three-dimensional (3-D) shapes—and how to combine them to create geometric shapes (initially imprecisely). For example, they may explicitly understand that a closed shape with three straight sides is a triangle.

Children then increasingly see relationships between parts of shapes, which are properties of the shapes. For instance, a student might think of a parallelogram as a figure that has two pairs of parallel sides and two pairs of equal angles (angle measure is itself a relation between two sides, and equality of angles another relation). Owing usually to a lack of good experiences, many students do not reach this level until late in their schooling. However, with appropriate learning experiences, even preschoolers can begin to develop this level of thinking.

What ideas do preschool children form about common shapes? Decades ago, Fuson and Murray (1978) reported that, by 3 years of age, over 60 percent of children could name a circle, a square, and a triangle. More recently, Klein, Starkey, and Wakeley (1999) reported the shape-naming accuracy of 5-year-olds as circle, 85 percent; square, 78 percent; triangle, 80 percent; rectangle, 44 percent. In one study (Clements et al., 1999), children identified circles quite accurately (92, 96, and 99 percent for 4-year-olds, 5-year-olds, and 6-year-olds, respectively), and squares fairly well (82, 86, and 91 percent). Young children were less accurate at recognizing triangles and rectangles, although their averages (e.g., 60 percent for triangles for all ages 4-6) were not remarkably smaller than those of elementary students (64-81 percent). Their visual prototype for a triangle seems to be of an isosceles triangle. Their average for rectangles was a bit lower (just above 50 percent for all ages). Children's prototypical image of a rectangle seems to be a four-sided figure with two long parallel sides and "close to" square corners. Thus, young children tended to accept long parallelograms or right trapezoids as rectangles.

In a second study (Hannibal and Clements, 2008), children ages 3 to 6 sorted a variety of manipulable forms. Certain mathematically irrelevant characteristics affected children's categorizations: skewness, aspect ratio, and, for certain situations, orientation. With these manipulatives, orientation had the least effect. Most children accepted triangles even if their base was not horizontal, although a few protested. Skewness, or lack of symmetry, was more important. Many rejected triangles because "the point on top is not in the middle." For rectangles, many children accepted no right parallelograms and right trapezoids. Also important was aspect ratio, the ratio of height to base. Children preferred an aspect ratio near one for triangles; that is, about the same height as width. Children rejected both triangles and rectangles that were "too skinny" or "not wide enough."

2.5 Factors Affecting the Use of Instructional Resources

Omondi (1987) has noted that publications in some subject areas in case of change in the syllabus are always late. Hence courses often have to be started before the pupils and teachers' handbooks are available. Teachers become unable to complete the year's work and pupil's attainment suffer. He further recognizes that apart from lateness of the books the books published by Jomo Kenyatta Foundation are constantly in short of supply. Also, the costs are high binding normally poor and books last only about one year. This intensifies the problem of shortage and sharing.

The importance of utilization of learning resources materials is also under scored by the Sessional Paper No.5 of 1988.The paper states that visual aids are basic tools for educational development must be made available for the learner to learn more skills in using learning aids. It is necessary for the teachers to encourage them to do so .However a good majority of teachers never does this. Gitari (1990) in his study on library facilities in selected primary schools in Nithi, emphasizes that there is acute shortage of room for storage of visual aids in most primary schools. This is not only in term of building but also shelves and cupboards. As a result of this, rats and ants prove to be great menace to the stock in addition to the theft.

Johnson and Rising(1995) supporting the same concurs and states that in addition, schools need good classrooms , each primary school need a resource centre. However in the absence of a centre as storage space for audio –visual aids is fir paramount importance. Investigating factors that contribute to pupils' failure in Kenya certificate of Primary Education, Kiragu (1990) found out those pupils with parents who had received no schooling rarely had many text books bought for them. In his study on availability and use of instructional media in teaching and learning in primary school,Omwono (1990) says that the situation is pathetic in some schools. He states that since the inception of cost sharing in primary schools, it has become the responsibility of parents to supply instructional media. This has caused serious shortage of the same in most primary schools as not all parents are economically able to do so.

A study carried out on the roles played by teachers' resources centres indicated that tutors have not met most of their objectives .The main weakness is that some of them have had no prior training in handling the materials they are supposed to guide the teachers to use. The staffing of the centers has been inadequate. For examples there are no qualified technicians to assist in the teaching aids production and maintenance and operation of audio-visual equipment. The said weakness has tended to limit the effectiveness of the centre tutors.

Umbima (1995) deplores the position of visual aids in some primary schools in Nairobi. His experience is that some primary schools may seemingly well- stocked with visual aids. However on closer examination, the stocks are usually of irrelevant and outdated materials. Rarely are they organized in a systematic manner. Most schools have not even had enough money to build a modest collection of visual aids.

2.6 Theoretical Framework

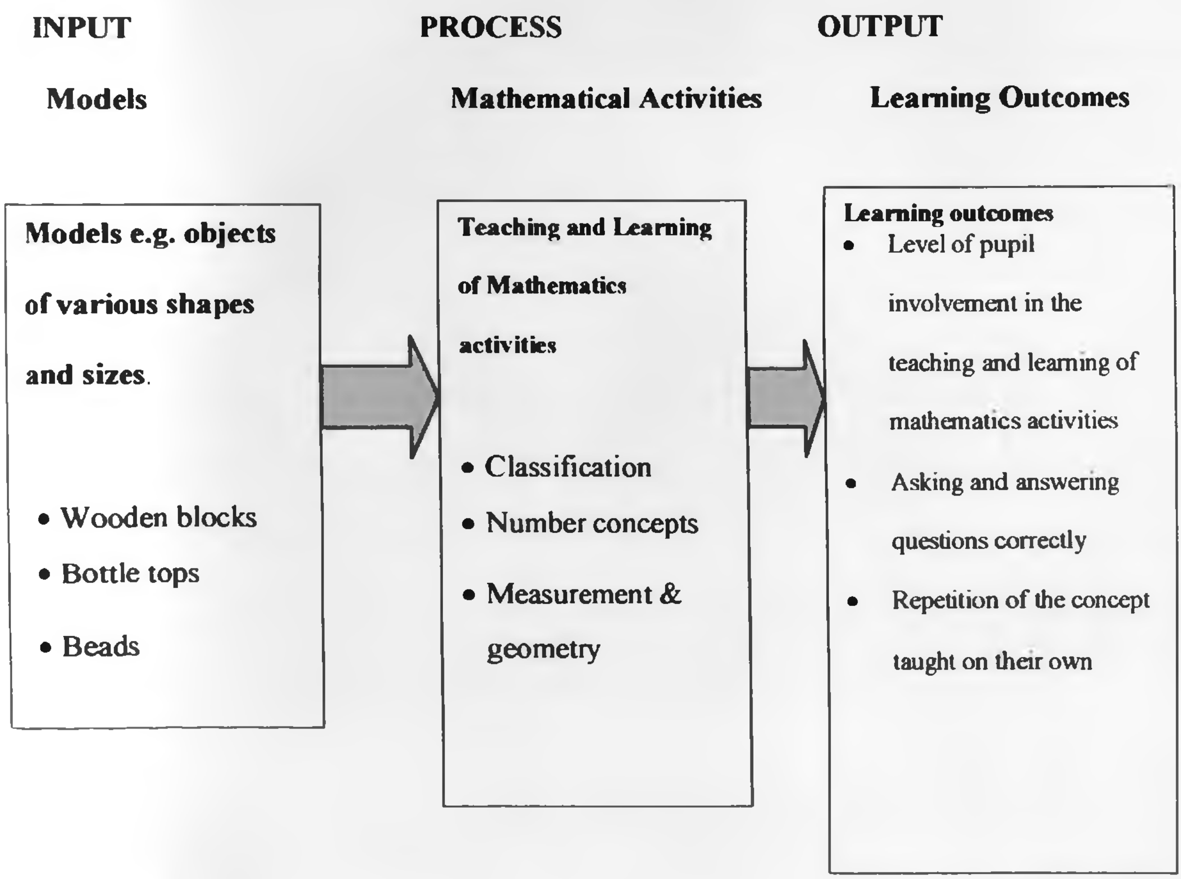
Piaget's (1967) theory of cognitive development addresses the sequences that children go through their learning about their world. Piaget establishes that children pass through four stages of cognitive growth. The second stage is the pre-operational stage that lasts from 2-7years. At this level, the child attends the specific attributes of situation at a time, cannot process multiple comparisons and does not have the ability to conserve quantity. The child makes global comparisons and thus learns how to classify. The child can discriminate visually among shapes, shapes and colors. Later the child can compare representations of objects or represent numbers. The basic skills is required is matching beginning with simpler objects and advancing to matching of different objects and sets of objects. Near the end of this stage, the child develops many necessary skills that can lead to the performance of higher level of mathematics. Lastly is the concrete operational stage that runs from 7-11 years. During this stage, children begin to question perceptions and to learn logical reasoning. They begin to manipulate their environment, mainly through mental pictures. At this time, children achieve flexibility and reversibility of thoughts as well as an understanding of conservation. Flexibility involves the ability to understand that 2+3=5, and 1+4=5. Reversibility, on the other hand, is the idea that some changes can be undone by reversing an earlier action. For example, 2+3=5 and 5-3=2. Reversibility is the prerequisite to understand the relationship between addition and subtraction.

Conservation is critical to the understanding of number. The child must understand that a set is not changed quantitatively by the rearrangement of the objects in that set. Models can be effectively used to demonstrate these concepts to young children as they can be assembled and disassembled to give meaning to concepts being explained. This makes it easier for children to internalize the concepts being explained. Mathematics instructions for the young children should therefore, focus on concrete learning experiences in order to assist children to develop the concept of conservation. These concrete learning experiences should provide an opportunity for experimentation, discovery, and flexibility of thinking, peer interaction and problem solving.

2.7 Conceptual Frame work

The conceptual frame work below provides a framework indicating the relationship between variables for this study.

Figure 2.1: Conceptual Framework



The conceptual framework presented above shows the relationships that exist between the variables identified for the study. The framework presents an input-process-output relationship between the variables. At the level of input, the framework identifies various models as used in mathematics for the teaching and learning in preschool. When these models are used in mathematical activities (which in this framework constitute the process), they lead to desired learning outcomes which constitute the output in this process. These mathematical activities include Classification, Number concepts, Measurement and geometry. The desired learning outcomes include but are not limited to the Level of pupil involvement in the teaching and learning of mathematics activities, Asking and answering questions correctly and Repetition of the concept taught on their own.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this study was to investigate the influence of models to improve on pupils' academic achievement of preschool mathematics.

3.2 Research Design

Ogula(1995) defines a research design as a plan, structure and strategy of investigation conceived so as to obtain answers to research questions. The study used a correlational research design to describe the statistical association between the variables of the study that is, the use of models and the pupil performance in mathematics. In order to achieve the correlation between the use of models and pupil performance in math, the study used a simple correlational presentation of data.

3.3 Target Population

Brinker (1988) defines a target population as a large population from whom a sample a population is selected. A target population is that which a researcher wants to generalize the result of the study. Kakamega Municipality has 25 public ECE and care centers. This study used only the public preschools for the study. These have a standardized curriculum and standard supervision. Table 3.1 below indicates the distribution of schools in the municipality.

Table 3.1 Preschools in Kakamega Municipality

Educational subzone	Number of preschools	Student population	No. of head teachers	No. of teachers
Amalemba zone	7	150	7	14
Shinyalu zone	5	120	5	10
Central zone	8	210	8	16
Milimani zone	5	100	5	10
Total population	**25**	**580**	**25**	**50**

3.4 Sample and Sample Procedure.

Mugenda and Mugenda(1999) defines sample as a smaller group obtained from the accessible population. For the purpose of this research, the researcher used simple random sampling technique. The municipality has a total of 25 public preschools. The researcher got the study sample by use of balloting whereby the names of the schools in each zone were written on small pieces of paper then randomly pick and 5 public schools to use in the study. This sample constituted20% of the schools in the study population. Anvy, Jacobs and Razariah (1972) argue that 10 to 20% of accessible population is acceptable in a descriptive research. Similarly, Ramenyi et al. (2003) reckons, a sample size of between 10 and 20% is considered adequate for detailed or in- depth studies. One teacher per school in the sample was used for the study. And each head teacher in the sample school was used for the study. This translated to 5 teachers and 5 head teachers.

3.5 Research Instruments

To facilitate the study, questionnaires, interview and observation schedules were developed by the researcher to solicit information for the study.

3.5.1 Questionnaire for the pre-school teacher

In order to obtain information, this study administered a questionnaire to the sample population. A questionnaire was suitable for this study because a large sample could be reached economically and greater anonymity provided to the respondents (Mason and Bramble 1997).The questionnaire will have three parts. Part one contained the elicited information on the teachers' personal data, such as the teacher's school, level of training and teaching experience. Part two had closed and open ended items which required the respondents to identify the learning resources they used in school, the models they used and the influence these models had on the pupils' performance.

3.5.2 Observation Schedule

The observation schedule was used to observe the usage of the instructional resources and their outcomes in the pre schools. The researcher observed what the children were able to do as a result of using models as an instructional resource, because human behavior changes with circumstances.

3.5.3 Interview guide for the head teachers

The researcher had a private meeting with each of the sampled head teachers to ask questions that allowed for clarification of what the researcher intends to obtain from her findings. This is because they are the ones in charge of the school and responsible for providing instructional resources to the school.

3.5.4 Interview with the preschool teacher

The researcher had a private meeting with each of the sampled teachers to ask questions that would allow for clarification of what the researcher intends to obtain from her findings. Also, this is important because the flexibility of the method is the presence of the interviewer who can explore responses with the persons being interviewed, ask additional questions to clarify points and in general tailor the interview to the situation. (Bramble and Mason 1997)

3.6 Instrument validity and reliability

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study. Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated. In order to test and hence improve validity and reliability of a questionnaire, the researcher first carried out a pilot study. According to Mulusa (1988) about ten percent of cases which represent the target population in major aspects can be used in a pre-test. The pilot study helped to identify items in the instruments which were ambiguous and very difficult. It was done by administering the research instruments to two pre schools that are not among the sampled once. The instruments were modified to improve the quality of the instrument and its validity.

Two pre schools in Kakamega County were involved in the piloting before data collection in Kakamega Municipality. The assumption during piloting is that the experience in responses of the head teacher, teachers and pupils from each school were quite similar to the others. The purpose of the study was to find out if the instruments would measure what they are intended to. Secondly it was intended to see whether the respondents would find the instruments clear, precise and comprehensive enough from the researcher's point of view.

3.7 Data Collection Procedures

Data collection began after the proposal was finally accepted and approved by the University supervisor. Data was collected through a questionnaire and interviews administered to pre-school, teachers and observation to find out the availability, use and storage of the instructional resources in pre schools. A research permit was obtained from the office of the President before going to the field. Permission from the MOE is also sought for data collection to take place. The researcher then visited the selected Early Childhood Education and Development Centers and distributed the questionnaires to the pre-school teachers for filling. Completed questionnaires were collected after two days from the day of distribution.

3.8 Data Analysis

The collected data from field work through the use of questionnaires, interviews and observation schedule was coded first to enable the analyses to be done. The results gotten were analyzed using descriptive statistics by use of frequencies and percentages. The results were tabulated using graphs and pie charts. The final results gotten were used to determine the impact of models on learning outcomes.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

The purpose of this study is to investigate the influence of models on the learning outcomes in mathematics in preschool. To obtain the data for this study, a structured questionnaire, oral interview and observation were administered to a sample of respondents from the sample schools. The researcher took notes on what was observed during interactions in the classrooms.

4.1 Bio Data on the respondents

This study sought to establish preliminary details on the respondents for this study. This bio data is vital in evaluating the years of experience and qualifications of the respondents as a measure of their ability and involvement in teaching preschool mathematics and their credibility as principal informants for the study. Respondents were asked to indicate the level of training each one had achieved at the time of the study. The findings are presented in table 4.1 below:

Table 4.1: academic and professional qualification of respondents

Designation	Level of education/training		
	Degree	Diploma	Certificate
Teachers	1	1	3
Head teachers	2	0	3

The data above shows the qualifications of the respondents. Of the teachers in the study sample, one had a degree in early childhood education, one had a Diploma in early childhood education, while three respondents had achieved P1 certificate in education.

The study also sought to establish the length of service these teachers and head teachers had served in their teaching service. The findings in this regard are presented in table 4.2 below:

Table 4.2: Years of Service of the Respondents

	Teachers		Head Teachers	
No. of Years of Service	Frequency	Percentage	Frequency	Percentage
< 1 year	0	0	0	0
1-2 years	0	0	0	0
2-5 years	1	20	0	0
5 - 9 years	2	40	1	20
□ 10 years	2	40	4	80
Total	**5**	**100**	**5**	**100**

From Table 4.2 shows the highest number of preschool teachers 40% (n=2) in the sample had worked for over 10 years while a similar number had worked for 5 and 9 years. Only 20% (n=1) of the teachers had worked for 2 to 5 years. With regard to the head teachers, data shows that the highest number of preschool head teachers 80% (n=4) in the sample had worked for over ten years while 20% (n=1) had worked for 5 to 9 years. Evidently, the sample used in this study was fairly well experienced to provide the data required for this study.

The study also sought to know for how long the respondents had taught at their current stations. This was essential to provide evidence of extended interaction by the teachers and the head teachers with the children in the preschool being examined in this study.

It was also intended to provide a basis for knowledge of the use of models in the teaching and learning of mathematics in preschool. The results are presented below in Table 4.3

Table 4.3: Years of Service at Current Station

	Teachers		Head Teachers	
No. of Years of Service in Current Station	Frequency	Percentage	Frequency	Percentage
< 1 year	0	0	0	0
1-2 years	3	60	1	20
2-5 years	0	0	1	20
5 - 9 years	2	40	2	40
□ 10 years	0	0	1	20
Total	**5**	**100**	**5**	**100**

Table 4.3 shows the number of years the teachers and head teachers in the sample had taught at their current stations. The highest number of teachers 60% (n=3) had taught at their current station for between 1 and 2 years. These were followed by those who had served for between 5 and 9 years. These constituted 40% (n=2) of the total sample.

With regard to how long pre-school head teachers had been teaching at their current station, the study established that each of the head teachers had been transferred on promotion to head their respective schools. Hence, their length of stay at their teaching stations was equal to the number of years they had been teaching at those stations. Those who had served between 1 to 2 years and 2 to 5 years constituted 20% (n=1) each of the sample respondents. Those who had served for between 5 and 9 years constituted 40% (n=2) of the sample while 20% (n=1) had been in their current stations for over 10 years. Hence, the pre-school head teachers in the sample had been in their respective schools long enough to give an objective and informed opinion about the pedagogic practices in the schools with regard to the participation of children with physical challenges children under their charge put together, those who had served in their current stations for over 5 years constituted 60% (n=3) of the respondents for the study.

4.2Use of instructional resources

Respondents were asked if they understood what instructional resources were and whether or not they used these in their classroom teaching. All the respondents indicated that they knew what instructional resources were and that they used these to teach the various subjects in their preschool lessons. When asked the type of instructional resources they frequently used to teach in classrooms, the respondents indicated their use of these instructional materials as follows:

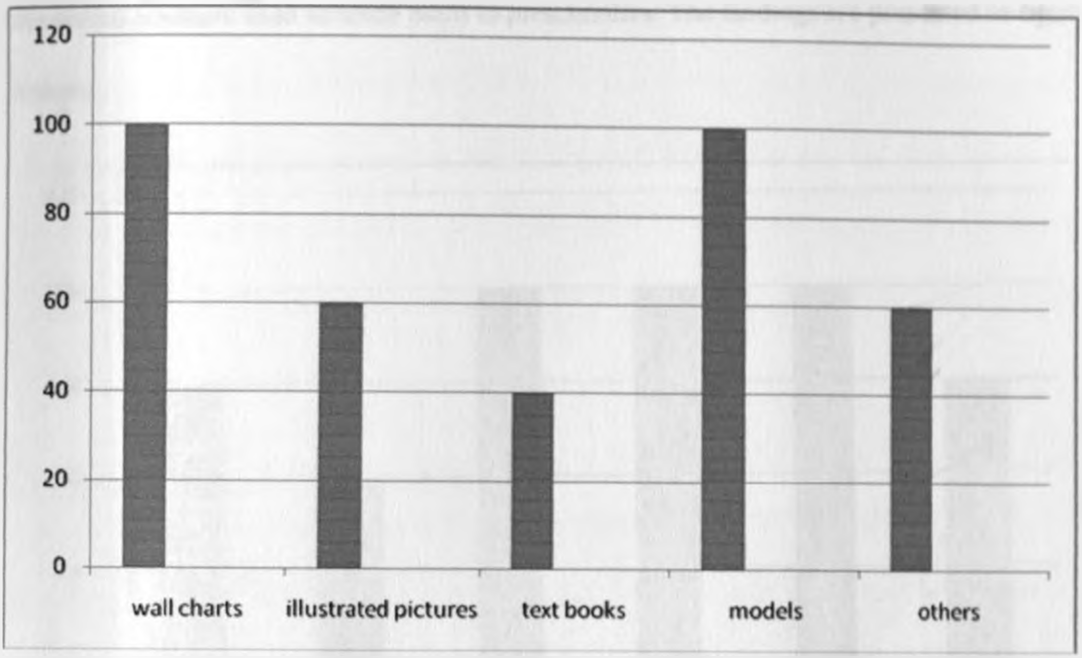


Figure 4.1: instructional materials commonly used by preschool teachers.

Data in figure 4.1 shows the instructional materials frequently used by preschool teachers. All the teachers indicated that they used wall charts and models. Sixty percent of the respondents indicated that they used illustrated pictures while 40% indicated that they used textbooks. Given the rural setting of the municipality, access to preschool books was slightly hampered by the economic capacity of the parents of the school hence the limited access to books as an instructional resource.

4.2.1 Models used in teaching classification

This aspect of data collection constituted the first objective of the study. The study sought to establish the use of models, as learning resources, in teaching classification to preschool pupils. To establish the use of models as a learning resource, the study sought to establish the learning resources teachers used to teach math to preschoolers. The findings are presented in figure 4.2 below:

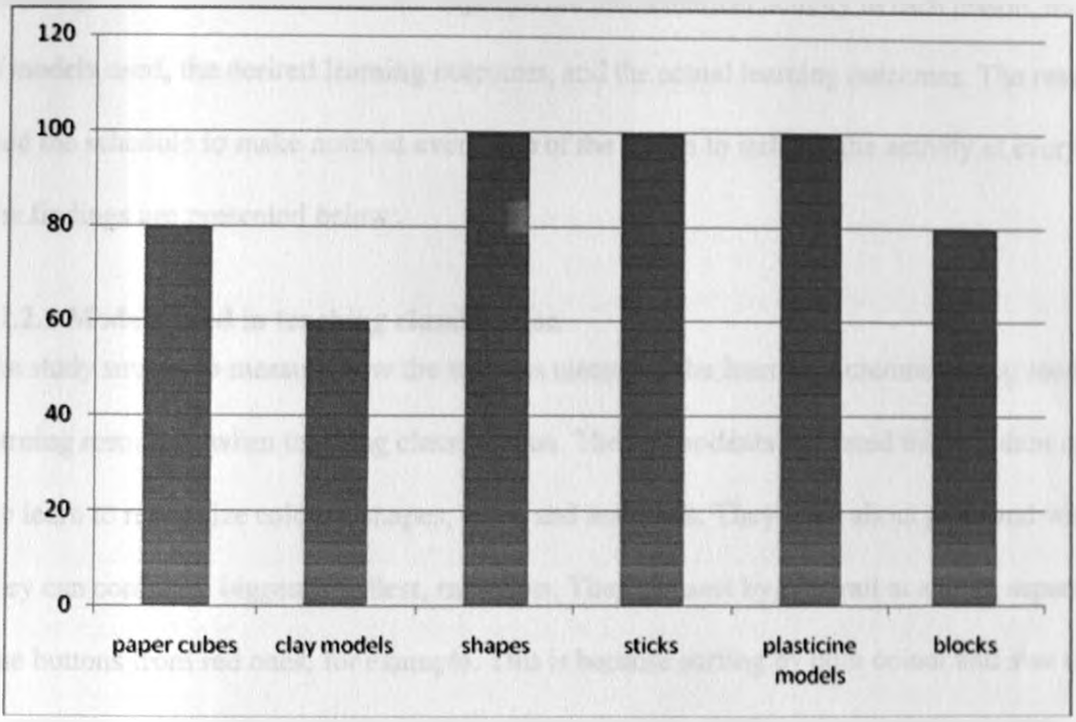


Figure 4.2: Models used in preschool teaching

Figure 4.2 indicates the various models used by teachers to teach math in preschool. The most popularly used models by preschool teachers were shapes, sticks and plasticine models. The shapes mentioned include triangular shapes, square shapes circular shapes and rectangular shapes. These are usually carved out of paper or cardboard. All the respondents indicated these as being commonest while 80% indicated that they used paper cubes or blocks. The least used models were clay models which accounted for 60% of usage as shown by respondents.

4.2.2 Effect of using models on pupil performance in mathematics

In order to gather data on the learning outcomes of pupils after exposure to models as a learning resource, the study observed lessons on classification, number concepts and measurement and geometry. The observation schedule captured the mathematical activity in each lesson, the types of models used, the desired learning outcomes, and the actual learning outcomes. The researcher used the schedule to make notes at every step of the lesson to indicate the activity at every stage. The findings are presented below:

4.2.2.1 Models used in teaching classification

The study sought to measure how the teachers measured the learning outcomes using models as learning resources when teaching classification. The respondents indicated that children at this age learn to recognize colours, shapes, sizes, and materials. They learn about parts and wholes. They can compare: biggest/smallest, more/less. They can sort by one trait at a time, separating blue buttons from red ones, for example. This is because sorting by both colour and size might be difficult. Some of the methods used by teachers to help children gain experience with classifying include:

Object sorting: in these activities, the respondents indicated that children use egg cartons or sheets of paper with two or more sections for grouping similar things such as coins, tools, keys, shells, fabric pieces, plastic figures, pictures from catalogues. In each lesson, teachers explained what they required the pupils to do. For instance, in school 1, the teacher told the pupils:

> "For this activity, you can put things that are alike together."
>
> When the children were through, the teacher asked:
>
> "How are the ones in this group alike?"

Parts and wholes: in these activities, the teachers intended the children to learn to identify parts of a whole and to classify these parts into the whole. Children were asked to cut clay shapes into pieces, match lids to containers, or put bolts and washers together.

The assessment of performance in these activities was done through random selection of a pupil to answer questions on classification. However, the teacher also monitored performance through observation of individual pupil performance of the activity given. The teacher assisted those who had difficulty in carrying out the exercises. Moreover, the teacher provided take-away exercises with the objects drawn in a mixed up manner and the pupils were required to classify these objects according to shape.

With regard to number work, the teachers indicated that preschool children best learnt numbers by hearing them used in a variety of contexts. It is easy to count plates when setting the table, number your socks aloud when folding laundry, or use number games with the pupils during play times. Some respondents indicated that they counted the pupils' fingers and toes. Anytime the teacher can use counting words and numbers with the children, they reinforce the idea that numbers symbolize a set amount of something and teach each pupil that counting means an increase in the number of items. These basic principles, according to the respondents, lay the foundation for all other math concepts.

The activities in this area included, manipulatives, which means using *items* with as visual aids of the mathematic concepts being taught. Simple manipulatives included blocks, and other simple objects that could be easily counted. The teachers used these to show the children addition and subtraction concepts by adding and removing objects as they discussed what was happening. For example, in school 2, the preschool math lesson using manipulatives proceeded as follows:

Step 1: The teacher used paper blocks and gave the instruction:

"Five boxes. One, Two, Three, Four and Five."

Then she counted the boxes and placed them on the table.

Step 2: Then the teacher instructed: "Let's count them together!"

She held up one of the pupils hand and helped guide the rest by pointing to each box as the class counted

Step 3: then the teacher introduced a simple addition exercise by adding one paper block to the five. She then instructed: "Five plus One is Six!"

Then she placed another box in the group of five and counted all of them

"Now we have six boxes. One, Two, Three, Four, Five, and Six"

She counted each of the six boxes out loud and then counted again holding a pupil's hand as she helped the class count each box.

The method of assessment of performance in this exercise included randomly asking pupils to count the boxes. All the pupils who were asked to do the counting did it well.

The lesson on shapes constituted a geometry lesson where the pupils learnt to identify shaped. These lessons include problems activities to get the pupils exploring and really thinking about the attributes of shapes. The pupils were provided with lots pattern blocks and other shape tiles so that they could explore and manipulate shapes in a very concrete manner. These include pattern blocks and square colour tiles. The children learnt shapes by a series of activities:

Activity 1: the teacher gave each pupil a paper circle and some colored square tiles. Then, he challenged them to fill the circle completely with the square tiles. They were not allowed to overlap the tiles and they had to cover the circle completely. They are unable to complete the challenge.

The most important part of this problem was the discussion that occurred during and afterwards regarding why they couldn't fill the circle with the square tiles. The class came to the conclusion that they couldn't fill the circle with squares because squares had straight edges and the circle had a round edge.

The teacher then challenged the pupils to use the square tiles to see what shapes they were able to make. They quickly discovered that they could make different sizes of rectangles and squares. The purpose of this activity was for the pupils to explore and wonder...they will start to see that the shape of a square's corners do not fit in a triangle's corners. The respondents indicated that these sequences of activity helped to building a schema upon which they would add to in the coming years as they learn more and more about geometry.

The assessment for performance in this activity was done through observation by the teacher. Also, the teacher went round the class and observed the pupils trying to fit the square tiles into the circle.

The study then sought to establish, from the respondents, whether or not there was a significant difference in performance when the models were used and when they were not used. The findings are presented in the chart below:

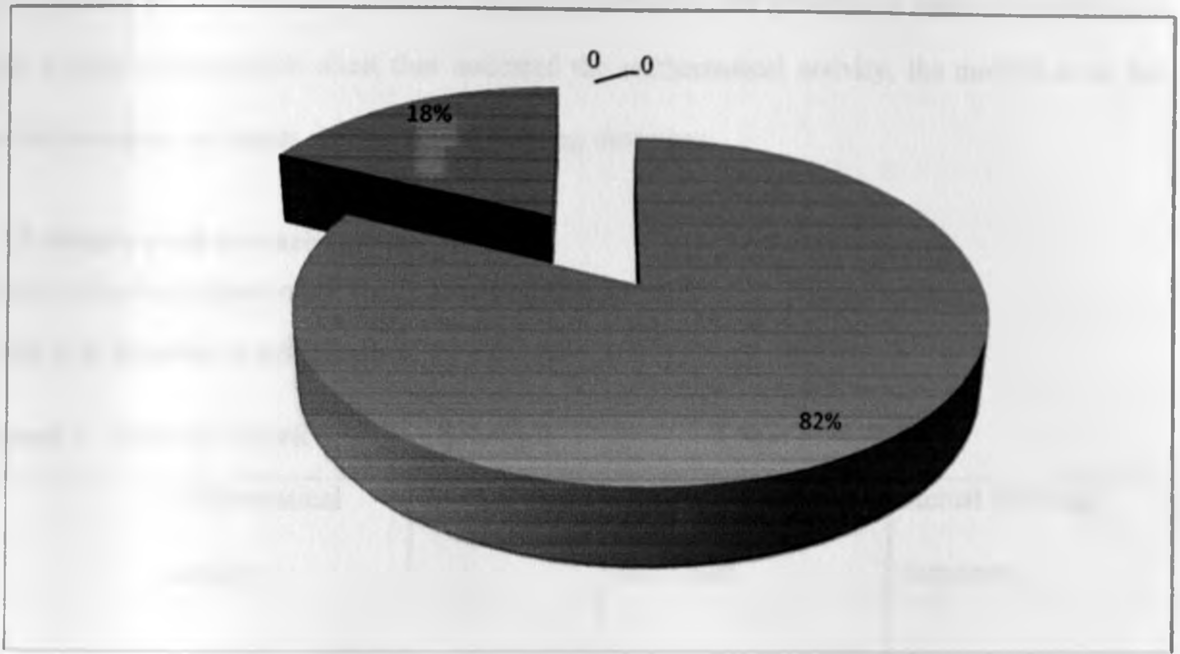


Figure 4.3: The difference in performance when models are used.

Figure 4.3 shows that 82% of the respondents indicated that there was significant differences in performance when the models were used to teach math in preschool. Only 18% indicated that there was no significant difference in performance. Those who said the use of models had significant impact on performance indicated that the use of models allowed both cognitive and psychomotor activity. Given that these were preschoolers, they enjoyed more lessons that had physical activity. The result was that they were more able to practice the exercises by performing the activities outside the classroom. Moreover, teachers indicated that models provided a good reference point particularly in the teaching of counting and geometry.

4.3 Findings from the observation

The study also employed classroom observation as a data collection method. The researcher visited the five classrooms and participated in the math lessons that covered the areas of interest for this study.

These included lessons on number work, classification and geometry. In this analysis, three of these lessons are presented to illustrate the use of models in the teaching of math. The researcher used a lesson observation sheet that indicated the mathematical activity, the models used, the desired learning outcomes and the actual learning outcomes.

4.3.1 Models used to teach number work

Below is the first lesson observed in teaching number work.

Table 4.4: Number work lesson 1

Lesson 1: Number Work **School A** **Time: 9:30 -9:55**

	Mathematical activity	Models used	Desired learning outcomes	Actual learning outcomes
Introduction	Recapitulation: reviewed last lesson on counting 1 -10	None	Pupils should be able to count 1 -10	Pupils counted 1 -10 individually and as a group
Step 1	Teacher introduced counting 10 -15	Numbered cuboids	Pupils should be able to count 1 – 15	Some pupils were able to count 1-15. Some got mixed up
Step 2	Counting bottle tops	None	Pupils should be able to count 1-15	Still some pupils got mixed up
Comments : the models were fairly well used but the learning outcomes were not fully achieved as desired.				

In the lesson above, the teacher starts off by recapitulating the previous lesson on counting 1-10. In this lesson, the teacher intends to introduce the numbers 11-15. The teacher introduced paper models of cubes that were stored in the closet. Since these were fewer than the number of pupils in the class, she divided the class into five groups of four. She then demonstrated the counting with the pupils repeating after her. Next, she invited three pupils to demonstrate the counting using the cubes in front of the class. Since the learning aids were few, the teacher decided to use bottle tops which she shared out in the groups with each group having four cuboids and 11 bottle tops. At the end of the lesson, the teacher randomly selected a few pupils to count 1 – 15. Two pupils were able to count without hesitation. One pupil slightly hesitated, and three pupils got lost in the count. We can therefore conclude that the lesson was fairly successful since 50% of the selected students were the only ones able to count successfully.

In the second number work lesson, things were slightly different from what took place in the first lesson. The evidence in the first lesson as shown in 4.3 above was that the teacher was not quite conversant with what models really were and the use of real objects constituted models in her opinion. Table 4.4 shows the proceedings in lesson 2 on number work.

Table 4.5: Number work lesson 2

Lesson 1: Number Work **School B** **Time: 11:20 -11:40**

	Mathematical activity	Models used	Desired learning outcomes	Actual learning outcomes
Introduction	Counting song	None	Pupils should be able to count 1 -10	Pupils counted 1 -10 individually and as a group
Step 1		Models of balls	Pupils should be able to count 1 – 15	
Step 2	Skip-counting		skipping the count by twos	Some pupils were able skip- count
	Skip-count by twos			Still some pupils got mixed up
Comments: skip counting was a bit challenging for those who couldn't confidently count from 1 – 15. The lesson was not quite successful				

A lesson on number work in the second school yielded almost similar results. This lesson began with a number song that the pupils knew very well. The teacher then asked the pupils to get outside the classroom and carry the ropes she had asked them to bring to school. The teacher then demonstrated counting while rope-jumping. The exercise elicited a lot of enthusiasm from the pupils. All the pupils were asked to count as the teacher jumped the rope. Afterwards, all the pupils were asked to jump and count as the teacher helped the ones who had problems jumping. The pupils were then divided into two's to jump and count. This exercise yielded little since the children concentrated more on the jumping than on the counting.

4.3.2. Models used in teaching measurement and geometry

This is one of the first lessons the children had learnton shapes. This lesson focused on five basic geometric shapes. The lesson focused on the names for the shapes, as well as each of their characteristics that made them that shape. The knowledge acquired in this lesson would give the children knowledge of other shapes as well as other defining characteristics. The students had not discussed shapes in their preschool class. Data in this regard is presented in table 4.5 below:

Table 4.6 Geometry lesson 1

Lesson 1: Geometry **School C** **Time: 8:20 - 8:40**

	Mathematical activity	Models used	Desired learning outcomes	Actual learning outcomes
Introduction	names of shapes they know.	– 1 yellow circle – 1 blue square – 1 red triangle – 1 green rectangle – 1 purple star	Identify the shapes	Identified shapes
Step 1	counting the sides and corners of each shape to identify the shape name		Counting sides of shapes	Counted sides of shapes
Step 2				
Comments: lesson was very successful				

In the lesson above, the teacher taught five shapes. First, were the circles. She hung the large yellow circle on the chalkboard. Next were squares. She explained that Squares had four straight sides that are all the same length, or size. She then put up the blue square on the chalkboard. Pointing to the shape, she explained two sides meet to form corners. There are four corners in every square. Next, were rectangles then triangles and lastly the stars.

The teacher then asked questions about the shapes the pupils had learned. The children were required to hold the shape up in the air after the teacher described it. The teacher used the following questions:

– Which shape has three corners?

– Which shape is round?

– Which shape has four sides that are all the same?

– Which shape is made of small triangles?

– Which shape has no straight edges?

– Which shape has five corners?

– Which shape has four sides that look different?

– Which shape has three sides and three corners?

Finally, the teacher reviewed the shapes one last time by holding up the larger shapes to the entire class and had them answer as a group what shape it was that she was holding up for them to see.

The lesson presented in 4.5 above presents a successful lesson using paper models to teach geometry. The details of teacher activity are presented and the lesson achieved its desired learner outcomes. The difference in approach to teaching the topic is significantly different from that used by the teacher in the lesson on number work. This brings to the fore the fact that pedagogical strategies are significant in achieving classroom success.

CHAPTER 5

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This study sought to establish the influence of models on the learning outcomes in mathematical activities in preschools in Kakamega Municipality. In this chapter, the discussion of the findings in chapter four will be made and conclusions and recommendations made based on these findings. The discussion of findings will be based on the objectives the study set out to achieve.

5.1 Summary of Findings

This study sought to identify some basic aspects concerning teaching using learning aids as a preamble to the use of models to teach mathematical concepts in preschools in Kakamega Municipality. In this regard, the study sought to establish bio data from the respondents. These included the length of service these teachers and head teachers had served in their teaching service. The study found that the highest number of preschool teachers had worked for over 5 years. With regard to the head teachers, the majority had worked for over ten years. Evidently, the sample used in this study was fairly well experienced to provide the data required for this study.

The study also sought to know for how long the respondents had taught at their current stations. This was essential to provide evidence of extended interaction by the teachers and the head teachers with the children in the preschool being examined in this study. Most of the respondents had served for at least 2 years.

All the head teachers had served for over ten years. Hence, the pre-school head teachers in the sample had been in their respective schools long enough to give an objective and informed opinion about the pedagogic practices in the schools with regard to the participation of children with physical challenges children under their charge.

The study found that preschool teachers used instructional materials frequently. Wall charts and models were the most popularly used. The least used were textbooks. Given the rural setting of the municipality, access to preschool books was slightly hampered by the economic capacity of the parents of the school hence the limited access to books as an instructional resource.

5.1.1 Objective 1: To determine the learning outcomes when models are used in the teaching of classification in mathematics activities in preschools in Kakamega municipality.

This study sought to identify the learning outcomes when models were used to teach classification in preschool. In order to arrive at this, the study sought to establish the types of models the teachers used when teaching math in preschool. The study found that various models were used by teachers to teach math in preschool. The most popularly used models by preschool teachers were shapes, sticks and plasticine models. The shapes mentioned include triangular shapes, square shapes circular shapes and rectangular shapes. These were usually carved out of paper or cardboard. Teachers also used paper cubes or blocks. The least used models were clay models. Teachers indicated that though clay was easy to access, it was too untidy to use and caused problems with cleanliness in class and with the pupils.

The study sought to establish how the teachers measured the learning outcomes using models as learning resources when teaching classification. The study found that the learning of classification included the recognition of colours, shapes, sizes, and materials. They learn about parts and wholes. They can compare: biggest/smallest, more/less.

They can sort by one trait at a time, separating blue buttons from red ones, for example. This is because sorting by both colour and size might be difficult. The assessment of performance in these activities was done through random selection of a pupil to answer questions on classification. However, the teachers also monitored performance through observation of individual pupil performance of the activity given. The teachers assisted those who had difficulty in carrying out the exercises. Moreover, the teachers provided take-away exercises with the objects drawn in a mixed up manner and the pupils were required to classify these objects according to shape.

5.1.2 Objective 2: To determine the learning outcomes when models are used in the teaching of number concepts in mathematics activities in preschools in Kakamega municipality.

With regard to number work, the study found that preschool children best learnt numbers by hearing them used in a variety of contexts. It is easy to count plates when setting the table, number your socks aloud when folding laundry, or use number games with the pupils during play times. Some respondents indicated that they counted the pupils' fingers and toes. Anytime the teacher can use counting words and numbers with the children, they reinforce the idea that numbers symbolize a set amount of something and teach each pupil that counting means an increase in the number of items. These basic principles, according to the respondents, lay the foundation for all other math concepts. This clearly corroborates Sifuna, Chege and Oamda, (2006) in their assertion that the significances of ECE lie in the fact that the curriculum provides a foundation upon which mastery of formal learning skills is planted. The successful transition and completion of subsequent levels is dependent on the foundation laid in early schooling. According to them, understanding math concepts opens many doors for children, from being able to tell time to grasping the value of money.

Furthermore, the study found that preschool children best learnt numbers by engaging in activities referred to as, manipulatives. These are activities where items are used as visual aids of the mathematic concepts being taught. Simple manipulatives included blocks, and other simple objects that could be easily counted. The teachers used these to show the children addition and subtraction concepts by adding and removing objects as they discussed what was happening.

The method of assessment of performance in this exercise included randomly asking pupils to count the boxes. In this case the study found that teachers began their assessment by using the whole class to respond to questions as they narrowed down to individual pupils. The responses in this regard were all verbal. All the pupils who were asked to do the counting did it well.

5.1.3 Objective 3: To find out the learning outcomes when models are used in the teaching of measurement and geometry in mathematics activities in preschools in Kakamega municipality.

The lesson on shapes constituted a geometry lesson where the pupils learnt to identify shaped. These lessons include problems activities to get the pupils exploring and really thinking about the attributes of shapes. The pupils were provided with lots pattern blocks and other shape tiles so that they could explore and manipulate shapes in a very concrete manner. These include pattern blocks and square colour tiles. The children learnt shapes by a series of activities requiring them to identify shapes or to describe these shapes. The assessment for performance in this activity was done through observation by the teacher. Also, the teacher went round the class and observed the pupils trying to fit the square tiles into the circle .Jones and Smith, (2002)assert that shape is a fundamental idea in mathematics and in development. Beyond mathematics, shape is the basic way children learn names of objects, and attending to the objects' shapes facilitates that learning .Children tend to move through different levels in thinking as they learn about geometric shapes (Clements and Battista, 1992). They have an innate, implicit ability to recognize and match shapes. But at the earliest, pre-recognition level, they are not explicitly able to reliably distinguish circles, triangles, and squares from other shapes. Children at this level are just starting to form unconscious visual schemes for the shapes, drawing on some basic competencies. An example is pattern matching through some type of feature analysis (Anderson, 2000; Gibson et al., 1962) that is conducted after the visual image of the shape is analyzed by the visual system. This implies, then, that the use of these varieties of activities in the preschool math lessons was directed in the right direction- to enable pupils to be able to discern shapes.

5.1.4 Objective 4: Evaluate the impact of the use of models on learner performance in mathematics in preschools in Kakamega municipality.

This study was principally interested in the influence of the use of models on learner performance in math. The study established that there was significant differences in performance when the models were used to teach math in preschool. Respondents indicated that the use of models allowed both cognitive and psychomotor activity. Given that these were preschoolers, they enjoyed more lessons that had physical activity. The result was that they were more able to practice the exercises by performing the activities outside the classroom. Moreover, teachers indicated that models provided a good reference point particularly in the teaching of counting and geometry. Furthermore, It is also important to note that teachers spent a lot of Teacher- time assessing the progress of the learners. The study found that the teachers assessed the learner's performance regularly both during the lesson and afterwards. However, the study also found that there was a disparity in the responses to the issue of assessment as given by teachers. This disparity in assessment procedure is significant because it highlights the lack of an assessment policy within the preschool. The assumption in cases such as these would be that there exists a singular/agreed assessment system that describes the manner and frequency of assessment of learner's progress in the school.

5.2 Conclusion

Following the discussion of findings done above, the below conclusions can be drawn:

1. The study of math in preschool is structured along learning activities to include using models to teach classification, number work, geometry and measurement.

2. Teacher input is instrumental in facilitating the effective learning of math using models. This is corroborated by Woolfurk (2004) who states that teachers' characteristics that are indicative of the effectiveness of the teacher are teachers' knowledge, clarity and organization, and warmth and enthusiasm. Woolfork adds that subjects do not necessarily have students who learn more. However, teachers who know more may make clearer presentations and recognize students' difficulties more readily. According to Woolfork teachers who provide clear presentations and explanations tend to have students who learn more and who rate their teachers more positively. Effective teachers know how to transform their knowledge into examples, explanations tend to have students who more and who rate their teachers more positively. Effective teachers know how to transform their knowledge into examples, explanations, illustrations and activities. These characteristics were found in the teachers in the sample for this study.

3. This study concludes that teachers were able to assess the performance of the learners through a progressive evaluation during each lesson. The study concludes that using models to teach mathematics at preschool enhances the learner's enthusiasm in learning concepts by engaging their motor skills. The results of the teachers assessment were used to provide feedback to the

learners on their progress. This is corroborated by Knight (2001) who states that feedback is a component of intervention processes.

The quality of a teacher feedback to student has a considerable impact on student achievement. Nicky (2001) further stated that feedback should involve imparting a "judgment of a child's strategies and skills, a child's attainment and giving information about the judgment" Furthermore, feedback needs to be given as soon as possible after the event. The greater the delay, the less likely it is that the student will find it useful or be able or be inclined to act on it. Feedback given too early before students have had an opportunity to work in a particular problem or task can be counterproductive. Clarke (2000) writing on quality of feedback argues that the purpose of marking children's work appears to be clear: it provides valuable personal feedback to children about their performance and related improvement. She further states that studies have shown that generally teachers pay little attention to the quality of their written feedback. There was marked improvement in performance when the models were used.

5.3 Recommendations

Following the conclusions made above, the following recommendations can be made:

1. There is need to strengthen facilities and teacher capacity in teaching maths at preschool. This may be done through capacity building and training of preschool teachers.
2. The methods of assessment in preschool math need to be standardized so the same procedures can be used to make assessment.
3. There is need to encourage closer participation of all stakeholders in enhancing the performance of preschool children in math.

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APPENDICES

APPENDIX 1

Interview Guide for the Head teacher

1. In your own opinion, explain the meaning of E.C.E

2. As the headteacher how do you ensure that E.C.E is provided in the rightful manner in your school?

3. How often do you provide instructional resources to the pre- school?

4. Do you ever make a follow up to ensure whether the instructional resources are being put into proper use by the pre- school teachers?

5. How do you ensure their maintenance and storage?

APPENDIX II

Interview guide for the teacher

For how long have you been teaching E.C.E.?

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....

1. How do you view the learning outcomes of mathematics activities when models are used in the teaching of E.C.E. in Kakamega Municipality?

   Give reasons as to why you have settled for the opinion above?

   ....
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   ....
   ....
   ....

2. Are there any organized meetings among you and other pre-school teachers in the division or zone to discuss the way forward in improving the learning outcomes E.C.E. in each division?

   ....
   ....
   ....

3. What is your attitude towards the use of models as an instructional resource in E.C.E.?

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   ....

4. For how long have you been teaching E.C.E.?

....

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5. How do you view the learning outcomes of mathematics activities when models are used in the teaching of E.C.E. in Kakamega Municipality?

   Give reasons as to why you have settled for the opinion above?

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6. Are there any organized meetings among you and other pre-school teachers in the division or zone to discuss the way forward in improving the learning outcomes E.C.E. in each division?

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7. What is your attitude towards the use of models as an instructional resource in E.C.E.?

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Appendix III:

Questionnaire for the teacher

My name is Sylvia Wendoh and I am pursuing a Masters Degree in early childhood education at the University of Nairobi. Kindly fill in this questionnaire to help me collect data for this study. All the responses to this questionnaire should be as objective as possible. The respondents to this questionnaire will be kept confidential. Thank you in advance.

Please fill in where applicable.

Name of School…………………………………………………

Division…………………………………………………………

Zone……………………………………………………………

1. Level of Teacher training

Degree ☐ Diploma ☐ Certificate ☐ Others……………………

2. Gender: Female ☐ Male ☐

3. How many years have you taught in Pre School?..............................

1-5years ☐ 6-10 years ☐ above 10 years ☐

4. What do you understand Instructional resources to be?

……………………………………………………………………………………

……………………………………………………………………………………

5. a) What type of instructional resources do you employ in your classroom instruction?

Wall charts ☐ Illustrated pictures ☐ text books ☐ Models ☐

others (specify)……………………………………………………………………..

b) At what point of teaching do you display your instructional resources?

At the start of the lesson ☐ during the lesson ☐ at the end of the lesson ☐

6. How do you acquire you the instructional resources you use in teaching?

Purchase ☐ Improvisation ☐

7. What factors hinder the acquisition of your instructional resources you use in teaching?

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8. Do you use models as an instructional resource in the general teaching?

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9. What is the attitude of learners towards models as instructional resources?.

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10. How often do you improvise instructional resources?

11. How do measure the learning outcomes in your teaching using instructional resources?

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12. Is there a difference in the learning outcomes when models are used in teaching mathematics? (please explain the difference)

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APPENDIX IV

Observation Schedule for the researcher

Name of School.................................Zone..............................Time ......

Lesson	**Mathematical Activity**	**Types Of Models Used**	**Desired Learning Outcome**	**Actual Learning Outcome**
Introduction				
Step 1				
Step2				
Conclusion				
Comments:				