IMPACT OF INSTRUCTIONAL MATERIALS ON PERFORMANCE OF NUMBER WRITING AMONG PRE-SCHOOL CHILDREN IN KAMUKUNJI DISTRICT OF NAIROBI COUNTY

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DECLARATION

This research report is my original work and has not been used for the award of degree in any University.

……. …….

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E57/79539/2012

This research report has been submitted for examination with my approval as University supervisor.

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DEDICATION

This research is dedicated to my mother Mrs. Esther Nyokabi Muiruri, my brother Mr. James Ng'ang'a Muiruri and my entire family who against all odds sacrificed for my education. Thanks for your support and encouragement.

ACRONYMS AND ABBREVIATIONS

A.S.E.I	-	Activity focused, Student centered, Experiment and Improvisation
CEMASTEA	-	Centre for Mathematics, Science, Technology Education in Africa
E.C.E	-	Early Childhood Education
E.F.A	-	Education for All
FIMS	-	First International Mathematics Study
I.E.A	-	International Education Association
IMD	-	Instructional Materials Development
J.I.C.A	-	Japan International Co-operation Agency
KCPE	-	Kenya Certificate of Primary Education
K.R.T'S	-	Key Resource Teachers
M.E.O	-	Municipal Education Officer
M.O.E.S.T	-	Ministry of Education Science and Technology
NACECE	-	National Centre for Child Education
P.D.S.I	-	Plan, Do, See, Improvise
S.B.T.D	-	School Based Teacher Development
SEP	-	School Empowerment Programme
SIMS	-	Second International Mathematics studies
SMASSE	-	Strengthening Mathematics and Science Secondary Education
TISS	-	Third International Science Studies
U.N.C.R.C	-	United Nations Convections for Human Right

ABSTRACT

The study investigated the impact of instructional materials of performance on number writing among pre-school children in Kamukunji District. It investigated the importance of instructional materials, examined the number writing activities done by children to acquire number writing skills, errors children make in number writing as well as the impact of in-servicing of pre-school teachers to facilitate number writing activities with the aim of enhancing children's performance in number work positively. The research design used was quasi experimental. It had control group and experimental group whose data was tabulated on the pre-test and post-test observation checklist. The 5 pre-schools head teachers and 15 pre-school teachers completed questionnaires which were analyzed using both qualitative and quantitative methods. Children in the experimental groups who used instructional materials in activities performed better than the other two groups. Their number writing skills, number sequence, number shaping, number sizing and number alignment performance improved tremendously due to active involvement in activities that used instructional materials. Their level of number reflection errors, number omission, number sizing, number spacing greatly reduced. The use of instructional materials helped the children to use their senses as well as developing children motor muscles and eye hand coordination. Those with special needs were easily detected. Material used helped to identify children's different multiple intelligences as well as children's interest and ability which helped in grouping them. The use of materials engaged children in activities and this provided a most effective means of clarifying many mathematical concepts and relations through experience of associating them directly with physical things. Activity methods increase concentration, perception and retention. Teachers learnt that they could use children's errors as learning agents to understand the child's thinking and hence become a basis of assisting the children. The materials helped children to use their senses as they modeled and destroyed as well as feeling the materials. They were also actively involved in manipulation of different materials. This helped in detecting children's weaknesses such as eye hand coordination and motor muscle problems and this enhanced an opportunity for early intervention at an early age. The researcher found the ECDE teachers had not been in-serviced for a long time and the issue needed to be addressed urgently. The report recommended the need to examine other factors that may be affecting children's performance in number writing as well as other factors contributing to errors children make in number writing.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Pre-school years are very important in the life of an individual. The foundation for learning mathematics and the basic attitudes is laid during the first five years of life. To stimulate mathematics learning and to foster health growth and development, children should be provided with appropriate materials, guidance, stimulation and care. Children acquire mathematics skills at an early age. In the pre-school, the teacher should build on and continue developing these skills and concepts through appropriate activities and materials (Mwaura, 1984).

According to (Hobart and Jill, 1999) instructional materials plays a vital role in teaching and learning at various levels of education, especially at pre-school level, where a strong foundation is needed. Materials usually employed in the production of instructional materials are to serve as teaching and learning aid. These materials include clay, plasticine, polythene paper, glue, papers, beans, carton, wood, soft stones, coloured chalks, pencils, scissors, crayons, tracing papers etc. Most of these materials are obtained from the children's immediate environment. These materials are readily available and easily manipulated. They are remarkably light in weight. According to the United Nations Convention for Rights of Children (U. N. C .R. C) education is a fundamental human right. In Kenya, the government through the MOEST realized the need for improvement of E.C.E .and ratified the (1990) Jomtien World Conference on Education for All (EFA) and the world education forum in Dakar, Senegal (2000) where use of instructional resources in pre-school was recommended.

In the Jomtien and Dakar conferences (Muiji & Reynolds, 2011) underscored the importance of instructional resources in ECE for purposes of improving children's learning. Availability of instructional resources enhances the effectiveness of schools as these are basic things that can bring about good academic performance in the learners. The successful learning of a pre-school depends on how the teacher plans, organizes and manages her class and particularly in the productions, use and storage of materials. The teacher should ensure to create a rich learning environment, appreciate what children learn by doing and bring children's environment closer to the classroom environment by using local resources (Njeru, 2010).

The child-centered method places the child at the central point of learning. The child is involved in his own learning. The child learns by doing and uses his/her own senses. The child controls the speed at which he/she learns new ideas. The role of the teacher involves encouraging guiding and providing materials required for learning. The teacher needs to encourage children to take part in the planning of their activities and in collecting materials. The teacher needs to provide children with a lot of materials and activities beginning with those materials that children are familiar with. Children learn through their senses. They handle what is at hand. Materials resources help children to look, feel, listen, smell, taste, imagine and dream about things (Mwaura, 1984).

Young children are active by nature and learn better when not over-controlled. They need to be encouraged to take part in many learning activities such as modeling numbers and order them in sequence. Children trace numbers in pairs. One child holds the number cut-out on the paper while the other one traces. Tracing numbers on thick papers is done by children. Children cut round written or traced numbers. These numbers are coloured by children using crayons, flowers, leaves and coloured chalks. Children weave and stitch numbers. Others do number puzzle where

different parts of a number are joined together to form a number. Mosaic and collage where glue is used and various seeds like beans, maize, green grams and rice help children write numbers. Using of potatoes and colors help children print numbers as well as joining dot activities. Children also write numbers using concrete materials like chalks, stones, charcoal (Mwaura, 1984). At the end children learn number formation, number sequence, number shaping, number sizing, number recognition and number alignment. (Mogaka F, 2009).

Children work in groups and learn to share materials and ideas. The teacher needs to encourage the children to help one another so that they work independently when the teacher is helping other children or is engaged in other activities. In this way, children learn to respect each other's abilities and ideas. The teacher ensures that children work is displayed for others to see (Mwaura, 1984). What children have done is kept in the environmental studies corner in the class. This caters for different interests as well as individual differences.

According to (Mutunga and Breakell, 1992) mathematics of ancient Egypt was concerned with problems in arithmetic and the stress was on practical use. Much near the modern times, the 17th century saw considerable development in the history of mathematics. According to (Muiji & Reynolds, 2011) the International Education Association (IEA) has studied the mathematics performance of children from a large number of countries on three occasions. The first international mathematics study (FIMS) took place in the 1960's. More recently the SIMS took place in the 1980's and then, the on-going TISS carried out in the past decade have produced valuable data on comparative performance of children in different countries in various aspects of mathematics. According to (Tucker, 2010), young children need to be active in their learning "Hands on" and "brains on". It is known that young children learn best through practical activity. Discovery and investigations are treated as an integral part of doing mathematics (Martin, 2011).

However the aim of mathematics education has relatively remained unchanged. (Taiwo, 1974) indicated that, it should be the aim of mathematics education to enhance the usefulness of an individual in his contribution to the economic development of society and the economic stability of self. Mathematics education assists one to think straight, solve problems and function effectively as a civilized state. (Kinyanjui, 2004) asserts that mathematics becomes not only the key to opportunity but as a tool of living. Mathematics is a way of thinking and reasoning which enhances education of a man no matter what place in the society (Taiwo, 1974).

It is also quite useful for the development of logical thinking and reasoning. These are essential ingredients in mental development and there is need to promote their development. (Kibui, 1993), say that mathematics is indispensable due to its influence in other fields of study like physical sciences, economics and engineering. As one aspires to join these professions, one must have a thorough knowledge of mathematics.

According to (Macharia, 2009) many teachers work in poor and depressed environments with scant resources and little motivation. Mathematics as a subject is activity oriented and the mastery of mathematics concepts cannot be fully achieved without the use of instructional learning materials. The teaching of mathematics without learning materials certainly results to poor performance. (Franzer, 1992) stressed that, a professionally qualified teacher no matter how well trained would be unable to put his ideas into practice if the school setting lacks equipments and materials necessary for him/her to translate his/her competency into reality.

Mathematics utilization value is one of the most recognized attribute. It is surely this perception which has given the subject its unquestionable compulsory status. It should be noted that, mathematics concepts are required by both the young and the old in their daily activities. In

1998, the government of Kenya through the Ministry of education and the government of Japan through Japan International Cooperation Agency (JICA) started a technical cooperation project known as Strengthening Mathematics and Sciences Secondary Education (SMASSE, 2004) in Kenya. This was due to the declining performance trenches observed in science subjects such as mathematics over the years in Kenya which has been blamed on many factors such as resources.

In 2003, the M.o.E started a distant learning course for Primary school teachers known as School Based Teacher Development (SBTD) where in-service training in mathematics, sciences and English subjects were addressed in the entire country in subjects which were performing poorly. The teaching methodologies and materials were addressed and the course took six months (Kiptoon, 2000). It was distance learning in-service course where teachers were not removed from their pupils for the in-service. The course explored collaborative learning and organization of resources. Teachers were in-serviced on mathematics, science and English due to their poor performance in KCPE over the years.

In our current educational system, pre-school education is not free and it's the responsibility of parents to buy instructional materials as well as payment of teachers through payment of school fees. Kamukunji District falls in the category where many parents belong to low income earners. Most of them perform petty jobs and hence lack of adequate payment of school fees. This enhances lack of adequate teaching instructional materials. Therefore the development of equipping ECE with instructional materials has been poorly done due to lack of funds. There is a scant instructional material to enhance number writing skills. Through children active involvement in activities many mathematical errors made by children would be reduced and hence impact positively to children's mathematics performance. This study investigated whether material resources used in number writing skills had significant impact in minimizing

mathematics learning difficulties and eradicating errors children make in number work from an early age. The table below is evidence that mathematics performance from standard one has been on the decline as tabulated below.

Table 1.1 Kamukunji District standard 1 term 1 mathematics performance.

Year	Term 1 (2011)	Term (2012)	Term 1 (2013)	Term 1 (2014)
Mean score	90.07	88.43	85.44	83.75

Source: MEO Kamukunji District.

The above table shows a declining performance in standard 1 term 1 in mathematics performance for the last 4 years (2011-2014)

Table 1.2 Kamukunji District KCPE results mean score 2010-2012

Year	2010	2011	2012
Mean score	44.04	44.48	46.85

Source: KNEC

The table above is evidence that mathematics has been performing poorly in this district. This performance shows the average score in the 3 years i.e. (2010 – 2012) an average aggregate D for all children in Kamukunji District and this is quite regrettable.

1.2 Statement of the problem

Curriculum designers in Kenya have not adequately suggested on how to address the number writing skills in any of the mathematics topic in the syllabus and lower primary. However it has been observed that learner experience difficulties in number formation, number shaping, number

sizing, number alignment which impacts negatively to children's performance. The researchers concern in the whole district was on poor number writing/formation. There is also a problem of spacing of numbers, omission of numbers, reflection of number, number alignment. They have contributed greatly in lowering the performance of standard I mathematics. The researchers concern also addressed in-servicing of teachers on number formation, number spacing concepts and errors children make in number work as well as improvisation of materials by both teachers and children. The researcher investigated how quality assurance and standards officers were enhancing capacity building in performance in number work.

1.3 Purpose of the study

The purpose of this study investigated the effect of instructional materials on performance on number writing/formation.

1.4 Research objectives

The study sought to achieve the following objectives in relation to the teaching and learning of number writing among pre-school children in Kamukunji District.

i) To investigate the importance of instructional materials on performance in number writing activities.
ii) To establish material used in number writing activities that enhances performance in number writing.
iii) To examine the effect of materials on minimizing errors children make in number writing.
iv) To investigate the impact of in-servicing teachers on material improvisation for number writing activities.

1.5 Research questions

The study was designed and expected to provide solutions to the following questions in relation to the teaching and learning of number writing/formation among pre-school children in Kamukunji District.

i) What is the importance of instructional materials on enhancing number writing concepts in relation to performance in number work?

ii) Which materials would be used in number writing activities to enhance performance in children's number work?

iii) What is the effect of materials on minimizing errors children make in number writing?

iv) Which materials would teachers be in-serviced to improvise to enhance performance for number writing?

1.6 Significance of the study

The study helped teachers to identify different multiple intelligences in children and hence build on children's potential. Teachers at an early age are able to identify special needs and learning difficulties such as eye hand co-ordination and finger motor difficulties and ensure they are addressed at an early age in children. The children are helped to use age appropriate instructional materials and engage in activities to acquire number writing readiness, shaping number, number sizing, number recognition, number sequencing, logical reasoning, the strengthening of finger motor muscles and reduce errors made in number writing. Collaborative learning in tracing is enhanced and social skills of sharing materials. Children appreciating others finished work which enhances the building of their self esteem. The policy makers are helped to bring awareness to all schools on the impact instructional resources help to eradicate errors children make in number writing e.g. number reflection, omission of numbers, number alignment and number sizing. The

teacher usage of improvised materials which are in child's immediate environment facilitates transition of children to primary schools easily. Parent's active involvement in the funding and the provision of instructional materials create a good relationship between them and the teachers/stakeholders.

1.7 Limitation of the study

The study was limited to quasi experimental research design. It is hard to know if responses are a true reflection of reality. Further teachers responses were a true aim of the researcher. A lot of instructional materials are needed to enable children engage in activities. The pre schools are not funded by the government and lack of parents providing both resources and materials results to children being taught theoretically. Teachers who lack creativity and are unable to improvise on the much needed materials will lay a poor mathematics foundation for children at their formative stage. Untrained teachers are not able to facilitate the children's activities effectively due to lack of expertise and skills. Extraneous variables such as home background of children are not included. The research was conducted in an urban setting where many teachers and parents discourage children to use clay and mud so that they don't soil themselves. The study was taken only in Kamukunji Districts and therefore, others should replicate the same in other areas. The researcher was not very sure whether the findings of this study can be generalized in other areas other than Kamukunji (Eastleigh Zone). If it happens, it must be done with caution.

1.8 Delimitation of the study

The study was limited to the children sampled in pre-schools in Kamukunji Districts. Some of their teachers were chosen to ensure adequate data collection. All the head-teachers of the sampled primary schools were included as respondents in the research study. It involved pre-school children in Kamukunji District public schools and their use of instructional materials to carry out number writing activities in their immediate environment. Teacher's active engagement in facilitating children in the use of instructional materials helped children in number formation/number writing.

The head teachers who are the school managers provided the materials and support the pre-school teachers. The stakeholders were involved in provision of the much needed materials and resources. The community/parents active involvement in the provision of materials and also resource people. The MEO and the TAC tutors were to sensitize parents on the importance of paying schools levies that is used to provide the much needed instructional materials. The TAC tutors were to in- service pre-school teachers on number formation, number spacing, errors in number alignment as well as omission of numbers in number writing activities.

1.9 Basic assumptions

The study adopts the following assumptions: - Number writing activities are an easy task and children can write correctly without any activity involvement. All pre-school teachers use instructional resources to teach number writing skills. Materials are adequately available in pre schools for use during mathematics activities. The parents, school heads and stakeholders provide materials as required by different schools to enable children model, trace, colour, draw, print and do number puzzle together. Mathematics is a difficult subject and only a few smart

children do it well. Teachers and parents actively participate in the improvisation of materials from children immediate environment.

Errors children make disappear with time as children continue doing number work. The MEO, and TAC tutors supervisors are actively involved in supervising the work going on in the ECDE centres. Often in service courses are held for teacher's capacity building. All children do easily carry out the number formation activities. That the Std I Kamukunji Division mathematics exam was an acceptable measure of children performance in number formation. The respondents gave honest and reliable information as they responded to questionnaires and interview questions.

1.10 Definition of key terms

Achievement: Level of attainment of mathematics skills.

Activities – refers to activity focused teaching and learning which is child centered

Errors- The wrongs made by children when writing numbers

Impact- The value and changes that will occur in the learning process

Improvisation- Use of local materials from the local environment

In-service course- This refers to the education and training activities engaged by pre-school teachers and principals following the initial professional certification.

Instructional materials - These are teaching aids that are used in the modeling, tracing, printing, colouring, weaving, mosaic and collage activities.

Learning - Involves children acquiring knowledge, skills, concepts through active involvement in activities.

Modeling numbers- The art of using clay, soil, plasticine to write numbers or number formation.

Mosaic/collage- The art of writing numbers using glue and seeds like beans, rice and green grams.

Number printing- Use of objects like potatoes and colour to print numbers

Number writing – refers to number formation or number shaping

Performance – Actual accomplishment of children as measured by marks obtained in a test.

1.11 Organization of the study

The study is organized into five chapters. Chapter one contains the background of the study, statement of the problem under study, purpose of the study, objectives of the study, research objectives, research questions, significance of the study, limitations of the study, delimitations, basic assumptions of the study and definition of significant terms.

Chapter two reviewed related literature under the following sub headings. Impact of instructional materials on performance in number writing or formation, importance of mathematics, activities in number writing, in service courses, improvisation of materials, errors children make in number formation, summary, theoretical framework and conceptual framework.

Chapter three covered research design i.e. Quasi experimental research design, target population, sample and sampling procedure, research instruments, validity, reliability of instruments, data collection and data analysis. There was pre test and post test of number writing activities and using instructional materials.

Chapter four represented the data analysis and discussion of research findings.

Chapter five focused on the summary of the findings, conclusion and recommendations stemming from the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter reviews the literature that is related to the study. Thus it thoroughly sets out the importance of the instructional materials on number formation, activities in number formation through use of instructional materials, errors children encountered in number formation teachers in-service courses, summary, theoretical framework and conceptual framework.

2.1 Importance of instructional materials on number writing activities

According to (Macharia, 2009) a resource is the same as a teaching aid used to make learning interesting and effective. Teaching aids and materials are supposed to meet the requirements of instructions. There is a wide variety of learning resources for making learning a stimulating experience.

According to (Wales, 1975), instructional resources which are educational inputs are of vital importance to the teaching of any subject in the school's curriculum. He was of the opinion that, the use of instructional resources would make discovered facts glued firmly to the memory of students. (Jekayinta, 2012) also added that, a well planned and imaginative use of visual aids in lessons will do much to banish apathy, supplement inadequacy of books as well as arouse students interest by giving something practical to see and do and act the same time helping them to think things out themselves. He said that selection of materials which are related to the basic contents of a course or a lesson helps in-depth understanding of such a lesson by the students in that they make the lesson attractive to them, thereby arresting their attention and

thus, motivating them to learn. In order to raise the quality of education, its efficiency and productivity, better learning materials are needed. (Jakayinta, 2012) commented that "Audio-visual materials, as an integral part of teaching-learning situations help to bring about permanent and meaningful experience. He said that, they provide first-hand experience where possible or of vicarious one where only that is feasible.

The use of multi- sensory aids, when well coordinated with other classroom learning activities can serve a double purpose. It not only served to stimulate interest but provides a most effective means of clarifying many mathematical concepts and relations through an experience of associating them directly with physical things (Batler and Wren, 1960). Today advances in technology has made it possible to produce materials and devices that could be used to minimize the teachers talking and at the same time making the message clearer, more interesting and easier for the learning to assimilate (Onasanya, 2008).

(Montessori, 1952) as well as other "historical voices in Early Childhood education believes that, mathematics should be introduced through objects, especially concrete instructional materials. (Montessori, 1952) classrooms use chips also known as "counters" to develop competence in counting. Other concrete materials used in order to demonstrate mathematics are beads and blocks. (Olouch, 2002) asserts that, care must be taken to ensure that materials prepared and produced are relevant. Care must be taken into consideration that, they are attractive and durable. (Juma, 2007) noted that classroom, schools and its surrounding encourage discovery involvement and an interest in the curriculum content by students.

(Njeru, 2010) attributed to the fact that, instructional resources are not as widely used in the pre-school as in the upper classes. He however felt that there was need and call for more research on how usage of resources such as charts, abacus and others impacts on pre school mathematics.

The influence of instructional materials in promoting students academic performance and teaching and learning in Educational development is indisputable. Instructional materials include both visual and audio visuals. These materials serve as supplement to the normal process of instruction (Wales, 1975). (Hobert & Jill, 1999) advance the view that natural materials are readily available and very familiar to the children, clay, water, sand, mud, paper, seeds, flowers and wood unlike most materials provided for young children cost nothing or very little. Children are also familiar with these materials. It is easy to involve children planning their own experiences with natural materials. Malleable materials include clay, mud and soil can be moulded in the same way as dough and plasticine. (Kinyanjui, 1982) advances the view that schools with adequate resources and well trained dedicated teachers perform better. (Muiji & Reynolds, 2011) advances the view that, the use of instructional resources enable children to learn the relevance of maths to "real life" and be able to transfer knowledge learnt in class to the outside world so that they can use their maths in everyday situations.

According to (Setidisho, 1996) teaching mathematics using manipulative materials has a long history in the 19th century. Pestallozi advocates their use and manipulative materials were included in the activity curricular in 1930's. The mid 1960's began another period of emphasis on the concrete objects and pictorial representation in mathematics instruction. (Kluwe & Misiak, 1990) observed, irrespective of approach used, learner participation is key.

2.2 Instructional material used in number writing activities

Number writing and number spacing are difficult skills for children at an early age. According to (Gichuba, 2009) children learning experience and accessibility to materials are important in number formation. Modeling helps in formation/shaping of numbers. Children have great difficulties in the modeling of numbers 2,3,5,8 and 9 greatly. A lot of practice in proper shaping of these numbers will not only helped in number formation but also in number sequence, number recognition and number counting (Mwaura, 1984). Tracing numbers using tracing paper helped children in accuracy of number formation. It is also helped children in spacing and sizing (uniformity of numbers). The use of construction of numbers of uniform size is important. Children when tracing are able to have uniformity of numbers in between the spaces. It also helps in number sequence and reduces the errors of reflection quickly. After continuous tracing, it registers in children's mind the direction the number formed should be.

Number colouring also encourage children in number formation due to their colour attractiveness. It assisted in the shaping since it's an activity they love. Children are able to observe the numbers as they continue colouring within the borders. Mosaic and collage activities using glue and seeds helps in number pattern formation. As they arranged different seeds to form numbers, number shaping, recognition, counting and spacing was enhanced. It also helped in erasing right to left hand co-ordination when writing numbers (Mogaka, 2009).

Number puzzle helped in creativity and innovativeness of children in number formation where different cut parts of a number were joined together in number formation. It assisted those who succeeded in knowledge retention. Number sequence and number alignment were mastered. Children were able to reason logically and in problem solving (Gichuba, 2009). Number printing

gave the children an opportunity to print numbers in sequence. It enhances number shaping, number recognition and number writing readiness.

All these activities also help children in eye hand coordination, and strengthening of finger motor muscles. Children displayed work at the nature corner makes learning enjoyable and act as a motivator and encourage children to participate more at home with the acquisition of these number formation concepts through use of local materials in number formation. Children are able to appreciate other children's abilities and respect their ideas.

The use of practical activities in learning need to be emphasized. (Butler & Wren, 1960) asserts that on its parts practical work in mathematics serves not only to stimulate interest but also provides a most effective means of classifying many mathematical concepts and relations through the experience of associating them directly with physical things. (Petty, 1993) indicates that one learns better while doing rather than watching or listening. Activity methods are known to increase concentration, perception and retention. (Farrant, 1997) encourages the use of discovery methods in that they encourage all round development in the child.

According to (Mwaura, 1984) the teacher must observe the child very closely in all activities especially when they are learning to write numbers. The teacher should make sure that she writes her/his numbers very well, clearly and in the same way all the time. (Muiji & Reynolds, 2011) acknowledges that, the early mathematical knowledge is important to children's learning and teaching in primary schools as counting, adding, subtraction and sharing form the basis of much learning in early school teaching.

Children build upon their existing knowledge to build up their mathematical competence. (Orton & Frobisher, 1996) acknowledges that, mathematics is widely regarded as one of the most important subjects in the school curriculum.

2.3 Effect on materials in errors children make in number writing

Children make errors such as number reflection, number omission, number shaping, number sizing and number alignment. All these are learning difficulties in children. The activities of number formation through modeling, tracing, printing, colouring, mosaic/collage, weaving are important in number formation. Most of the numbers children had problems in were 2 written Mogaka F, (2009).

Children also make errors in number sequence thus 1,2,3,5,6,10. The child has omitted numbers 4, 8 and 9. The other error involves not knowing which number come first i.e. ___6, 7, or which number comes after 2, 3, ____. Children also make number errors of writing some numbers bungled together as follows 1, 2, 345 67 8910.

2.4 In-service teachers on improvisation of materials for number writing activities

In service training can be defined as structured activities that are intended to increase the skills and knowledge of teachers in an area (Good, 1973). The need to continually improve professionally is necessary in order to respond to a wide range of demands as a result of rapid and ever changing world.

Harries (1989) described in-service as “any planned programs of learning opportunities afforded to staff members of schools, or other educational agencies for purpose of improving performance of the individual already assigned positions.

Teacher trainee need to be taught how to recognize common children's errors and misconceptions in mathematics and to understand how they arise, how they can be prevented and how to remedy them. Kossy (2000) reports that when children are asked how they felt about making mathematical mistakes. They expressed strong feelings of anger, frustration and disappointment. Cock (1999) and Kossy (2000) both reflect a glowing view in the research evidence that mathematical errors can provide a useful insight for teachers into a child's thinking and understanding, an effective mechanism for assessment for learning and with sensitive handling can enable children to learn from mathematical mistakes viewing them "as" learning agents".

Current thinking and research is recommending to give greater status and value to learn from "mistakes" as a mechanism to assist further learning. It is self evident that such a shift will necessitate teachers adopting a constructive attitude to their pupil's mistakes according to Kossy (2000) and recognizing that analysis and discussion of mistakes or misconception can be helpful to their mathematical development.

Spooner (2002) suggests that, placing children situation where they feel in control of identifying mathematical errors and misconceptions leads to greater openness on the part of children to explore and discuss their own misconceptions. Many children have difficulties in writing numbers in sequence which can be alleviated by children active involvement in number formation through modeling, tracing, colouring, and number puzzle. Teachers in-service is focused on omission of numbers like this 1,2,3,6,7,10. The child has not written 4,5,8,9.

SMASSE as an INSET program has the following objectives:-

To inculcate a positive attitude in teachers teaching mathematics and sciences. To encourage teachers to change from the traditional methods of teaching to more heuristic child centered approaches. To encourage teachers to improvise teaching resources and materials which are cheap and locally available and guide teachers in terms of curricular interpretation and implementation (Ouko, 2005) citied in (Oirere, 2008).

In 2003, the MoE of Kenya started a distant learning course for primary schools known as School Based Teacher Development (SBTD) where in-service training in mathematics, science and English was addressed in the entire country in subjects which were performing poorly. The issues addressed were teaching methodologies and materials resources. The course took six months. Teachers were in-serviced on mathematics, science and English due to their poor performance (Kiptoon, 2000).

2.5 Summary

Instructional materials make learning interesting and effective. Children were actively involved "hands on" and "brains on" and all senses were involved. Materials encouraged discoveries and learning becomes a stimulating experience. Eshiwani (1983) talks of school facilities having a strong effect on performance. The discovered facts are glued firmly on to the memory of children. Children acquire in-depth concept of the content. As children manipulated material and engaged in different activities, different multiple intelligences was observed in different children. This enabled the researcher to build on children's observed potential. The materials enabled children to engage in activities according to their abilities and hence catered for individual differences. Children with difficulties such as special needs were observed e.g. eye hand coordination, motor problems and this enables addressing these problems at an early age. It

enables the teacher to prepare and plan activities putting in mind children's abilities and catering for individual differences.

Children acquire social skills as they share materials and display of children's work enhances children to develop self esteem. The capacity building on the side of teachers through in service course was a necessity. The Quality Assurance and Standards Officers level of supervision needed to be increased. In-servicing of teachers increases their skills and knowledge on how to facilitate the children's activities, for the purpose of improving performance. In-service helps teachers on how to recognize children's errors and difficulties. It provides an opportunity for the teacher being provided with useful insight into a child's thinking and understanding which helps the teacher to view mistakes as "learning agents".

Teacher capacity building on activities involving modeling numbers, tracing numbers, printing numbers, colouring numbers, number puzzle which helps in accuracy in number formation and shaping, number recognition, number sequence and number alignment. Some of the schools are intended to become model schools where others are expected to go and learn from both teachers and children's work.

2.6 Theoretical Framework

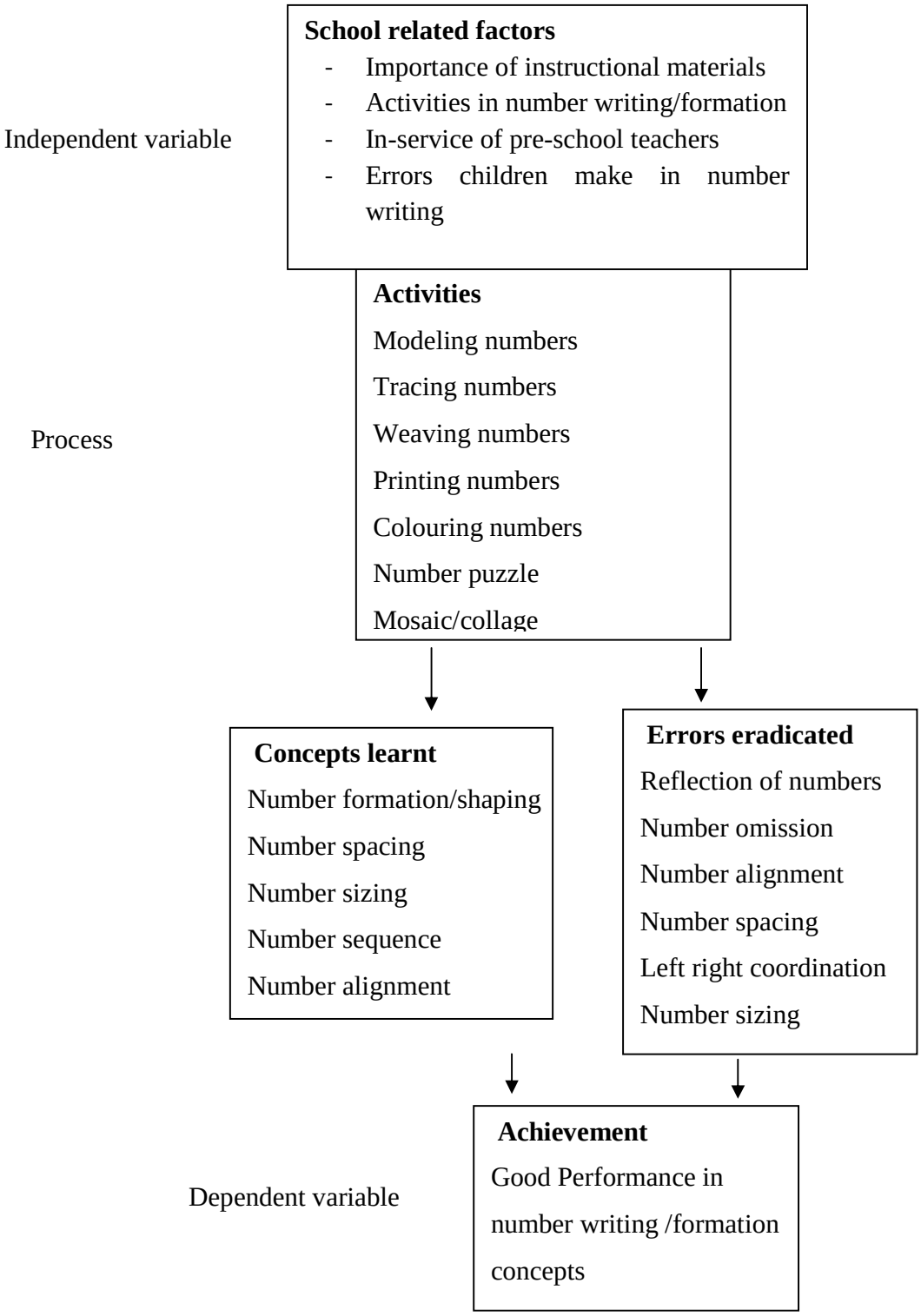
The study reveals that:- Constructivism views learning as an active learning activity. Most constructivists such as Jean Piaget, Vygotsky, the Gestalt Psychologists, Bartlett ,Brunner and John Dewey share two main ideas that "learners are active in constructing their own knowledge and that social interaction are important to knowledge construction. According to Jean Piaget, children should learn using concrete materials from the local environment. They should be

actively involved in manipulating materials in order to construct their own knowledge. According to Piaget learning is a constructive process (Donnel, 2009).

Lev Vygotsky emphasized the role of social environment in children development. He saw children as active organizers of their own knowledge. Thus discovery is assisted or mediated by teachers, family members and peers. He suggested that facilitators and care givers needed to do more than just arrange the environment (Johnstone , 2009). Brunner considers environmental and experimental factors in the development of cognition. Dewey's ideas have practically and widely been used in ECDE through use of child centred methods (Santrock, 2009).

2.7 Conceptual framework

Figure 2.1 Impact of materials and activities in number writing



CHAPTER THREE
METHODOLOGY

3.0 Introduction

This section consists of Research Methodology. It is organized as follows Research design, target Population. Sample Size, Sampling Procedures, Research Instruments, Validity, Reliability, Data Collection Procedure and Data Analysis, pre test and post test.

3.1 Research design

Orodho (2006) describes research design as the arrangement of conditions for collections and analysis of data in a manner that aims at combining relevance to the research purpose. The study used Quasi experimental research design that examined the impact of instructional materials on performance of number writing skills in pre-school children. It goes further to focus on importance of instructional materials, number writing activities, errors children make in number writing and in-serving of pre-school teachers in enhancing number writing concepts in young children.

3.2 Target population

Sommer (1986) defines target population as the entire group of people in a category. In this study, the target population includes 18 public pre-school in Kamukunji District of Nairobi County. It also includes the pre-school teachers and head teachers.

3.3 Sampling size and sampling procedure

Of the 18 public pre-schools in the district, only 5 are sampled for the purpose of this study and only one of them is a boy pre-school while the other 4 were mixed schools.

The pre-schools were identified through random sampling method in which the names of the public pre-schools were written on pieces of paper which were then folded and placed in a container. 5 pieces of paper were randomly picked and the pre-schools whose names appeared in those papers constitute part of the sample. The respondents of the study include the pre-school teachers from the 5 sampled schools and a total of 15 pre-school teachers. All the head teachers of those pre-schools making a total of 5 and 200 pre-school children were grouped into 2 categories namely:-

Control group who did not receive any treatment after the pre-test and experimental group of pre-school children who received treatment after the pre-test. Each group had 100 pre-school children. The pre-school teachers were involved in helping of collecting the data.

3.4 Performance test

A test of writing numbers 1-20 was prepared in advance and administered on the pre-school children in both control group and experimental group. The researcher liaised with the pre-school teachers so that they assisted in administration of the test. The children were asked to neatly write no. 1 – 20 on a paper that was provided. The papers were collected and the shaping of numbers, spacing numbers, omission of numbers, alignment of numbers, and errors in number writing were checked.

The second (test) was administered immediately after lessons in which the teacher had used instructional material to the experimental group for a period of two weeks. The control group did not use any resource materials in their activities. The researcher then compared the results. The schools were labeled A, B, C, D and E to conceal the identity of the school. Each school tested was marked and the mean calculated for each school.

3.5 Research instruments

Data pertaining to the head-teacher provision of instructional materials and the pre-school number work teachers was gathered through questionnaires, one for head teachers and the other for the pre-school teachers.

Head teachers questionnaire

The head teacher's questionnaire (HQ) was divided into two sections. Section A consisted of 6 items and gathered demographic data of head teachers such as age, academic qualifications, administrative experience and school factors such as size of the school population and category. Section B consisted of 5 closed and open ended questions probing questions touching on materials and performance in number work.

Pre-school teacher's questionnaires

The second instrument was the pre-school teacher's questionnaire which was divided into **two** sections. Section A consisted on questions teacher's demographic information; sex, age, teaching experience and professional qualification. Section B consisted on instructional materials, number writing activities, errors children make in number writing and pre-school teacher in service course and workshops. Data pertaining performance of children was obtained from the Kamukunji District MEO results.

Observation checklist for children

Children activities involved modeling numbers, tracing numbers, colouring numbers, using concrete materials, number cuts as well as the errors the children made in number writing.

Pre test for children

Control group and the experimental group were involved in number writing without the use of any instructional material activities.

Post test for children

The experimental group received treatment of using instructional material in activities of number writing while the other group did not and the results were analyzed.

3.6 Validity

According to Mugenda and Mugenda, (1999) a research is said to be valid if it measures what is supposed to be measured. There is truthful in the data collected. The pre test of children in experimental group was done and recorded. During the post test the experimental group, pre-school children used instructional materials and engaged in activities involving modeling of numbers, tracing numbers, weaving numbers, colouring and cutting numbers. The result of pre test and post test of the pre-school children were analyzed and conclusion made.

Validity of the instruments

To enhance validity of the questionnaire, a pre-test (pilot study) was conducted on a population similar to the target population (Mulusa, 1988). The pilot study was conducted in 2 public pre-schools. In this case the pilot study involved 2 head teacher and 5 pre-school teachers from 2 public pre schools in Bahati zones. Bahati zone was selected for the pilot study because 5 pre-schools in Eastleigh zone were involved in the main study. Furthermore, Bahati zone has characteristics similar to those in Eastleigh zone and therefore the finding of the study were likely to be the same in both zones.

According to Mulusa (1988), about ten cases, which represent the target population in all the major respects can be used in a pre test. To further improve validity of instruments, the researcher consulted university lecturers who are experts in the areas of education instructions.

3.7 Reliability of instruments

A reliability test is a method of making the test reliable by pre testing the instruments. Mugenda (2008) noted that pre-testing is essential. These pre testing errors found in the study which can later be corrected. Moreover, pre testing of instruments helps to estimate time needed to administer the instrument.

3.8 Data Collection Procedure

The researcher applied for the authorization permit to collect the data from the D.E.O Kamukunji District and she was granted permission to access the schools and collect the data. The researcher went to schools and gave copies of the questionnaires to the school head-teachers and the pre-school teachers. Respondents personal data was collected and analyzed. In areas of pre-test and post-test observation checklist of children, the pre-school teachers from the sampled schools helped in the analysis and data tabulation. Discussions of children's work was done between the researcher and the pre-school teachers.

3.9 Data Analysis

Data analysis was done using tables, percentages, mean, frequencies, histogram, pie chart and bar graph. Data analysis involved examining what had been collected and making deductions and references. The data was analyzed using both quantitative and qualitative dimension so as to present a true reality of the phenomena.

3.10 Ethical Concerns

The study ensured that the researcher observed confidentiality of the information. That was done by hiding the identity of the respondents' example "Those involved were not to write their names". It was wise to establish a good rapport with the respondents.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSIONS OF THE FINDINGS

4.0 Introduction

The chapter presents the data analysis, interpretation and discussion of the findings on the impact of instructional materials on performance of number writing concepts among pre-school children. The research objectives and questions analyses the importance of instructional materials in enhancing children in number writing activities, effects of material use in errors children make in number writing, classroom material corner for number writing activities display and in-servicing of teachers on material improvisation for number writing activities. Figures, tables, percentages, pie chart, line graphs and histograms used to summarize the information obtained. The pre test and post test were administered to control group and experimental group before and after the experiments were analyzed. The pre-school teacher's provided the experimental group with materials and facilitated their activities in number writing using instructional materials after the pre-test and the analysis has been discussed in this chapter.

4.1 Importance of material in number writing activities

The study showed that material used in number writing activities was plasticine, tracing paper, number cuts from manila and crayons for colouring. Activities were modeling numbers, tracing numbers and colouring them. The study showed that mathematics was about number writing. Many preschool children in both control group and experimental group struggled to write numbers in their papers using their pencils with great difficulties. They had problems of shaping numbers, number sizing, number spacing and number alignment. Others too were found having

omitted some numbers as well as writing numbers facing different directions. The pretest activities showed that number writing was a difficult skill for many young children. The preschool teachers were needed to ensure children write numbers in the provided papers. The children in both groups were copying the numbers from the chalkboard, and number chart hang on the wall. Most of the number charts were old charts. According to (Nacece, 1984), the teacher when teaching number writing must make sure she writes her numbers very well, clearly and the same way all the time.

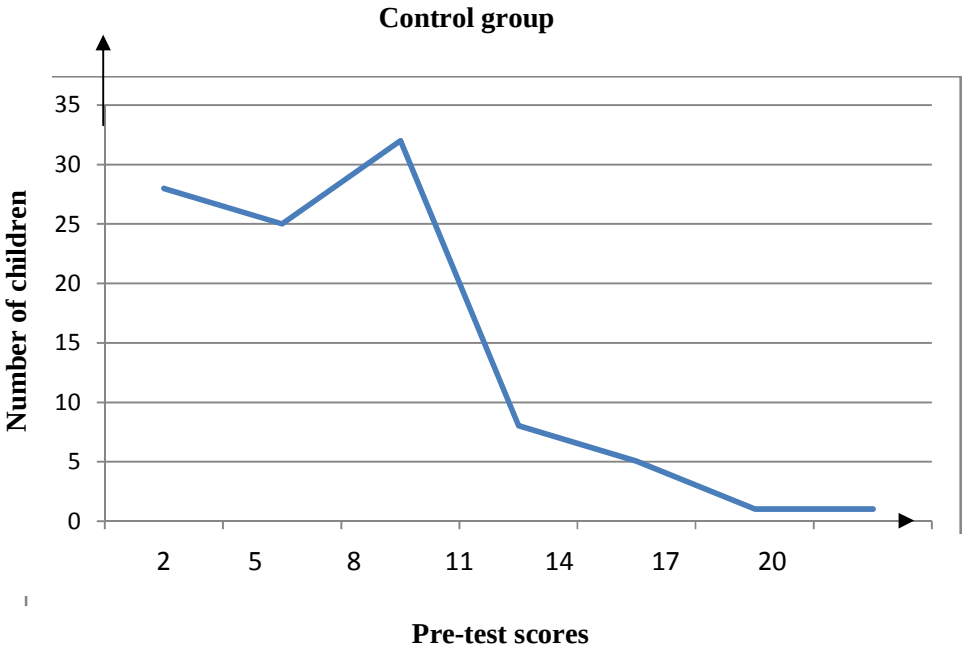


Figure 4.1: Pretest performance for control group

The study showed that many preschool children during the pre-test had difficulties in number writing skills. The frequency table on the **appendix c** showed that many of the children scored poorly on number writing as the graph was skewed on the left. More than 75% of the children

shaped, spaced, sized and aligned their numbers incorrectly. In some schools, children were asked by their teachers to write numbers in the air. Each of the 5 sampled schools had some children coming from nearby slum i.e. sampled purposively since most of them did not have nursery education. The pre-test was done without any treatment of any group. The standard deviation was 3.79 which was negative and hence indicating low marks.

4.1.1 Pre-test performance for experimental group

These pre-tests were administered to the group before any treatment as tabulated in the distribution table appendix E. i.e. use of materials and engagement of activities in number writing. They were given the same test as control group.

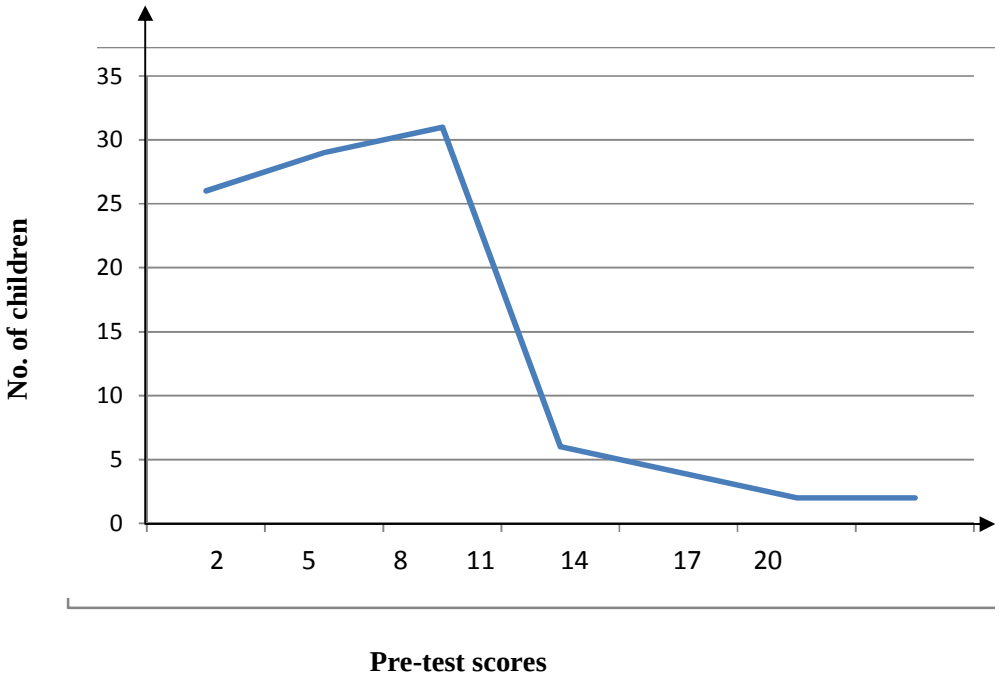


Figure 4. 2 Pre-test performance for experimental group

The study showed that children from the experimental groups scored a mean score that had many children having low marks but slightly higher than control group. The pre-school children were tested on number shaping, number spacing, number sizing and number alignment. The tests were

administered before any treatment. The majority of children had their scores below average and this is shown by the line graph which is skewed to the left side. It showed that very few children had acquired the number writing skills which provides a child with a strong mathematics foundation at an early age. The pre-unit teachers were expected to facilitate children with pencils and paper that would engage children in number writing activities through use traditional methods of coping numbers taught in the abstract into their books. The standard deviation was 4.32. the deviation was mostly negative hence indicating low scores. Teachers helped the children to hold their writing tools e.g. pencil, chalk, stones.

4.2 Post test material number writing activities

The control group was to continue writing numbers in their paper using the pencil. They used the traditional method of learning where they were taught in the abstract. The work of the teacher was to copy numbers on the chalk board for children to copy in their books. The teacher facilitated by helping the children hold their pencils and guided the child to shape, size, space and align numbers as they saw them on the chalkboard. The experimental group was provided with plastacine for modeling activities. The children were facilitated to model numbers 1-20 and displayed them on the table/desks. The children kept on modeling and destroying the numbers. The activity helped them to feel and see the number and shape of the numbers. The children modeled numbers and ordered them in sequence Nos 1-20. The preschool children were facilitated by both the preschool teachers and the researcher. To avoid monotony, children other times were provided with umber cut outs having tracing papers stapled on it to copy on top of the tracing papers what they could see. That helped them to see the shape, space, sizing and aligning the numbers. The children later were helped to colour the traced numbers using crayons. The

children work was always displayed for others to see. The work was always assessed by both the researcher and pre-school teachers to see children's number writing activities development.

4.2.1 Post test performance for control group

Figure 4. 3 Post test performance for control group

The study showed that there was only a very slight improvement in performance of number writing as tabulated in appendix F. Teaching and learning was teacher centred and children were passive listeners. The children got bored due to lack of involvement. They had low attention span. Maintaining class control became difficult. Children's interest was not catered for as well as individual differences. The performance increase was negligible. It was difficult for the teacher to know each child's interest and ability and hence did not cater for them. Since the children did not use materials, they did not have the opportunity not only to see the number

shapes but also to feel and manipulate different materials. The standard deviation was 4. 23. That was only 0.44 increases in performance. The researcher found that when children got stuck in their work, they became withdrawn.

4.2.2 Post-test performance for experimental group.

The study showed that the group used instructional materials and engaged in activities during number writing, teaching and learning activities. The children were actively engaged and hence knowledge retention and acquisition. They were provided with plasticine for modeling number activities, tracing papers that helped them to trace number cut out and later colour them with crayons.

The researcher noted that as children touched materials, they understood the concepts taught. The material usage enabled the teacher to detect those with problems involving finger motor muscle and their eye hand coordination for early intervention. The researcher was helped to know the children's abilities and the activities that interests them and hence added more materials. The researcher was helped to know the children whose motor muscle had fully developed and those who had not. Children had the opportunity to display their work in the learning corners. That gave children an opportunity to appreciate other children's work. As children used different materials and engaged in activities, different multiple intelligences were observed. That gave the pre-unit teachers the opportunity to build on different children's potential. (Afolabi, 2006) asserted that, instructional materials had positive influence on achievement in mathematics.

During number writing activities, the preschool teachers were able to easily identify each child's capability which helped in grouping them. The activities enabled the child to think and reason

logically. The preschool children's creativity and innovativeness was made manifest. The teachers facilitated not only in modeling, tracing and colouring numbers but also in arranging them in correct number order sequence. The number writing activities through use of material number writing, shaping, sizing, spacing and alignment.

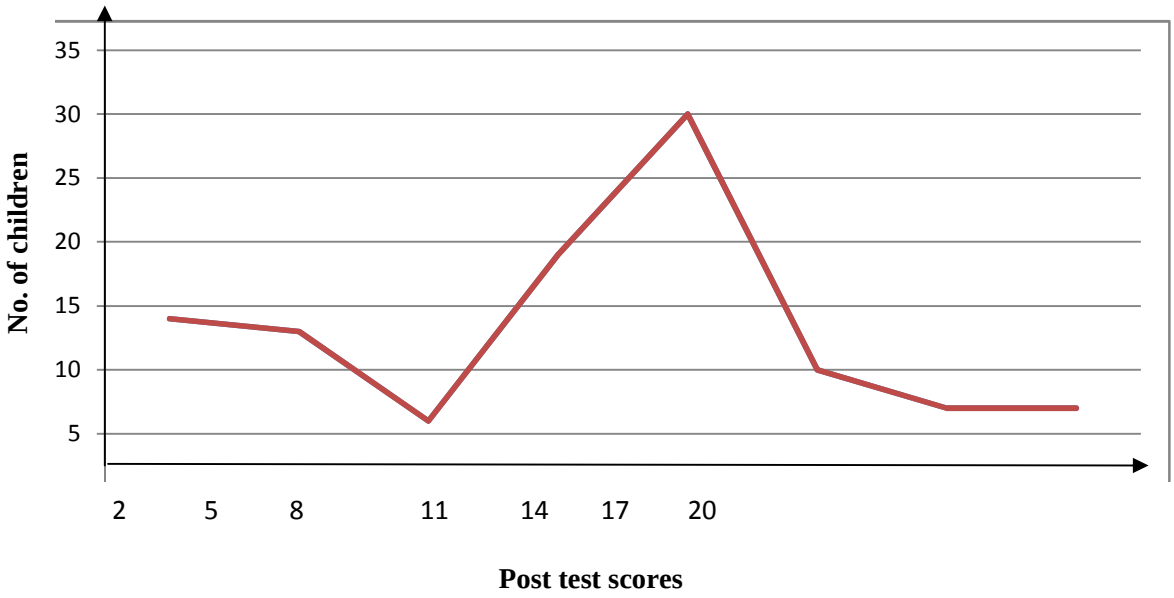


Figure 4. 4 Post test performance for experimental group

The post-test distribution table at Appendix H showed that post-test scores represented by the lines graph skewed on the right side. This showed a positive performance that was registered after learning and teaching using instructional materials that are age appropriate in number writing as well as active engagement of children in the activities.

The frequency distribution on table on appendix 'H" was a clear proof that when children had their "hands on" and "brains on" in their activities, knowledge acquired and concepts were acquired and hence knowledge retention. The researcher observed that the learners were

participating fully in the teaching, learning process. There was a lot of discovery and manipulation of materials and the children enjoyed the lesson and that enhanced their curiosity. The standard deviation was 7.50 which was 3.18 increases in achievement from 4.32. That was the highest increase in achievement when compared to the control group that did not use material instructional resources. According to (Onasanya, 2008) instructional materials are tools and equipment that helped the teacher in effective teaching. Well planned use of visual resources in lessons do much to banish the boredom, supplement inadequacy of books as well as arouse the pre-unit children that gave them something practical to see and do and at the same time helped children to think things out for themselves as cited by (Wales, 1975).

4.3 Materials needed for number writing in ECDE centres

The study showed that materials wear out, get lost and become torn. The researcher found that, it was important to renew the materials in the ECDE Centres since children like new things. The control group was not to be provided with any material for activities during pretest and post test but the experimental group was to be provided with different materials for activities during the post test. The study showed that new materials that were provided to the experimental group helped children to develop interest in different activities. Use of materials by the experimental group helped them to concentrate in their work. Inadequacy of materials made children get bored. The plasticine material was the mostly used by many schools during the modeling by the experimental group. Clay / wet sand was not used though found in the local environment. Many teachers felt the children would soil themselves. Other material that was given to the experimental group during the post test was number cut out, flash cards, tracing papers, and crayons. The preschool teacher and the researcher displayed number blocks and number charts in the class for both groups to see. Those children who used materials enabled the teacher to know

their capability and hence grouped them. Children creativity and innovativeness was displayed. The teacher was able to know where to assist the individual child as well as identify those learners who could recognize and order numbers in sequence. Those with learning difficulties were identified and helped. Those who were modeling, tracing and colouring numbers were seen assisting those with learning difficulties (peer tutors). Material use helped to understand the thinking of the child. (Muiji and Reynolds, 2011) underscored the importance of instructional resources in ECDE centres for purposes of improving children learning. Availability of instructional resources enhances the effectiveness of school activities as these are basic things that can uplift academic performance on the learners.

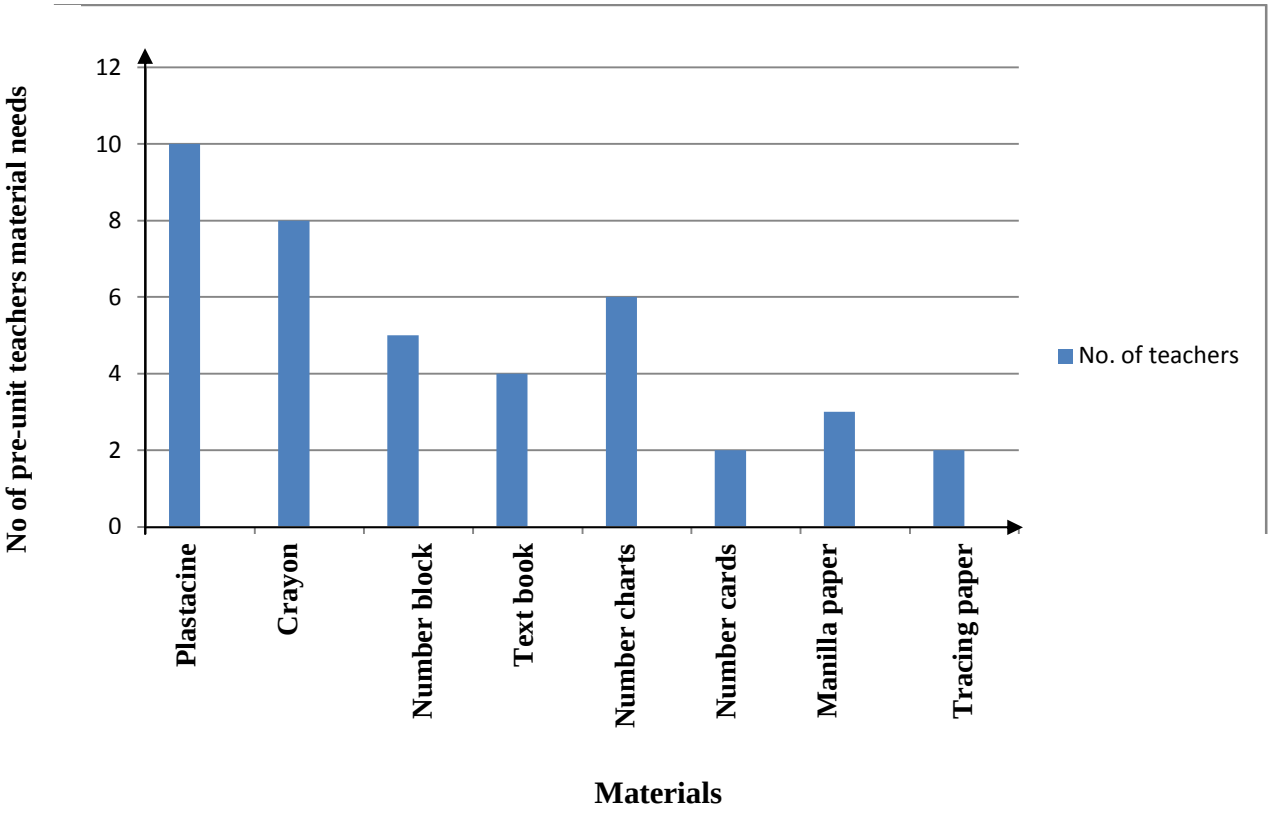


Figure 4. 5 Materials needed for number writing in ECDE centres

The study showed that many pre-unit teachers needed more plastacine 10(25%) for modeling number activities. Others needed more crayons 8 (20%) due to wearing out after sharpening. Different children showed different interests of materials as well activities. Catering for individual interests was found to be important. Number blocks 5(12.5%) as well as number charts 6(15%) for display in the mathematics corner was also needed. Tracing paper 2(7.5%) was needed to enhance number writing and number spacing. According to (Macharia, 2009) many teachers worked in poor and depressed environments with scant resources and little motivation.

4.4 Effects of material use in errors children make in number writing

The study showed children make number reflection errors, number omission errors, number sizing errors, number spacing errors and number alignment errors.

4.4.1 Number reflection errors

Number reflection errors means that the children had written the number facing the opposite direction. The researcher found that some children who were attending Islamic Madrasa's were writing the numbers in the Arabic way i.e. from right to left and hence having most of the numbers reflected.

Other children were confusing some numbers with letters e.g. 9 was p/b, 3 was m/w, 5 was S, 2 for z and 7 was L. Some children lacked confidence in their work and hence copied the reflected numbers from other children. There were still those who were unable to transfer the number from the chalkboard or wall chart to their books. The child was found having transferred what was in his/her head. The teachers teaching style whereby they taught number facing the children. The children ended up seeing the numbers facing the opposite direction. According to (Swan, 2001) despite what children are taught, children seem to make the same mathematical errors and

construct their own alternative meaning. According to (Cockburn, 1999), children make errors due to carelessness, misinterpretation of symbols, due to misconceptions and inability to do a complex task.

Pre-test performance in reflection errors table (Histogram)

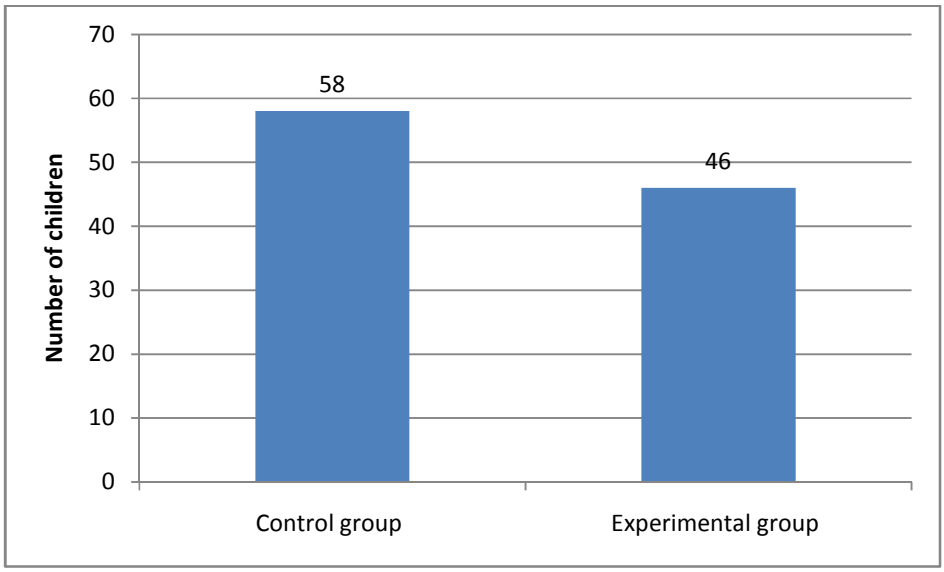


Figure 4.6: Reflection error groups (Histogram)

The graph above gives the information about the pre-test performance that was done by the control group and the experimental groups before the treatment of any group. The frequency table Appendix I shows that control group had received no treatment and had made the most reflected errors. The researcher found that the number 7 and 9 had been reflected most. Children who reflected number 7 and 9 also ended up reflecting numbers 17 and 19. The other number which were reflected more were the two digit numbers such as 12, 13, 14, 15, 16, 17, 18, 19. Pre-unit children in the control group recorded the most reflection errors. That could be attributed to having learnt number writing through the traditional methods where lack of instructional

materials and activities were not used. The histogram shows that the control group had 58 children who had at least made a reflection error where as the experimental group had 46 children who had made at least a reflection error during the pretest stage. The control group continued to be helped to write number using the traditional method of look and write. The experimental group also during the pretest had not received any treatment and also copied numbers from the numbers on the chalkboard, and number chart.

4.4.2 Post test performance in number reflection errors in children

The experimental group was provided with materials for activities to enhance number writing skills. The materials were plastacine for modeling, tracing number cuts using tracing papers and colouring number cut out with crayons during their number writing activities. The number of children with reflection errors reduced from 46 to only 10 children who were still making reflection errors. The control group continued to learn through the traditional methods of writing through coping from the chalkboard. The teachers facilitated the number writing. The children were not provided with any materials for activities and hence many continued making the reflection errors as tabulated below. The children who used the materials were able to order the numbers in sequence on the table /desk. They also observed the numbers they were tracing and colouring. According to Swan, (2001) despite what children are taught, children seem to make the same mathematical errors and construct their own alternative meaning.

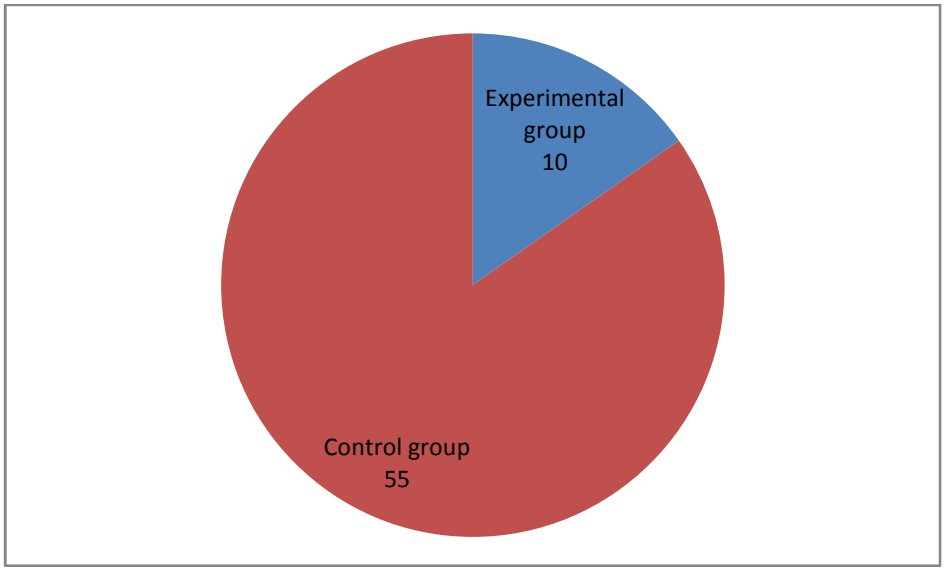


Figure 4.7 Post test performance in number reflection errors

4.5 Number omission errors

The researcher found that some numbers were missing and that meant lack of ordering the numbers in the correct sequence. Some numbers were skipped by the children during the number writing activities. The study showed that over confidence by some children as well as carelessness contributed to skipping of numbers. Children love competing. The high speed of writing made them omit some numbers. A few children were confusing numbers 3, 5 and 8. As they wrote 3, they were found omitting 5 or 8 since they were thinking they had already written it. Some of the children who had not mastered number sequence in nursery were found skipping some numbers due to lack of having not mastered the number sequence. Due to not knowing what was expected from them, they just repeated the number that they could see i.e. 0,1,1,1,4,5,5,5,8,9. Most of the children who had made omission errors were found to have been underage children. (Kossy, 2000) asserted that mathematical errors provided a useful insight for

teachers into a child's thinking and understanding. With sensitive handling, it enabled the pre-unit teachers to learn from mathematical mistakes, viewing them as learning agents. The researcher found that learning difficulties involving eye hand coordination to the children made them not write some numbers. Some children were found copying from others incorrect number order sequence and that made them omit some numbers.

4.5.1 Pre-test performance in number omission errors

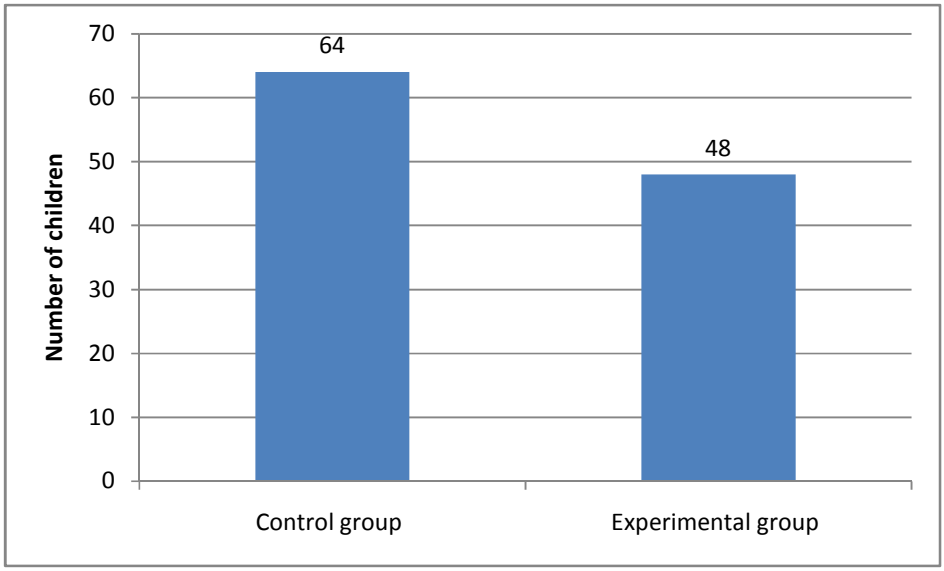


Figure 4. 8 Pre-test performance in number omission errors

According to the histogram above results indicates the omission errors that the researcher found in the number writing activities. The frequency distribution table on appendix J displayed the pre-test analysis that was found before the treatment. The control group had the most omitted numbers. Most of the children omitted number 13, 14,15,16,17 and 19. The number writing was

showing the children also had difficulties in writing them and this could have been attributed to lack of mastery of the number concepts.

The experimental group also was found having skipped some numbers and particularly numbers 15, 18 and 17. The control group had the most omitted errors. The number of errors was attributed to lack of activities and material use probably used in the pre-school.

4.5.2 Post test performance number omission errors

The control group did not receive any treatment. They continued using the traditional methods of learning and hence many preschool children continued omitting numbers. Some copied from others and others missed numbers due to the competition they were involved in. 52 children had still omitted a number or some numbers. The experimental group was provided with materials like plasticine. They were facilitated to model number in sequence as they displayed the numbers on tables /desks. They saw and felt the numbers. During the tracing activities they read the numbers out and touched them and later colouring activities of numbers with different colours of crayons. That enhanced number writing concepts. The experimental group that had 48 children with omitted numbers reduced to 12 children where as the control group reduced to 58 children as tabulated below:

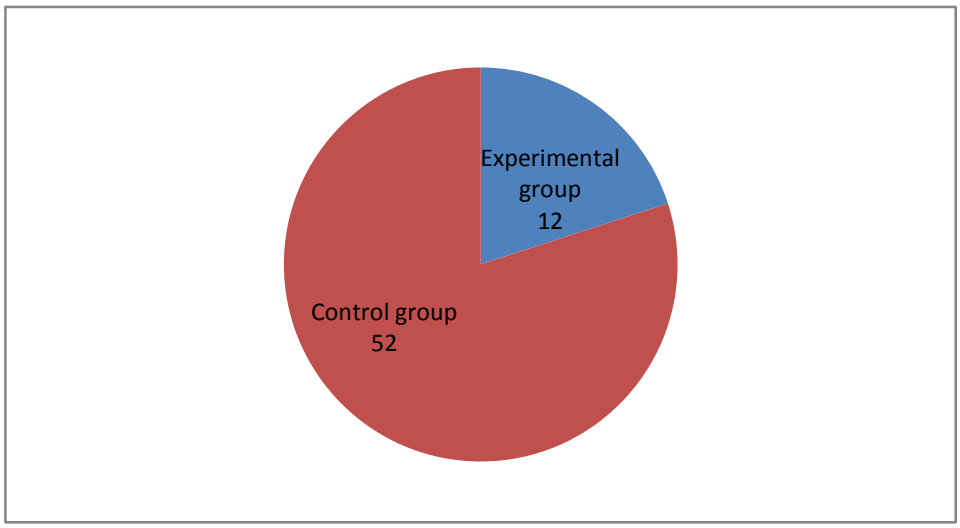


Figure 4.9 Post test performance in number omission errors

The impact of material and activities in reducing the number of children with number omission errors is tabulated above. The number of children with number omission errors reduced greatly.

4.6 Number sizing errors

According to the study, number sizing errors meant that the child wrote some numbers too big or too small and hence there was no number size uniformity. The study showed those who had the problem organizing their work. They were found writing some big numbers and hence the remaining numbers were squeezed in a small tiny place and hence lack of number size uniformity. It was also found that the child had lack of proper interpretation of the number shape. That meant the child having the number in the head but was not coming out properly on paper. The researcher found many children having complications when writing 2,3,5,6 and 8 and hence their number work lacked uniformity. The study showed that lack of control of pencil as they write brought number sizing errors and hence non uniformity in number writing. Others had difficulties transferring the numbers from the chalkboard to the book. (Spooner, 2000) suggested

that, children should be placed in situations where they feel being in control of identifying mathematical errors.

4.6.1 Pretest performance in number sizing errors

The preschool children in the control group were helped to space numbers through practicing to write numbers which were copied from the chalkboard onto the squared papers. Each number was to be written within the squared book boxes and shaped as the preschool teacher had written on the chalkboard and number chart. The experimental group also used the traditional method to write the numbers in the abstract through coping in squared books. It was found that even after being told to ensure the numbers be written within the boxes. The control group had 56 children whose numbers were either too big or too small and lacked uniformity whereas the experimental group had had 61 children making number sizing errors.

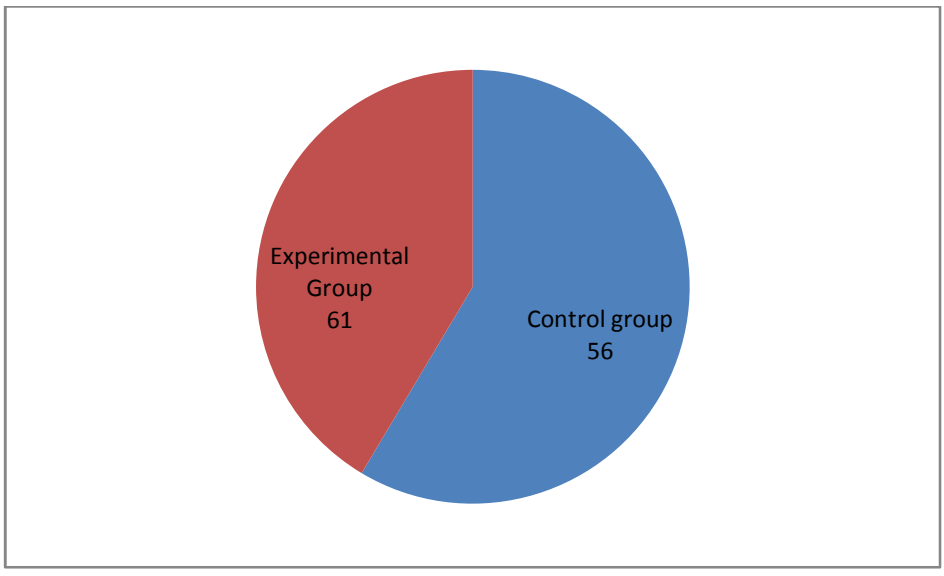


Figure 4.10: Pre-test performance number sizing errors

4.6.2 Post test performance for number sizing errors

The preschool teacher and the researcher provided the experimental group with number cuts which were stapled using the tracing papers. The numbers were the same sizes and children were not only supposed to trace but also to colour after tracing. This enhanced number sizing concepts. The emphasizes were on children avoiding to write some numbers too big and others too small and hence giving a funny meaning. The experimental group reduced from 61 to 17 children. The control group which did not receive any treatment had many children who continued making the same errors, and only 2 children managed to write the numbers correctly. The rest 54 continued making the number size errors. The control group number of children reduced but even after many practices of writing numbers in the abstract. 54 children were still writing numbers either too big or too small and hence non uniformity.

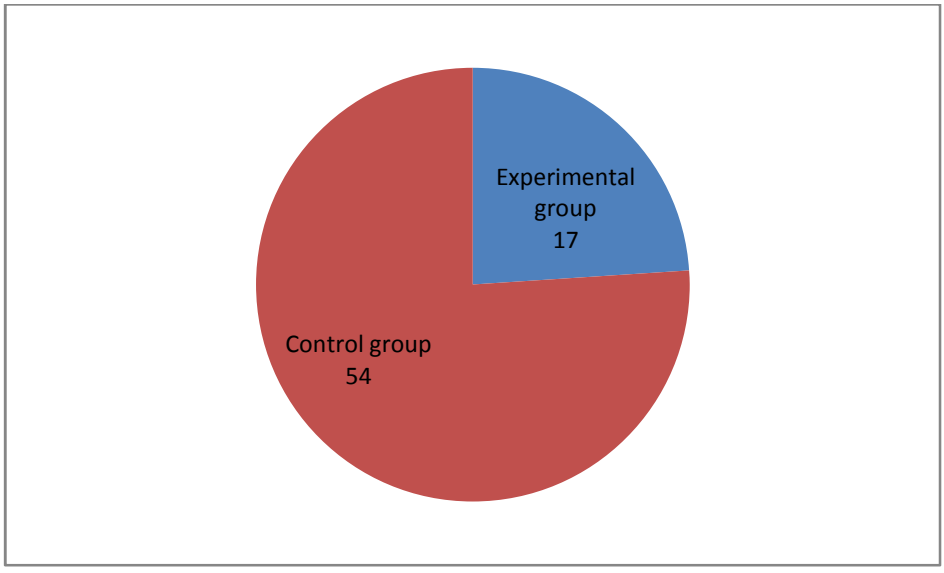


Figure 4.11 Post test performance for number sizing errors

The above shows how children active involvement of using materials enhanced number writing activities to the experimental group. The active use of having children having “hands on” and “brains” on activities using materials that enabled those making errors in the experimental group to reduce greatly.

4.7 The number spacing errors

The study showed that some children were writing numbers too far apart and in others too close together. The researcher found that, the problem was contributed by lack of proper eye hand coordination. Others had not been guided by their teachers on how to write and space numbers as they wrote. The study revealed that unguided children wrote numbers either too close, far apart or any howly i.e. 12345678910111213141516171819 20 or 1, 2, 3 4,5 678 9 10

4.7.1 Pretest material activities for number spacing errors

The control group and the experimental group was facilitated in number writing by both the preschool teacher and the researcher in spacing numbers using abstract methods. The two groups were provided with lined papers in which the teachers facilitated number spacing in the abstract and the histogram below shows how children were spacing numbers.

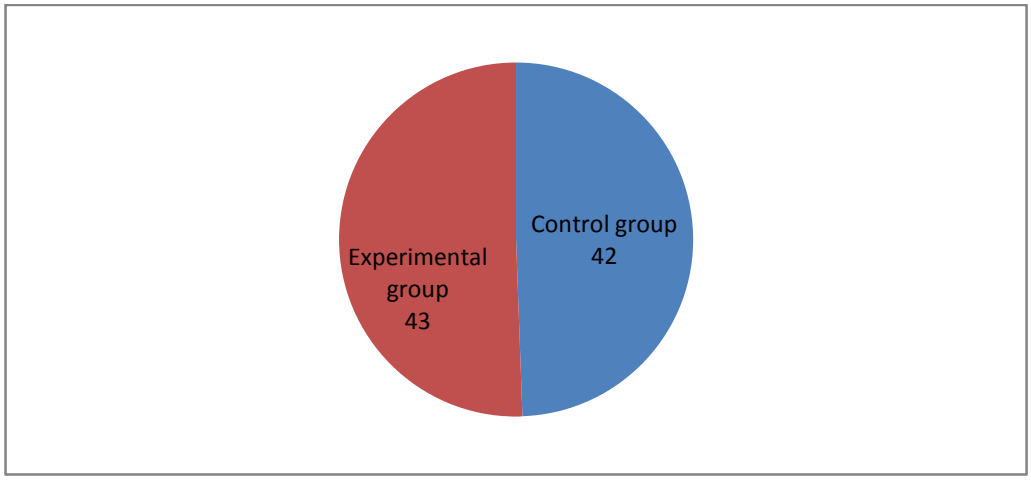


Figure 4.12 Pretest performance in number spacing errors

The study done by the researcher found that the abstract or traditional method of teaching and learning was not helping the children in number spacing. The control group had 42 children with number spacing errors. Experimental group had 43 children.

4.7.2 Post test performance in number spacing errors

The experimental group who had treatment through use of materials and engaging children in material activities enhanced children in spacing the numbers. The pre-unit teachers guided the children by drawing the lines where children were to write the numbers. The tracing, modeling and colouring activities of the experimental group enhanced the guiding of children in number writing activities. It was only the experimental group that was involved in material activities through use of arranging the number cut outs in sequence. The teachers later provided children with papers with lines spaced for them thus 1 2 3 4 5 where they were supposed to write numbers. The tracing of numbers and colouring numbers provided enhanced experimental group in number spacing. The number of children of those in the experimental who could not space

properly reduced from 33 to 8 in the experimental where as the control group that did not use any many materials in activities reduced errors from 35 children to 22 children.

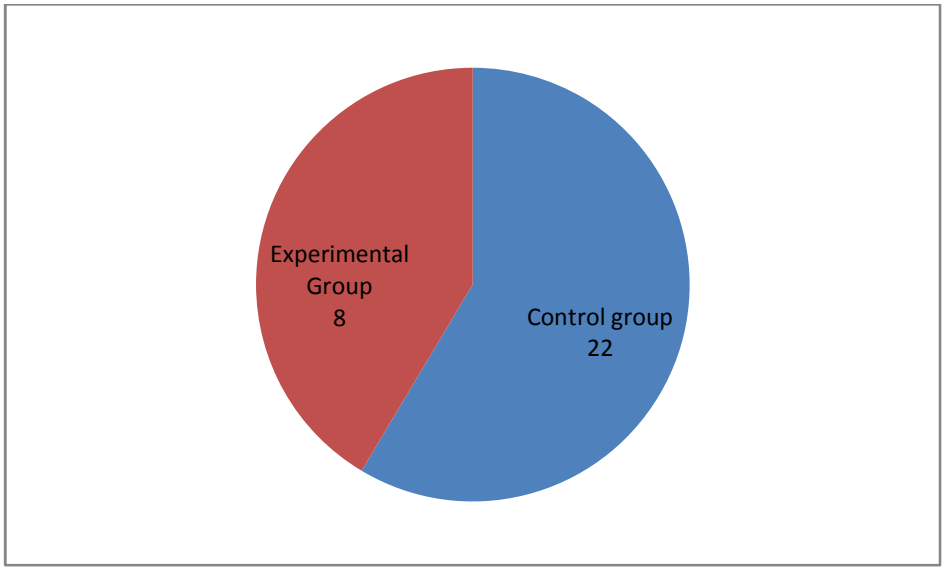


Figure 4. 13 Post test performance in number spacing errors

Experimental group who used materials in number writing activities reduced to 8 children and the control who continued in the abstract had minimal reduction of 22 children. The impact of materials or number writing activities was made manifest in the experimental group.

4.7.3 Number alignment errors

The children number alignment was found to be writing numbers in a mixed way and without a proper pattern. This was mostly found with children who wrote the number on plain paper which did not have guidance lines. Those children who did not practice writing numbers regularly were

found having the same problems as well as those with the problem of eye hand coordination. (Petty, 1993) asserted that, one learned better while doing rather than watching.

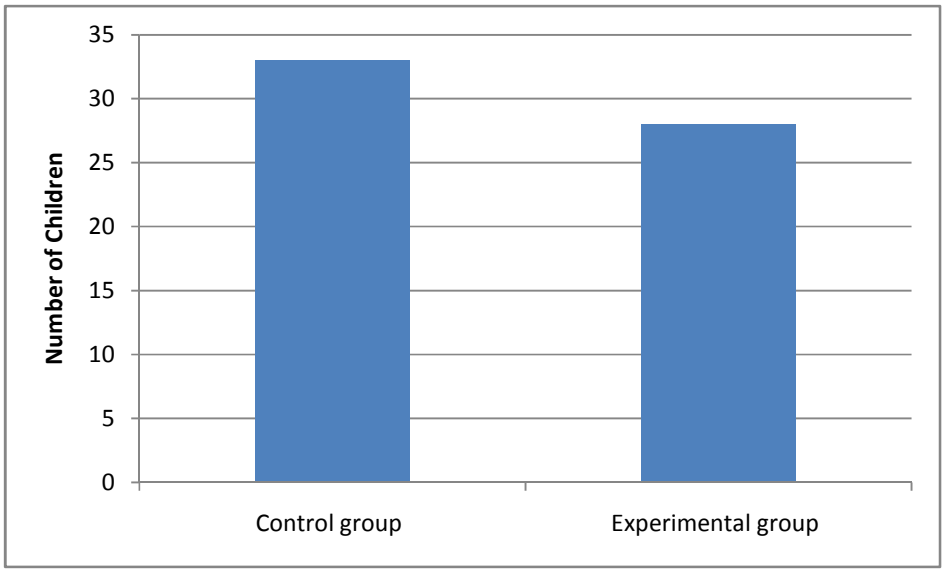


Figure 4. 14: Pretest Performance in number alignment error groups

The researcher found that control group had the highest number of children with number alignment errors 33, whereas experimental group had 28. The control group was to continue learning using the traditional methods where as the experimental group was after the pre-test to continue learning using different material in activities in number writing.

4.7.4 Post test material activities in number alignment errors

The researcher and the pre unit teachers engaged the experimental group in number modeling activities, tracing number activities and number colouring activities. According to the study the experimental group was provided with adequate plastacine to model numbers 1 to 20 with the

teacher's guidance. The children were modeling and destroying what they had modeled. The children touched and felt the shape. They were engaged in their activities and hence concentrated in what they were doing. The control group number of children reduced from 33 to 31 whereas the experimental group reduced from 29 to 9 children. Tracing number activities was also carried out in the study using typed numbers with a tracing paper stapled on top. Tracing enabled the children to shape, see the spacing and number size. The activities were enhancing children number sequence and hence mastery of the number order.

The researcher and pre-school teachers facilitated number colouring of the already cut out numbers. Children coloured and drew the numbers that were drawn. All these activities were helping the children in the holding of writing tools and acquisition of the number writing skills, number shaping, number sizing, number spacing and number alignment.

The control group did not receive any treatment. The children continued writing numbers in the abstract. They copied the numbers to their books from the chalkboard, from the displayed number blocks and from the number chart that was hanged at the mathematics corner. The children in the control group got bored in the process and just watched others carrying out activities. The learning was passive and mostly teacher centred. These children were not self motivated and were not even curious compared to those who used materials in their activities.

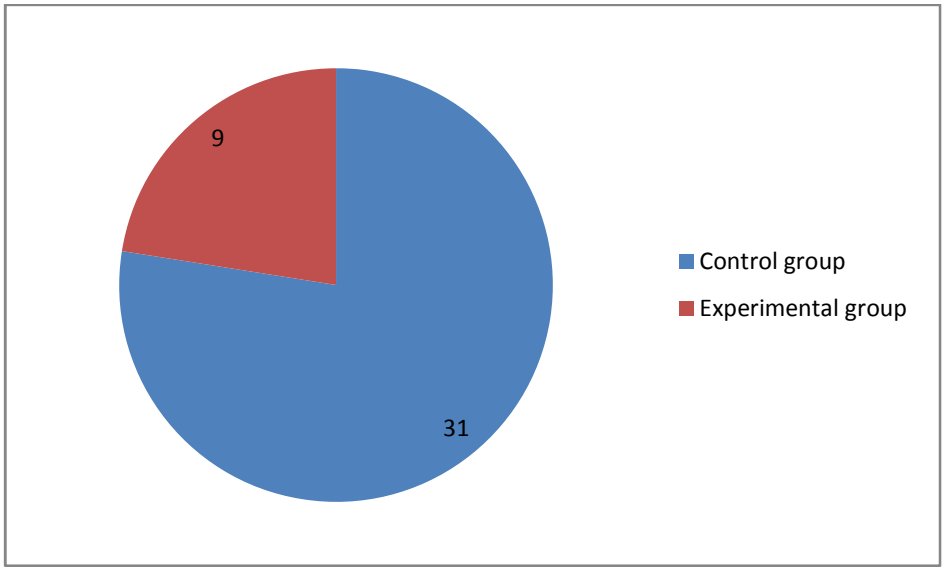


Figure 4.15: Post-test performance for control and experimental group

The above pie chart indicates the post performance of control group who did not use any instructional materials and activities in number writing. In these groups of children the pre-unit teachers used the traditional methods of instruction. There were very few children who performed well. The researcher observed that, those who scored low marks were many. They still had problems with number shaping, number sizing, number spacing and number alignment. The children's work still contained the errors of reflection, omission and lack of mastery of the number writing order of sequence. The young children were mostly seen engaging in their own activities and class control was poor. The children with nursery background also did not make much improvement though most were observed to have a number writing background. Performance improvement was very minimal and they were even more bored and made noise during the teaching and learning process as compared to the control group. The children in control group who were stuck in their work were looking withdrawn.

4.7.5 Pre-test performance for control and experimental group in number shaping

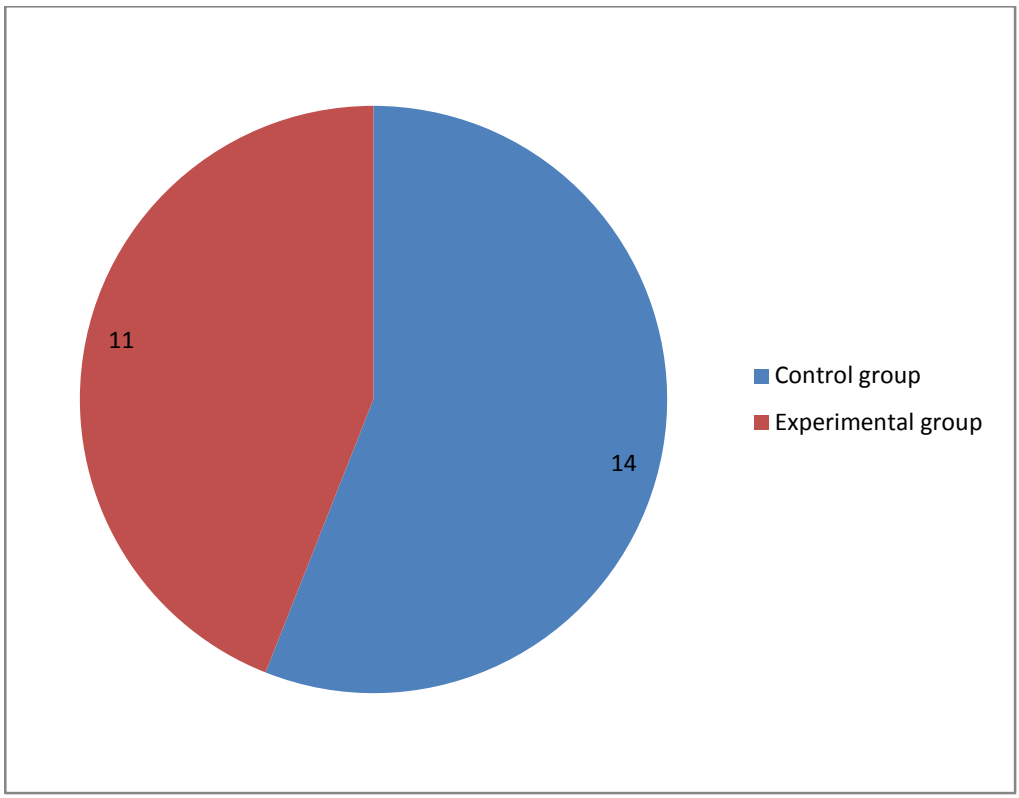


Figure 4. 16 Pre-test performance for control and experimental group in number shaping

Children in the pre-test in both groups got bored and made noise during the teaching learning process since they were learning using the traditional method of copying from the chalkboard and number chart. Their performance was low as many were trying to shape numbers in the abstract way. The teacher tried to help the children shape numbers and most of them scored low marks. About 14 children in the control group could hardly shape the numbers whereas 11 children in the experimental group had great difficulties in shaping numbers in the abstract.

4.7.6 Post-test performance for control and experimental group in number shaping

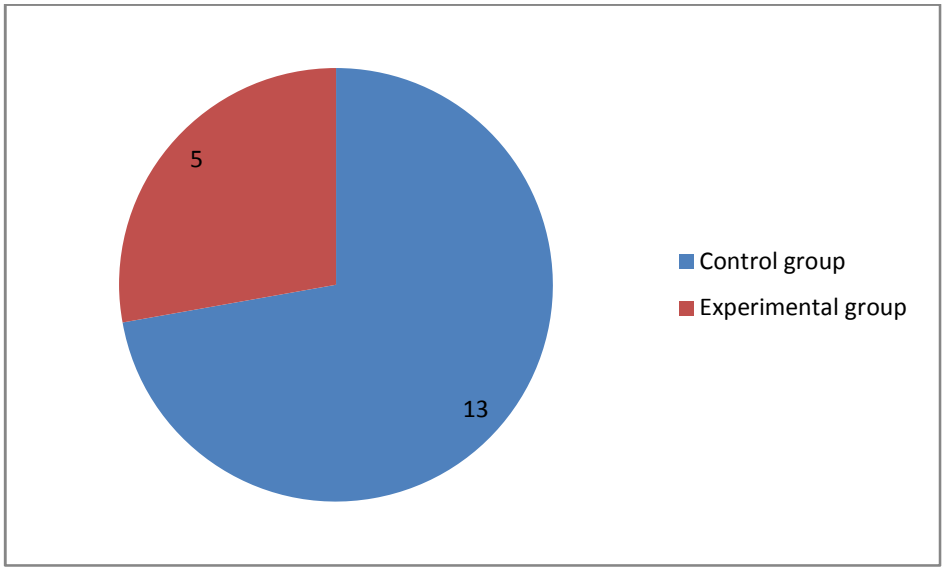


Figure 4. 17 Post-test performance for control and experimental group in number shaping

According to the above pie chart the researcher found that, instructional materials and engaging children in activities during the teaching learning process uplifted the performance of the children achievements. Children were observed being actively engaged in number formation, through modeling, tracing and colouring activities. The researcher observed the children deeply concentrating in their work. Children grasped the number writing concepts and most of them scored above average. The children were seen visiting the mathematics corner frequently where they had displayed their work. They could be seen destroying what they had modeled previously and modeling the numbers again in a better way. Learning took place with minimal supervision of the class teacher. The pre-unit teachers were only facilitating the activities and providing materials as well as adding more materials to the groups. Children were fully concentrating in their work. The children talked about their work and were seen identifying the good work others

had done as well as correcting one another. The children were observed being happy when their work got displayed. As the performance portrayed, use of instructional materials and active engagement of children in number writing activities enhanced acquisition of number concepts and hence a strong mathematics foundation to the children at an early age. It enhanced quality and efficiency in the teaching and learning process. It was also observed that children errors had greatly reduced.

4.8 Classroom material corner for number writing display

The study showed that displaying of children's work motivates them to be actively engaged in more number writing activities such as modeling numbers, tracing numbers and colouring them. It revealed children's creativity and innovativeness. The children saw others work and that helped to build their self esteem. The teacher and children were actively engaged in displaying the children work. Children were seen visiting the mathematics display corner.

According to Gichuba (2009), after development and improvisation of materials. It is important that they are displayed according to the learning area. Display in the classroom is part of the learning environment. A good display makes learning enjoyable, acts as a motivator hence encourage children to participate in more activities. The researcher and the pre-unit teachers found that number writing concepts was a key component in enhancing mathematics performance in children at their formative stages. They facilitated the children in shaping, spacing, sizing, aligning and writing numbers in sequence.

Table 4. 1. Post test display of performance of number writing concepts

Concept	Control group				Experimental group			
	Competed		Never completed		Competed		Never competed	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Number shaping	21	21	79	79	59	59	41	41
Number spacing	35	35	65	65	52	52	48	48
Number sizing	17	17	83	83	51	51	49	49
Number alignment	29	29	71	71	56	56	44	44
Number writing	41	41	59	59	64	64	36	36

The above table summarizes the scores of each concept taught in number writing skill taught.

The researcher and the pre-unit teachers observed children in control group struggling to shape, space, size and align numbers. They were using the traditional methods of learning. In number shaping only 21 children managed to completed with difficulty while 79 were not able to shape the numbers correctly. It also took time for the children to shape the numbers as written on the chalkboard or wall chart. The children kept on rubbing and sharpening pencils and talking to each other. Those children who got frustrated with the exercise were observed having withdrawn. In control group only 35 children managed to space the numbers well while 65 were found having either the numbers too close or too far apart. Number sizing involved the numbers having uniformity in their sizes. Only 17 children completed while 83 never completed to have uniformity in number writing. Some numbers were found to be too big and other small. The biggest problem was found in the two digit numbers like 12, 13, 14, 15 etc. it took the researcher and the pre-unit teachers to give the children squared books but many still wrote the numbers

outside the squared box. Only 29 children managed to align the numbers properly while 71 never managed to acquire the skill.

The experimental group was given materials such as plastacine by the researcher and the preschool teachers. They were facilitated to model number 1-20. They kept on modeling and arranging the numbers on top of their working tables. They were observed modeling and destroying what they had modeled. The researcher and the teachers facilitated the activities. The children were busy and concentrated on their number modeling activities. They touched and felt the shapes. They could be heard counting as well as displaying their work. In the next activity they were tracing numbers which had tracing paper stapled on it. This gave the groups the opportunity to see the spacing of number, sizing, as well as number writing order sequence. After tracing, they displayed their work in the mathematics corner.

The tracing activity was followed by colouring the same numbers. They later displayed their work. In the subsequent lessons they were allowed by the researcher to carry out the activities of their interest. Some traced numbers, others modeled numbers as the others coloured their numbers. This helped the teachers to identify different abilities and children's potential as well as their interests. The children enjoyed seeing their work displayed on the mathematics corner. 59 children which was above average completed to shape the numbers and only 41 never completed. The children on their own were seen collecting materials and were doing the tracing, modeling and colouring their numbers during their free time. The researcher found that, due to the many activities done by children in number writing, through modeling, tracing and colouring, many children managed to acquire the number sequence order concept. Also the errors of reflection and omission were greatly minimized.

In conclusion, the researcher found that learning using materials and engaging children in activities was not only interesting but also enhanced motivation and saved time to acquire the number writing concepts. Different materials and different activities were able to cater for individual differences. In the control group the teacher was using traditional methods (look and write). The slow learners were not taken care of as the teacher kept on advancing with the concepts even when the slow learners lagged behind. The experimental group performed well and the performance was above average in all concepts where as in the control group most learners performed poorly and had low marks.

4.9 In-servicing of teachers on material improvisation for number writing activities

The study showed that, ECDE centres had inadequate instructional materials that could be used for engaging children in number writing activities and hence need for improvisation of materials.

The teacher sand the researcher used bottle tops which were numbered on the inside. Children were engaged in arranging them in sequence. The teachers helped those with difficulties immediately. Though use of manila number cut outs in the children in the experimental group could make a number book through sticking. Collecting of seeds, fruits, stones, pebbles, buttons and wood and using an informal setting helped children write numbers through arrangement of those items. Locally available materials was found plenty for children to engage in number writing activities. These number writing activities were to be used by children at home and in school.

The teachers were encouraged by the researcher to use matching items of written number through games. Also children activities where children could stand on a number. Children were to continue filling missing number using number cards or number cut out. (Good, 1973) asserted

that, there was need to improve professionally in order to respond to a wide range of demands as a result of rapid ever changing world.

On material improvisation, only 6(40%) of the teachers were engaging in improvising a few materials to supplement the inadequacy of materials in the ECDE centres. According to (Hobart and Jill, 1999) instructional materials played a vital role in teaching and learning at various levels of education and especially where a strong mathematics foundation was needed. Many of the pre-school teachers were found to be rarely engaging in the improvisation of materials in the ECDE centres. The researcher found that the teachers and pre-school children were hardly using the clay in modeling numbers that was found in the children surrounding environment. More than 9 (60%) were rarely improvising materials for their ECDE classes. (Afolabi, 2006) asserted that teaching can only be effective with adequate and relevant instructional materials. The researcher found that assessment was helping the teacher to know whether the children had acquired the number writing concepts.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The chapter consists of the summary of the findings, conclusions of the findings and recommendations of learning of the impact of materials on acquisition of number writing concepts at children's formative stage.

5.1 Summary of the findings

The study revealed that number writing concepts cannot be acquired without use of adequate age appropriate materials and active engagement of children in the activities. Material used in activities helped children to be active participants in the teaching and learning process. Children in the control group and experimental group scored low marks during the pretest. The pretest was done without any treatment of any group. During the pretest, children had difficulties in number shaping, sizing, spacing and alignment. They also made reflection errors and omission errors. Due to the many children who wrote numbers incorrectly, the graph was skewed on the left.

During the post test, the control group continued to learn number writing using the traditional method where they were taught in the abstract. The teacher wrote numbers on the chalkboard and number chart and the children copied in their books. The teacher facilitated by helping children write numbers correctly. The children continued scoring low marks which was attributed to lack of involvement in material number writing activities.

The experimental group was provided with materials which was age appropriate during the post test. The children were provided with plasticine fro modeling numbers, tracing paper, number cards, number cut outs and crayons for colouring the traced numbers. The children were observed modeling and destroying the numbers. The material activities helped them to feel and see the number and shape of the numbers. They modeled and ordered the numbers in sequence. The tracing activity helped children to see the shape, space, sizing and alignment of numbers. The children also coloured the traced numbers. The children's work was always displayed for others to see in the mathematics corner. The material usage helped children to write numbers correctly, shape, space as well as minimizing the errors in their work.

Children involvement in number writing activities helped the teacher to detect those with problems involving finger motor muscles and eye-hand coordination for early intervention. The material used had positive influence in number writing as the children attained high scores and the graph was skewed on the right. The children creativity and innovativeness was made manifest. The use of materials in activities enhanced a lot of discovery and manipulation of materials and children enjoyed the lesson and their curiosity was aroused. Material used by the children gave them something practical to see and do and at the same time helped them to think things out for themselves.

Kamukunji District pre schools did not have adequate materials. On the part of the teacher, improvisation of materials was very low and lack of adequate age appropriate materials that can be used to engage children in number writing, number shaping, number spacing, number alignment was inadequate. That has been hindering use of activities in the teaching learning process.

5.2 Conclusion

Teaching and learning using age appropriate materials and engaging children in activities of modeling, colouring, tracing enhances acquisition of number work concepts and hence improves performance in mathematics. The researcher carried out experiment to find out the impact of instructional materials on number writing concepts where children were shaping numbers, spacing numbers, uniformity of number sizes and number alignment. The teaching and learning in the control group was carried out in the abstract (using traditional methods). While the experimental group carried out number writing activities using materials such as plastacine, number cut out being traced and colouring the number cuts.

It was observed that use of materials and engaging children in activities was not only interesting but also built their self esteem when their work was displayed. The learning was observed to be self centred, children creativity and innovativeness was displayed. The use of material enabled the teachers to prepare materials and plan for children activities in their groups according to their ability. The teachers were able to group children according to interest and ability. This catered for their individual differences.

Provision of materials in the ECDE centres was found to be an necessity since children learning by doing enhances knowledge retention. When using materials and particularly in tracing the colouring they were really concentrating in their work. That meant that, parent sensitization on funding preschool and provision of materials was a necessity and should be encouraged.

There was also a need of having trained preschool teachers through in-servicing them so as to keep them updated in the number work methodologies that can help children in their formative. Stages t o acquire the appropriate number writing skills. Trained and in-serviced teachers were in

a better position to use the errors children were making as learning agents which could help them to understand the child's thinking.

5.3 Recommendations

5.3.1 Improvisation of materials for number writing activities

The choice and use of materials is the responsibility of the teacher. Since the ECDE Centres are not funded by the government and the payment of school levies in the District is minimal, the teacher should embark in the improvisation of materials in the local environment to enhance number writing skills. Children can use stones or sand to form number shapes with the teachers guidance. The children can activity engaged in use stones seeds bottle tops during their free activities to form number shapes as well as bottle tops which are found in their environment.

5.3.2 In-servicing of teachers on material use in number writing activities

The preschool teachers should be in-serviced in the carrying out of children activities in number writing. In-service and workshop should involve how to use material to help eradicate the errors children make as a way of understanding the child's level of ability. In-serving teachers should also involve areas of grouping children and provision of remedial work which is to their ability through material activities. Different, ways of assessing children as they use material in activities should be addressed so as to encourage children in their number writing activities.

5.3.3 Number work syllabus

Material number writing activities should be addressed effectively since they form the foundation of learning at the formative stages of children's learning. The current preschool syllabus has given little attention to number writing activities. The syllabus should be restructured by the curriculum developers in such a way that number writing, number spacing, number sizing, number sequence; number alignment is adequately addressed. They should also update the curriculum so that schools with computer technology can be able to use it. The computer should by now involve technological means of teaching number writing using computers. This would encourage the parents to equip their ECDE centres with the latest technology.

5.3.4 Identifying errors children make through use of materials in activities

The teachers should ensure they use identify each of the errors children were making. That would help them to know what the children know and build on that. That meant moving from known to unknown. The teacher training should enlighten them never to discourage children in the errors they make. Children errors would enable the teacher to understand their thinking and assist them from that level through use of material activities.

5.4 Suggestions for further study

There was need to examine other factors that may have been affecting children performances in number writing/formation other than use of materials and active involvement in activities in number writing . There was need to find out what other issues could be contributing to children making errors of reflection, omission in number writing apart from the one found in this study.

Relocate this study of number writing concepts to other counties to ascertain reliability of these findings and particularly what contributed to children making reflection errors, number omission, number spacing , number sizing and number alignment.

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Appendix A: Observation checklist for children activities

The purpose for this observation checklist for children is to collect data concerning instructional materials on performance of children number writing among preschool children in Kamukunji District. The pre-school identity will be treated with strict confidentiality and information obtained will be used for academic purposes only.

Name of the pre-school ……

1. Type of instructional materials children were using in the ECDE centre

    a) ----------

    b) ----------

    c) ----------

    d) ----------

2. Children to write numbers 1-20 in a piece of paper.

3. Children modeling activities using plastacine.

4. Children tracing activities using number cut outs and tracing paper stapled on it.

5. Children colouring number cut outs

Appendix B: Questionnaire for pre-school teachers

Instruction

This questionnaire designed to gather information about the impact of instructional materials on performance in number writing among pre-school children in Kamukunji District of Nairobi County. Strictly confidentiality is an assurance. Hence do not write your name or the name of the school. Please indicate the correct option as correctly and honestly as possible by putting a tick (√) on one of the options. Please respond to all the items.

Part A

1. What is your gender?
   a) Male ( )
   b) Female ( )
2. Indicate your age in years
   a) Below 20 years ( )
   b) 26-30 years ( )
   c) 31-40 years ( )
   d) 36-40 years ( )
   e) 41 and above ( )
3. What is your highest academic qualification?
   a) M.E.D ( )
   b) B/ED ( )
   c) Diploma ( )
   d) Certificate ( )

   Others _____

4. Indicate your teaching experience

   a) 1-5 years ( )

   b) 6 -10 years ( )

   c) 11-15 years ( )

   d) 16-20 years ( )

   e) 21 and above ( )

Part B

1. Record all instructional materials used in your pre-school in facilitating children's number writing skills;

   _____
   _____
   _____
   _____
   _____
   Etc

2. Which of the following activities do you use when enhancing writing skills in number work? Tick the ones you use

   a) Modeling ( )

   b) Number puzzle ( )

   c) Number cutting ( )

   d) Tracing (numbers) ( )

   e) Mosaic/collage ( )

   f) Colouring ( )

3. For each of the ticked activities above, how does it help the children in number writing

   _____

4. Do you improvise any instructional materials for number writing?

Yes ☐ No ☐

5. If yes, which materials and how do you use them to benefit the children in number writing?

_____

_____

6. Which errors do children normally make in number writing?

_____

_____

7. Explain the cause of the errors children make in number writing?

_____

_____

8. Do your children enjoy number work activities? Yes ☐ No ☐
9. If yes, what do you think contributes to their interest

_____

_____

10. Explain what can be done to eradicate number writing errors to enhance performance in number work.

_____

_____

11. Which concepts do children acquire in number writing activities

_____

_____

12. Have you attended any in-service course or workshop for the last five years?

    Yes ☐ No ☐

13. In case you attend any of the workshops what would you suggest the teachers should discuss involving number writing/number formation

    _____

    _____

14. What other challenges do you encounter when teaching number writing

    _____

    _____

15. What recommendations would you suggest to the following:

    a) Other teachers

       _____

       _____

    b) Head teachers

       _____

       _____

    c) Parents

       _____

       _____

    d) Policy makers

       _____

       _____

APPENDIX C

Pre-test performance in number writing control group

True class boundaries	Class intervals	Midpoint x	Frequency (f)	fx	x^2	fx^2
0.5-3.5	1-3	2	28	56	4	112
3.5-6.5	4-6	5	25	125	25	625
6.5-9.5	7-9	8	32	256	64	2048
9.5-12.5	10-12	11	8	88	121	968
12.5-15.5	13-15	14	5	70	196	980
15.5-18.5	16-18	17	1	17	289	289
18.5-21.5	19-21	20	1	20	400	400
			$\sum f=100$	$\sum fx = 632$		$\sum fx^2=5422$

Variance = $\sum fx^2 - \frac{(\sum fx)^2}{N=100}$ = $\frac{5422 - 3994.24}{99}$

$= \frac{1427.76}{99}$

$= 14.42$

Standard deviation $\sqrt{14.42} = 3.79$

APPENDIX E

Pre-test performance in number writing experimental group

True class boundaries	Class intervals	Midpoint x	Frequency (f)	fx	x^2	fx^2
0.5-3.5	1-3	2	26	52	4	104
3.5-6.5	4-6	5	29	145	25	725
6.5-9.5	7-9	8	31	248	64	1984
9.5-12.5	10-12	11	6	66	121	726
12.5-15.5	13-15	14	4	56	196	784
15.5-18.5	16-18	17	2	34	289	578
18.5-21.5	19-21	20	2	20	400	800
			$\sum f=100$	$\sum fx = 621$		$\sum fx^2=5701$

Variance = $\sum fx^2 - \frac{(\sum fx)^2}{N=100}$ = $\frac{5701 - 3856.41}{99}$

$\frac{}{N-1}$

= $\frac{1844.59}{99}$

= 18.63

Standard deviation $\sqrt{18.63}$ = 4.32

APPENDIX F

Post test performance control group

True class boundaries	Class intervals	Midpoint x	Frequency (f)	fx	x^2	fx^2
0.5-3.5	1-3	2	27	54	4	108
3.5-6.5	4-6	5	23	115	25	575
6.5-9.5	7-9	8	31	248	64	1984
9.5-12.5	10-12	11	9	77	121	1089
12.5-15.5	13-15	14	6	112	196	1176
15.5-18.5	16-18	17	1	17	289	289
18.5-21.5	19-21	20	3	60	400	1200
			$\sum f=100$	$\sum fx = 683$		$\sum fx^2=6421$

$$\text{Variance} = \frac{\sum fx^2 - \frac{(\sum fx)^2}{N=100}}{N-1} = \frac{64.21 - 4664.89}{99}$$

$$= \frac{1796.11}{99}$$

$$= 18.14$$

Standard deviation $\sqrt{18.14} = 4.23$

APPENDIX H

Post test performance experimental group

True class boundaries	Class intervals	Midpoint x	Frequency (f)	fx	x^2	fx^2
0.5-3.5	1-3	2	14	28	4	56
3.5-6.5	4-6	5	13	65	25	325
6.5-9.5	7-9	8	6	128	64	384
9.5-12.5	10-12	11	19	154	121	2299
12.5-15.5	13-15	14	30	350	196	5880
15.5-18.5	16-18	17	10	170	289	2890
18.5-21.5	19-21	20	8	80	400	3200
			$\sum f=100$	$\sum fx = 975$		$\sum fx^2=15034$

$$\text{Variance} = \frac{\sum fx^2 - \frac{(\sum fx)^2}{N=100}}{N-1} = \frac{15034 - 9506.25}{99}$$

$$= \frac{5527.75}{99}$$

$$= 7.50$$

Standard deviation $\sqrt{7.50} = 3.18$

Appendix I

Pre-test number reflection errors for both group

`

	Control group I			Experimental group	
No.	Frequency	No. of children	No.	Frequency	No. of children
1			1		
2	I	1	2		
3	II	2	3	II	2
4	II	2	4		
5	III	3	5		
6	II	2	6	II	2
7	~~𝍸~~ ~~𝍸~~ II	12	7	~~𝍸~~ II	7
8			8		
9	~~𝍸~~ IIII	10	9	~~𝍸~~ ~~𝍸~~ II	12
10	II	2	10		
11			11		
12	II	2	12	I	1
13	II	2	13	IIII	4
14	II	2	14	II	2
15	II	2	15		
16	II	2	16	III	3
17	~~𝍸~~	5	17	~~𝍸~~ I	6
18	~~𝍸~~I	5	18		
19	II	2	19	~~𝍸~~	5
20	II	2	20		
Total		58			46

APPENDIX J

Pre-test number omission errors for control and experimental group

	Control group			Experimental group	
No.	Frequency	No. of children	No.	Frequency	No. of children
1		0	1		
2	I	1	2		
3	II	2	3		
4	II	2	4		
5	II	2	5	III	3
6	IIII	4	6		
7	I	1	7		
8	II	2	8	~~IIII~~	5
9	II	2	9		
10	III	3	10	1	1
11	II	2	11		
12	III	3	12	I	1
13	~~IIII~~	5	13	II	2
14	~~IIII~~	5	14	~~IIII~~	5
15	~~IIII~~ I	6	15	~~IIII~~ IIII	9
16	III I	6	16	IIII	4
17	~~IIII~~	5	17	~~IIII~~ II	6
18	IIII	4	18	~~IIII~~ III	8
19	~~IIII~~	5	19	IIII	4
20	IIII	4	20		
Total		64			48

Appendix L

Questionnaire for head-teacher

Instructions

This questionnaire is designed to gather data about yourself and your school to be used in the study of impact of instructional materials on performance of number writing among pre-school children in Kamukunji District. Hence, do not write your name or your schools name.

Please indicate the correct option as correctly and honestly as possible by putting a tick (√) on one of the options. For this questions that require your own opinion, use the spaces provided. Kindly respond to all items.

PART A

1. Indicate your age in years
   a) Below 20 years ( )
   b) 20-30 years ( )
   c) 31-35 years ( )
   d) 36-40 years ( )
   e) 41and below ( )
2. What are your highest academic qualification?
   a) MED ( )
   b) B/ED ( )
   c) Diploma ( )
   d) Certificate ( )
   e) Trainee ( )

   Others _____

3. Indicate your professional experience as a head-teacher?
   a) 1-5 years ( )
   b) 6-10 years ( )
   c) 11-15 years ( )
   d) 16 and above ( )
4. How long have you been a head teacher in this school? _____years
5. What is the category of your school?

   Day ( )

   Boarding ( )

   Day/Boarding ( )
6. What is the total number of your pre-school children?
   a) 0-30 ( )
   b) 31-50 ( )
   c) 51-75 ( )
   d) 76-100 ( )

   Others _____
7. What are your teaching subjects? _____

Part B

1. What are the problems that interfere with good performance of your students in mathematics?

   _____

   _____

   _____

2. What are the possible solutions you have stated in question 1

   _____
   _____
   _____

3. Is there a mathematics panel in you school for the subject evaluation _____

4. If yes, what strategies do you have to improve this subject _____

   _____

5. Who provides material resources for your school?

   _____

   _____

6. Are there in-service course held in this zone involving preschool teachers?

   _____

   _____

7. If yes answer in Q 6 is yes how often? _____

8. What are the contributing factor for declining mathematics performance

   _____

   _____

Thank you very much for your cooperation

Appendix M
Pre test for preschool children

Answer all questions

1. Write numbers 1-10
2. Model numbers 1-10
3. Fill in the gaps

   1, 2, 3, 4, 5 __ __ 8 ___10
4. Trace numbers 1-20
5. Write the number missing

   ____ 12
6. Write the number 7 ___ ___

Tick the correct answer

7. Which material is used to colour numbers

   Tracing ☐
   Clay/plasticine ☐
   Potatoes ☐
   Crayons ☐
8. Which subject do you love most?

   Language ☐

   Number work ☐
9. Which activities in number writing do you love most

   Modeling ☐
   Tracing ☐
   Colouring ☐
10. Arrange these numbers in the correct sequence

    9, 4, 1, 7, 3, 2, 5, 6

APPENDIX N

Post test for pre-school children

LESSON 1

1. Write numbers 1-20 in a sequence
2. Fill the missing numbers 1, 2, 3, __, 5, 6, 7, 8, __, __

LESSON 2

1. Arrange these numbers in order sequence 6, 7, 8, 1, 4, 9, 10, 3, 5, 2
2. Fill the missing number
   a) ___ ___ 9
   b) 7 ___ ___
3. Match numbers with words

Two	5
Four	6
One	10
Six	1
Nine	4
Five	7
Ten	2
Seven	6

4. Plasticine/clay is used for
   - ☐ Colouring numbers
   - ☐ Modeling numbers
   - ☐ Tracing numbers

Appendix O: Research authorization

UNIVERSITY OF NAIROBI

COLLEGE OF EDUCATION & EXTERNAL STUDIES

SCHOOL OF EDUCATION

DEPARTMENT OF EDUCATIONAL COMMUNICATION & TECHNOLOGY

Telephone: 020-2500759, 020-2500760 P.O. BOX 30197, 00100 NAIROBI

020-2500762, 020-2460056 P.O. BOX 92, 00902 KIKUYU

20th May 2014

TO WHOM IT MAY CONCERN

RE: MUIRURI JANE NJERI REG No: – E57/79539/2012

This is to certify that Muiruri Jane Njeri Reg No: – E57/79539/12 is a bonafide student of the University of Nairobi, Department of Educational Communication and Technology. She is pursuing a course in M.Ed, Early Childhood Education. Her project Title is **"The Impact of Instructional Materials on Learning of Number Writing among Pre-school Children in Kamukunji District of Nairobi County."**

Any assistance accorded to her will be highly appreciated.

Yours faithfully,

UNIVERSITY OF NAIROBI
ASS. DEAN
SCHOOL OF EDUCATION
20 MAY 2014
P. O. Box 92 KIKUYU

DR. Paul A. Odundo
CHAIRMAN, DEPARTMENT OF EDUCATIONAL COMMUNICATION AND TECHNOLOGY

Appendix P: Permit from DEO Kamukunji District

MINISTRY OF EDUCATION

Telegrams: "LEARNING"
Telephone: 0722574317
Fax
When replying please quote
REF. KMKJ/GEN/VOL 111/778

DISTRICT EDUCATION OFFICE
KAMUKUNJI DISTRICT
P.O BOX 74629
NAIROBI

3rd SEPTEMBER 2014

National Council for Science and Technology

P.O Box 30623-00100

NAIROBI

RE: RESEARCH AUTHORIZATION FOR MUIRURI JANE NJERI TSC 141194

The above named is a teacher currently on duty at Moi Airbase Primary School. She is taking a course at the University of Nairobi and therefore needs authorization as per regulations. The relevant documents are attached.

JAMES M ONGATI
DISTRICT EDUCATION OFFICER
KAMUKUNJI DISTRICT

CC

COUNTY DIRECTOR OF EDUCATION

COUNTY DIRECTOR TSC