# A STUDY OF PRE-SCHOOL CHILDREN'S COMPREHENSION OF SOME MATHEMATICAL CONCEPTS IN NAIROBI, KENYA

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BY

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## DECLARATION

"This thesis is my original work and has not been presented for a degree in any other university."

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"This thesis has been submitted for examination with my approval as university supervisor."

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# ACKNOWLEDGEMENT

This thesis reports the findings of a study in which four hundred children of the age range four to six years from nine day nurseries and five pre-schools in Nairobi City participated. The researcher is indebted to the Nairobi City Council for their permission to conduct the study in schools administered by them and to the headmasters, headmistresses and teachers of these schools who provided time and space for testing the children and created a suitable working atmosphere.

Many thanks go to my supervisor, Dr. G. S. Eshiwani, whose suggestions and comments were most valuable particularly during the early stages of planning the strategy for conducting this study, and to J. M. Igaga whose advise on how to handle the little children proved very useful. W. Young and Scot Wallace's invaluable assistance in the statistical analysis is most appreciated.

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# ABSTRACT


A Study of Pre-School Children's Comprehension of Some Mathematical concepts.

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## 1. Purpose

To determine to what extent children of the age range four to six years comprehend the mathematical concepts of classification, number, vocabulary and visual memory. To investigate the hypotheses that there are no differences in understanding of mathematical concepts between children:-

a) attending High Cost (HC), Medium Cost (MC), and Low Cost (LC) schools;

b) of different age groups - 4, 5 and 6 years.

c) of different sexes.

To determine the relationships between concepts in the main areas of operation.

## 2. Rationale

A child begins to learn the day he is born. Starting from scratch, what he learns in his first seven years is the foundation for all his later learning. Children who join pre-school institutions have already had mathematical experiences outside of school. If school should be continuous learning situation, the mathematical experiences should be continued, and pre-school teachers can enjoy extending the mathematical concepts that children already have as well as introducing new concepts that the children can easily understand depending on their stage of development. The teacher must know the abilities

of the children she has to teach so that she can build an appropriate instructional programme.

Pre-school education and its instructional program are receiving increased attention all over the world. Kenya, in her attempt to keep up with modernisation and educational change, has realised the need for planned pre-school education. Recently, at the Kenya Insitute of Education Pre-School Section, a long waited for curriculum guide was published. Its usefulness, however, is yet to be evaluated. In Kenya, research findings have yet to show what mathematics our pre-school children comprehend so that instructional programmes and curriculum can be based on what is known of our own Kenya children.

3. Research Design and Procedure

The sample consisted of 400 children drawn from 9 Day Nurseries and 5 Primary Schools with pre-schools attached to them. All these schools are administered by the Nairobi City Council. Children from the Low Cost schools were 213 while 87 were from Medium Cost Schools and 100 from High Cost Schools, 120 children were 4 years old, 138 were 5 years old and 142 were 6 years old.

The method of stratified random sampling was used to select children from different types of schools and different age groups.

The children were tested individually using some standardised (for U.S.A.) test batteries for kindergarten children but modified to suit Nairobi children. The children were required to respond, in most tasks, to concrete materials. A pilot study to test the appropriateness of the scales to be used in the main study and to try out the materials selected was done in December, 1976. Final testing was done in January, February and March, 1977, with the help of assistants trained by the author.

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4. Findings

Nairobi children displayed poor knowledge of names of colours and shapes and pre-measurement vocabulary. Knowledge of these was necessary in the classification tasks.

In counting, the task became increasingly difficult as the children dealt with numbers larger than five. Ordinal numbers, writing numerals and conservation of number were some of the most difficult of the number concepts.

Differences in comprehension of mathematical concepts between children from different types of schools were found. Children attending the HC schools did better than those attending the MC schools who in turn did better than those in the LC shcools. The ANOVA and the difference between means tests were used for this.

The regression analysis revealed age differences. The older the child, the better was his or her comprehension of mathematical concepts.

No differences due to sex were found.

Classification, number, visual memory and vocabulary were found to be positively highly correlated.

## 5. Interpretation

The researcher concluded that there was great need for compulsory, standardised pre-schools education in the City of Nairobi. The curriculum should include pre-mathematics readiness activities which are played as games with an emphasis on pre-mathematics vocabulary. The study indicated that there are many school related experiences that many children do not master in their home environments, particularly, those children with more limiting home backgrounds without manipulative objects, books, writing materials or parental guidance on school oriented experiences.

The findings of this study indicate that the differences observed in the number of children who are admitted to secondary schools from the HC, MC and LC Primary Schools begin right from pre-school level. The effects of differential educational provision both at home and/or in school on the future Kenyan society should be urgently explored.

The language policy within the city pre-schools and primary schools needs reviewing. A test, like the one used in this study that uses the official medium of instruction rather than the children's mother tongue, reveals the weakness of a policy that is not enforced.

## TABLE OF CONTENTS

# LIST OF TABLES

# CHAPTER ONE

## 1.0 INTRODUCTION

Long before the advent of formal education brought into this country by the early missionaries in the second half of the 19th Century, the Kenyan children, all rural then, knew some mathematical concepts. In the communal grazing areas, the African boy was taught to recognise his herd not by counting but by size, colour, shape and name. In the forest, he could classify edible, non-edible and poisonous fruits, roots and leaves. He could identify plants through smell, colour, size and shape of flowers, leaves, branches and stems. He learnt to tell the time by looking at the position of the sun in the horizon so that he would know the best time to open the kraals and let his herd out. By looking at the size of his shadow, he would know when to take his animals to the river at midday and the best time and speed to take them home and reach there before sunset. Spatial orientation was very well developed. A boy could find his way in the forest where an European would need a compass.

At home, the girl learnt the right quantities of food to cook for the family and add a little for the unexpected guest or stranger. She could measure using various sizes of calabashes. In a pot of food, she had to carefully measure the right quantities of maize and beans, and later on add the right quantities of bananas and vegetables to make a well balanced mixture. Among the wild vegetables, she could classify the edible from the non-edible ones. She learnt to estimate the volume of water consumed in the home by the various sizes of gourds. She could estimate the amount of firewood needed in her home per day or even per week by different sizes of loads. She could tell the time by looking at the sun and the size and direction of her shadow.

Many games and incidences where counting was used were common, but it was taboo to count people or animals. Memory was very important and nothing was written. Recall and recognition by children was often informally tested by the father and/or the mother. A child who could not commit large amounts of information to memory was likely to be looked upon as mentally deficient in some way.

To-day, a large part of this education has disappeared, for it obviously has lost relevance in a world so different from the African past. The society and its values have changed. Those living in urban areas have a completely different environment from the old rather closed environment where members of the same clan and tribe lived together. Their education was geared to conserve the cultural heritage of the family, clan and tribe, and to adapt children to their physical environment. It prepared children for life with a clear understanding of their responsibilities as members of their community. To-day's education, among other things, aims "to provide for the child in the early years of schooling a balanced and co-ordinated education experience made up of the development of communication skills, the acquisition of literacy, numeracy and manual dexterity, sense-training, individual training in self-expression and self-control, and social training"[1]. The new and the old aims of education are not mutually exclusive. They are all preparing children for life, but with different emphasis.

What mathematical concepts the Kenyan urban children in Nairobi possess can best be discovered through testing for it is only through test performances that teachers can ascertain the children's ability to reach particular instructional objectives that the teacher will have prepared. Proper organisation of the instructional procedures may be impossible without knowledge of the "entering behaviour" as Glacer's (1962)[2] basic teaching model shows. This entering behaviour describes the child's level before instruction begins. It refers to what he has previously learned, his intellectual ability and development, his motivational state, and certain social and cultural determinants of his learning ability, all of which are interrelated and interdependent. Tests bring about a closer scrutiny of what is generally accepted by curriculum developers

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1. Kenya syllabus of Primary Schools: Ministry of Education, Nairobi. 1975, p.x.

2. Glacer, R. ed. Psychology and Instructional Technology in Training Research and Education, Pittsburg: University of Pittsburg Press, (1962). pp.1-30.

and teachers as normal number, classification, vocabulary and visual memory knowledge at the pre-school and standard one level by revealing areas of strength and weakness. This is absolutely essential so that the planned instruction may be based realistically on the knowledges and needs of the children. The teachers can then allocate the correct amount of time for learning a concept in a particular situation. Inattention to this variable usually results in too little time being allotted to learning various tasks and in too much material being presented too fast. The quality of instruction, that is, the degree to which the instruction is organised so that it is easily acquired by the child, will depend on the teacher's adaptation to the special needs and charateristics of the children who the teacher must be able to understand.

Children start learning at the time of birth. They develop at different rates in different areas depending on their innate ability and the environment in which they are brought up. Since teachers teaching these children do not start from scratch, the best pedagogy, then, is to find out what these children know in certain identified areas, in the case of this study, in their comprehension of mathematical concepts, and then teachers can enjoy enlarging on what these children know. Their knowledge can be used to develop other new but related experiences.

## 1.1 PURPOSES OF THE STUDY

The primary purpose of this study is to find out what mathematics Kenyan pre-school children in Nairobi know. Since not all aspects of mathematics can be tested within the short time available, some mathematical concepts are identified in four main areas: Classification, Number, Vocabulary and Visual Memory.

Once the mathematical concepts known by the pre-school children in Nairobi are confirmed, various statistical tests are done on them to show, among other things, whether or not there are differences in comprehension of mathematical concepts between

1. Children of the age range 4 to 6 years;
2. Children from different categories of schools;
3. Boys and girls of pre-school age;
4. The relationship between various tasks.

## 1.2 DEFINITION OF IMPORTANT TERMS:

### 1) Pre-School:

Pre-primary education is a term which includes a range of infant institutions. The more specific labels used in Nairobi and other urban centres are: 'day nursery',' 'kindergarten,' and 'pre-school'. Similar institutions in rural districts are commonly known as 'day care centres.' In this study, the terms 'pre-school' and 'nursery school' are occassionally used to mean pre-primary education in general. There is not an overall body to manage, develop and supervise pre-school education. Pre-schools in Nairobi are owned by the City administration, individual entrepreneurs, self-help committees, church and welfare organisations. The City Council day nurseries are under the Department of Health. While the pre-schools - the pre-primary classes attached to a few primary schools - are under the Department of Education. The self-help nurseries are administered by parents' committees but are supervised by the Department of Social Services within the City administration. Nearly all of the proprietary day nurseries are Asian and European owned and managed.

2) Types of Schools:

There are three different types of schools in Nairobi both at pre-school and primary school level. Among the 15 day nurseries run by the Nairobi City Council,

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | "High Cost" schools | charge | K.shs.250 | per | month | per | child. |
| 4 | "Middle Cost" " | " | K.shs.200 | " | " | " | " |
| 8 | "Low Cost" " | " | K.shs. 75 | " | " | " | " |

The day nurseries are much more expensive than the primary schools. There are 78 primary Schols run by the Nairobi City Council. An earlier categorisation (1969), which is now not popular, had categorised them into three groups.

'C' schools, formerly for European children only, were and still are "High Cost", charging K.shs.597 per year per child.

'B' schools, formerly for Asian children only, were and still are "Medium Cost" charging K.shs.160 per year per child.

'A' schools, formerly for African children only, were and still are "Low Cost", charging K.shs.60 per year per child.

## 1.3 STATEMENT OF THE PROBLEM:

Several questions arise from the introductory part where one wonders what mathematical concepts the Kenya pre-school children in Nairobi know. The author sees herself as a standard one teacher who, at the beginning of the year, starts wondering what sort of children she is going to have in her class. She secretly worries about many things that she can find no solution to, unless studies at pre-school level are increased. Some of the questions that bother her are:

1. What mathematical concepts do these children know or do not know so that I can plan my work accordingly?
2. How far has their language developed so that I can begin academic instruction through a language that they understand because there is no provision in the mathematics syllabus for me to teach the language related to mathematical concepts?
3. Have they had any experiences fostering development of the muscles and co-ordination of eyes and hand movements so that they are physically and mentally fit?
4. How good is their visual perception so that they can see and differentiate objects in their environment which would help in the classificatory exercises of the "New Maths" curriculum?
5. What mathematical experiences have they been or not been exposed to so that I can bridge the gap between pre-school and school experiences by trying to understand their backgrounds and where necessary compensate for what seems to be lacking?

6. How can I make mathematics interesting so that in the course of orienting children to school life, I can create a favourable impression of learning mathematics and generally create a favourable impression of the school?

7. Can these children conserve numerousness, length, mass and weight to be able to cope with the exercises prepared in their syllabus?

8. Are their differences in age going to affect their understanding of mathematical concepts?

9. Which are their weakest areas? Are they in classification, number, vocabulary or in visual memory?

10. What is the significance of language in their understanding of classification, number and visual memory?

11. Is the learning of one area related to the learning of the other area, for example, does the learning of classification aid the learning of number etc.?

12. Do different experiences both in their homes and in their pre-schools affect their understanding of mathematical concepts?

13. Since I expect these children to remember objects and pictures which I will be showing them, how good is their visual memory?

14. Do past experiences influence classification, number, vocabulary and visual memory? In which particular areas would children from different socio-economic groups be poor in so that I can give emphasis to bridge any gaps that may be existing between the children's comprehension of mathematical concepts?

## 1.4 RESEARCH QUESTIONS:

Not all questions just raised could be tested on. These were narrowed down to a few specific research questions that can be statistically tested, bearing in mind the purposes of the study mentioned.

These include:

1. Is there any difference in comprehension of mathematical concepts between children from different types of schools judging from their total scores in the test batteries?

2. If there are any differences in comprehension of mathematical concepts between pre-school children from different types of schools, are such differences found in

   a) Classification
   b) Number
   c) Vocabulary
   d) Visual Memory

Various studies done in the west and reported in chapter two show clear differences in understanding of mathematical concepts between children from medium and low or high and low socio-economic groups. In Nairobi, three categories of schools exist - high, medium and low cost. Whether or not differences in comprehension of mathematical concepts exist between pre-school children from these three categories of schools is of interest in this study.

3. Is there any difference in the mathematical concepts acquired by children in the age range 4 to 6 years?

4. If there are any differences in the mathematical concepts acquired by children in the age range 4 to 6 years, are these differences found in

   a) Classification

   b) Number

   c) Vocabulary

   d) Visual Memory

Piaget, in his studies on children's intellectual development, advocates that children's comprehension of concepts is largely governed by age. This conclusion is supported by many studies done in the western countries and in many cross-cultural studies some of which are reported in chapter two. None of such studies have been done in Nairobi. It would be interesting to find out whether Nairobi children follow the same pattern as has been found in the western and other countries.

5. Is there any difference in comprehension of mathematical concepts between girls and boys of pre-school age?

6. Are the differences found in

   a) Classification

   b) Number

   c) Vocabulary

   d) Visual Memory

Most studies on sex differences at these early ages do not show any significant sex differences. Whether this is true of Kenyan`children in Nairobi and their comprehension of mathematical concepts is of interest in this study.

7. Is there any difference between counting beans and counting members of a given set?
   Here, the interest is whether it is easier to count a fixed number of pictures than to count a certain number of beans from a larger heap.

8. Is there any difference in visual memory between objects and pictures?
   It would be interesting to find out which of the two visual aids is better remembered.

9. Is there any correlation between children's performance in the total score and
   a) Classification
   b) Number
   c) Vocabulary
   d) Visual Memory

The extent to which the scoring of one type of task affects the total score of all the variables is of importance at this pre-school level of education.

10. Is there any correlation between comprehension of classification skills and
    a) Number
    b) Vocabulary
    c) Visual Memory

11. Is there any correlation between comprehension of number skills and

    a) Vocabulary

    b) Visual Memory

12. Is there any correlation between comprehension of vocabulary and visual memory?

    The above three questions deal with relationships between variables. It would be interesting to find out the strength of their relationship. Categorisation of subjects at the pre-school level is impracticable and the interdependence of subjects is much more than in later years of primary school.

13. Is there any correlation between

    a) writing and identifying numerals

    b) naming and identifying colours

    c) naming and identifying shapes

    d) rote counting and counting of beans and pictures

If the above are highly related, it may be a good idea to deal with them together at pre-school level, for example, identify a number and learn to write it.

14. Is there any correlation between vocabulary skills and non-vocabulary skills?

    The role that language plays in the comprehension of the mathematical concepts in the test is of interest in this study. If there is a correlation between vocabulary and the non-vocabulary mathematical concepts, then the language of the test will have influenced the overall performance.

15. Is there any difference in conservation of number between children of 4, 5 and 6 years?
In the various cross-cultural studies done in Africa and in western countries, conservation of number has been found to be a function of age. The researcher would like to know whether or not this is true of Nairobi children.

16. Are the observations in classification and number similar to Piaget's and other Piagetian researches' observations of children at the pre-operational level? If they do agree, this study will contribute to the universality of children's behaviour at this stage and in the skills tested on.

## 1.5 SIGNIFICANCE OF THE PROBLEM:

After many years with little change in mathematics curriculum in schools, Kenya, like the rest of the world, finds herself in an era of "new maths", typified by the acquisition of concepts. Revolutionary changes have, consequently, taken place in mathematics programme in primary and secondary schools and also in Teacher Training Colleges, mainly in the content and methods used. In Teacher Training Colleges, the new requirements for student trainees demand a credit in mathematics and one science subject. Many colleges of science and technology have been initiated all over the provinces of Kenya because of the urgent need for engineers, technicians and middle level skilled manpower. Parents, politicians, "educators are awake to the fact that our world of to-day rests on science and science rests on mathematics

.......... so, a complete understanding of fundamental mathematical concepts is vitally important for your child". (Kunz, 1970)[1]. People have discovered the intellectual powers in children, which are seen as determined in a far-reaching way by early learning processes. They are searching for the possibilities of a better development of children's intellectual gifts in the pre-school years.

In Kenya, pre-schools are popular institutions, and demand for them is increasingly growing. In 1966 in Kenya, there were 2,000 centres registered accommodating 66,000 children. In 1968, there were 4,600 centres with 175,000 children. In Nairobi alone, there are about 200 pre-schools compared to 165 in 1968 and less than 40 in 1960[2]. These centres in Nairobi accommodate nearly 20,000 children. Kenya's rate of population growth is one of the highest in the world. As the population increases, so does the need and competition for better education. Parents, just as much as teachers, are concerned about what their children learn right from pre-school level. But a controversy over the content and pedagogy at pre-school level exists between parents on one side and teachers and curriculum developers on the other side.

In 1973, a questionnaire was given to heads of various pre-schools in Nairobi - church organisations, self-help nurseries, private entrepreneurs and the Nairobi City Council

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1. Kunz J. Modern Mathematics Made Meaningful, (Cuisenaire Company of America, Inc., 1970) p.7.

2. J.D. Herzog, A Survey of Parents of Nursery Centre Children in four Communities in Kenya, (University of East Africa, Social Science Conference, Nairobi, 1969).

(N.C.C.) by the Pre-School Project at the Kenya Institute of Education (K.I.E.)[1]. They were given a list of 12 possible objectives, which included some skill goals as well as readiness and adjustment goals. They were asked to arrange them in order of importance, in order to show their views about the important objectives in pre-schools. The heads of schools were also asked to rank the same objectives the way they think, from their experience, the parents would rank them.

While the head of nursery schools emphasise the readiness and adjustments goals, the heads saw parents as interested in getting their children to acquire skills like reading and doing sums. Probably these parents viewed these skills as the most impurtant from the academic point of view. Similar results had been obtained in an earlier study by Herzog (1969)[2] in which most parents reported that they send their children to the nursery school to be better prepared for later eduction. A compromise between what teachers and parents want done at pre-school level can be reached through studies, like the present one, which shows what children at this pre-school level are capable of understanding in the way of mathematics. Once this is ascertained, a well planned curriculum should be developed and carefully and systematically carried out and supervised so that it can be challenging and stimulating, thus laying good foundation for later school life. A thousand mile journey begins with the first step, says an old Chinese proverb.

1. Kabiru, M. "A Survey of Characteristics of Nursery Schools in Nairobi," Pre-School Education Project, K.I.E., 1973 (mimeo).

2. J.D. Herzog, 1969. Ibid.

Good nursery education helps a child to take his first step in the journey through his school life with pleasure and confidence and so prepares him for the world.

Pre-school education can be a good preparation for the Primary School. A child who has benefitted from such an opportunity passes on to standard one ready and eager to accept the challenge of learning, generally. He has harmony and rhythm in his movements, is happy and confident in himself, is mentally alert and has spontaneous creative ability. Such a child will undoubtedly feel secure in his relationship with other people, both in the family and in the larger group outside his house. This feeling of security is an essential factor in his development.

In Kenya today, at the beginning of standard one, no account has been taken of pre-mathematical experiences previously exposed to children so that the teacher has absolutely no idea as to what mathematics these children know. The teacher has a well laid out mathematics syllabus - the Kenya Primary Mathematics (KPM) Book one. All children have to use this book, irrespective of their background experiences. In this book, the first chapter is on sets. This seems to assume children have had classification experiences. The chapter on number assumes children can count and conserve numerousness to be able to understand the meaning of numbers. Geometry begins in unit three with ideas of straight and curved lines. Many authorities on children's intellectual development, like Piaget, suggest these should not come before three dimensional figures as children's first notions in geometry are topological rather than Euclidean or projective ideas. The addition and subtraction of numbers assume children have already developed reversibility of thought to be able to comprehend meaningfully such computations. Fractions assume children posses knowledge of parts of a whole. Measurement exercises assume children can understand pre-measurement concepts and can conserve length distance and mass. All this shows what is generally accepted as normal mathematical knowledge by curriculum planners for children at the beginning of standard one class. To crown all, the teachers' as well as the pupils' books are written in English, a foreign language, and one that about 90% of Kenya's children hear for the first time in school.

A child, introduced too soon to number work, is likely to find himself in an entirely frustrating situation. If he has the minimal understanding of numeracy, he will be confused and dismayed by the signs and symbols. Since it is during these formative years that a child discovers what learning is all about, whether or not he likes it, and if he does not develop a healthy attitude towards learning now, he may probably always dislike school and have serious academic problems, it is important for the teacher to determine the concept to be learnt, then find out the child's comprehension of the concept and in this way determine the stage in the growth of understanding the child is in and then plan her instruction accordingly. According to Ausubel (1968)[1], the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly. This study will show the level of comprehension of some mathematical concepts that Kenyan children in Nairobi are in.

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1. Ausubel, D.P. "Facilitating Meaningful Verbal Learning in the Classroom". The Arithmetic Teacher Vol.15, No.2 (1968).

Kenyan children in Nairobi experience differential provisions both at home and in pre-schools. Children living in over-crowded and shared homes, with an incidence of frequent removing, poor health attributable to housing conditions and unbalanced diets, absence of manipulative objects and books in the home and an inadequate motivation towards schools, learning and educational achievement, have a more retricted academic life prior to joining school than those who live in more spacious area of the city, with proper family units and more closer family ties and adequate provisions of the basic needs of life. Pre-schools, like the homes, differ in the fees charged and in the consequent provision of materials and services offered. This study will show whether these differences in children's backgrounds are reflected in their comprehension of some mathematical concepts.

Generally in Nairobi, pre-schools and primary schools are neighbourhood institutions. The cheap pre-schools and primary schools are largely situated in low income communities living in the low cost residential areas of the city. The medium and high cost schools are situated in medium and high cost residential areas respectively. Gakuru (1976)[1] found out that children from low cost pre-schools attend low cost primary schools and those from high cost pre-schools attend high cost primary schools. The low cost primary schools do not do as well as the high cost primary schools in the Certificate of Primary Education (CPE)[2] Examination.

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1. Gakuru, O.N. "Pre-primary Education in Kenya" Institute of Development Studies, Nairobi, 1976

2. Certificate of Primary Education (CPE) Examination is done by all Kenyan children at the end of the 7th year of Primary Education. It consists of 3 papers all of which are examined in English and carry equal weight. These are English, Mathematics and General Paper which consists of Geography, History, Science and Civics.

According to the International Labour Report (1972)[1], the mean difference between the high and the low cost school passes "is well over one standard deviation". A very small percentage (just under 29%) of children from low cost primary schools secure a place in secondary schools. About a half come from medium cost schools while more than three quarters of children from high cost primary schools secure a place in secondary schools. This can easily be explained in table 1 below.

Table 1 : Percentage of Children Admitted to Secondary Schools in the last six years from different categories of schools in Nairobi[2]

| Year | High Cost | Medium Cost | Low Cost |
|---|---|---|---|
| 1971 | 61.1 | 49.1 | 18.1 |
| 1972 | 87.8 | 46.3 | 22.2 |
| 1973 | 92.0 | 53.1 | 24.0 |
| 1974 | 91.6 | 55.3 | 30.0 |
| 1975 | 77.4 | 68.5 | 28.2 |
| 1976 | 65.5 | 44.3 | 16.9 |
| Average % | 79.2 | 52.8 | 23.2 |

This study is significant in that it can show whether difference actually start at pre-school level or not and if they do, this should highlight the problem that the Nairobi education system could be creating educational differentiation whose effects are felt right from pre-school through the Primary school and CPE and indeed, throughout life.

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1. <u>Employment, Icomes and Equality - a strategy for increasing productive employment in Kenya.</u> International Labour Organization (ILO), 1972, p.523.

2. Information obtained from the City Education Officer's Yearly Reports - author added up figures.

Such differences in secondary schools admissions where children from the low cost schools have the lowest number of children admitted, the differences in pre-school provisions and experiences both at home and in the pre-schools, and an effort to strike a balance between what teachers feel should be taught to children at this level and what parents feel their children ought to be taught, call for an investigation of what mathematical concepts these pre-school children possess. Kenya has, in the past, tended to copy curriculum from western countries without ascertaining at what level our Kenyan children operate in various areas. In this study, four basic areas of operation have been identified and questions set so that the responses given by Nairobi children can help in the assessment of their operational levels. The basic mathematical concepts that have been identified are; classification, number, vocabulary and visual memory. An attempt to describe the significance of these concepts for pre-school children is made.

Classification

As children explore the world in which they live, they learn to recognize and name the various objects they see. Among the first objects recognized, for example, are mother and these days in Kenya, the feeding bottle. Later, other objects are pointed out and named, such as cup, spoon, cat, dog, cow, sheep, house, tree etc. These objects are recognized on the basis of certain physical properties, such as colour, size, shape or certain patterns of behaviour. In being able to recognize an object, the child has classified it into a certain category different from the many other objects, based on certain unique charateristics or properties.

The study of the physical world (science) becomes one of classification. As new objects are discovered, they must be sorted and classified in relation to the objects already discovered. The logical conclusions of sorting and classifying is sets (Frobisher and Gloyn, 1969). [I.] The idea of a set is fundamental in mathematics. Classification, then, is the main tool for correct learning of modern mathematics, particularly, at the pre-operational level. Ability to classify, as various cross-cultural studies have shown, depends on age. It is hoped that differences in this ability will be observed among the Kenyan children of different ages in Nairobi .

Number

Number is an idea or abstration and not an object in the physical world, but it does need a physical framework in which to develop for children. It is from the world of number that people can use the idea to describe relationships between objects in the physical world, for example - two cats, two trees, two sweets. Two is a property common in the three sets of, otherwise unrelated objects. Matching and one-to-one correspondence precedes and is basic to counting. Children learn to count by imitating an ordered pattern of words. However, unless the teacher makes it very obvious, it can happen that some children may not realise that each number name refers to a set of that many things, not the single object he may be looking at. This can be overcome by the physical manipulation of objects during counting. However,

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I. Frobisher, B. and Gloyn, S. Infants Learn Mathematicas, A Book for Teachers, (Duxford C of E School, Cambridgeshire and Isle of Ely, Ward Lock Educational 1969).

unless a child can conserve numerousness, computation using symbols has no meaning to him. Siegel and Hooper (1968)[1] defined conservation as "the cognition that certain properties (quantity, number etc.) remain invariant (are conserved) in the face of certain transformations". This process is considered by Piaget (1962)[2] as "a necessary condition for all rational activity". The author has selected number tasks in the proposed study because of their significance in understanding mathematics and because number tasks have been misused and misapplied in some pre-schools completely disregarding the children's ability which is largely governed by, among other things, age.

Vocabulary

The pre-number stage of mathematics is largely concerned with language. As relationships of size, quantity and position play such an early and important part in mathematics, a more precise understanding of words describing these relationships is necessary. These can be introduced during the many experiences with concrete materials that children should be exposed to. The language of mathematics employs carefully chosen terms that lack redundancy. Mathematical statements which share statements in everyday language should be used to show the relevance of mathematics in ordinary play. The author selected certain words in the mathematical vocabulary because they are basic to

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1. Siegel, I.E. and Hooper, F.H. Logical Thinking in Children, Research based a Piaget's Theory. (Holt, Rinehart and Winston, Inc.1968), pp.ix and 295 - 296.

2. Piaget, J. The Child's Conception of Number, (London. Routledge and Kegan Paul, 1952), p.viii.

understanding mathematical concepts. Constant use of such words is imperative particularly in Kenya where English is the official medium of instruction for all levels of school and yet it is not the mother tongue of African children being studied.

Visual Memory

Memorizing things is not new to the African child as it was the only way learning could be tested since the African languages were not written. Traditionally, both visual and verbal memory were very important. The child was expected to recall much of the information imparted to him during the everyday activities and play when teaching took place. A boy way expected to learn the names of the wild plants, roots and fruits and their uses. Animals in the herd were not counted but the boy was expected to recognize them by names and appearances. The girl had to know the grains and the edible wild vegetables and fruits to be able to prepare a meal for the family in the absence of the mother. History of the tribe and clan, its traditions, ancestors, taboos and heroes had to be learnt. History was so much a part of many traditional societies that someone who could not commit large amounts of information to memory was likely to be looked upon as mentally deficient in some way. In Kenyan Primary Schools to-day, retention is mainly tested through recall and recognition. Tasks on short term visual memory have been selected to show how much children recall familiar objects and pictures a few seconds after viewing them. If recall fails, recognition is then tested. If remembering is better with visual objects than visual pictures, a recommendation that real objects should be used as far as possible in teaching young ones will be made.

## 1.6 LIMITATIONS OF THE STUDY

Limitations on the choice of schools:

In Nairobi, there is no overall body to manage, develop or supervise pre-school education. 15 Day Nurseries accommodating 1,118 children and 13 Pre-schools accommodating 563 children are under the Nairobi City Council. There are 70 Self-Help nurseries accommodating 5,105 children while there are 107 Private nurseries accommodating 7,423 children. Except in the nurseries managed by the Nairobi City Council, all the others, differ, among other things, in the quality of teachers employed, buildings and school equipment. The Self-Help nurseries mainly cater for the many children whose parents cannot afford the lowest fee charged by the City Council while the Private nurseries, generally, cater for children whose parents can afford exorbitant fees which are more than the highest fees the City Council charges. These latter two groups seem to consist of children from two extreme economic and most likely social groups as well. To avoid any bias, only children attending the City Council Schools were tested in this study. Nairobi is an international city with children from all over the world. Home backgrounds and experiences differ. For this reason, only Kenyan African children were selected.

Limitations on the mathematical concepts to be examined:

Only some mathematical concepts are tested on in view of the limited time available for research. A longer test would also be difficult to administer because little children get tired and fed up of something much faster than grown ups.

Limitations on the times available for testing:

Although the Nairobi City Council Pre-schools operate the whole day, full day children sleep in the afternoon which limited the testing times to mornings only. Very few children were co-operative in the tests after their siesta and before they go home in the evening.

Limitations on the language of test:

English is the medium of instruction in all city schools. The test was, therefore, written and administered in English. This proved difficult in most cases where children could not understand the directions given in English. This made some children give up too easily and this may depress the results. 'Performance' in English may be more related to school, but may not reflect 'competence'. With such young children, mother tongue would, perhaps, have been more appropriate.

Limitations on methods and procedure of testing:

Although in the directions on the test to the testers, they are asked to treat the tests as games and to put in a word of encouragement here and there and generally adopt a positive attitude, the testers' enthusiasm, competence and general personality in the way they handled the children and the materials could influence the little children's performance in the test.

Limitation on the choice of the subjects:

No intelligence test was administered prior to the test on mathematical concepts. Any children who were of the required age were randomly selected. This means children of different levels of intelligence, although of the same age, were subjected to the same test under the same conditions.

Limitations on division of children into socio-economic groups

The assumption that children attending high cost, medium cost and low cost schools come from high, medium and low socio-economic status, respectively, brings doubts as to whether this is the best division of children into socio-economic groups. A questionaire given at the beginning of the test did not prove very useful in aiding the categorisation of children into socio-economic groups, particularly because although the children could reasonably say whether their fathers and/or mothers worked or not, many had no idea what work or even positions their parents held. It was, therefore, impossible to categorise children by any other means, but the schools they attended, which were already categorised. Perhaps with more time and funds available, a questionaire and/or interview with the parents would have helped in categorising professional/managerial parents, clerical/skilled parents and semi and unskilled parents as was done in the study by Povey and Hill reported in chapter two.

Limitations on availability of related literature:

The absence of local research studies relevant to the present one and the brevity of most studies done in other countries was a major constraint. A study done by Ruth Beard (1957) on mathematical concepts possessed by pre-school children was ordered through the university library in June, 1976, but had not arrived at the time of writing, just over one year after the order had been placed.

## 1.7 VARIABLES CONSIDERED

1. The dependent variable in this study is the comprehension of mathematical concepts as revealed by the scores on the tests.

2. The independent variables in this study are

   (a) Pre-school preparation - for some, this is both at home and in the pre-school, for others, it is home preparation alone.

   (b) Age - the children tested in this study are of three age groups 4,5 and 6 years. Piaget and others say that education is confined by the children's developmental sequence. Their maturation stage is, therefore, important in their cognitive development.

   (c) Sex of children - although no major differences have been found in cognitive development between boys and girls, their general behaviour, for example, their attitude to the testers who are all women might have an influence on their performance.

   (f) Different types of schools - the children tested come from three categories of schools, high cost, medium cost and low cost schools. These schools offer different experiences, the quality of which depends on the amount of fees charged.

3. Extraneous variables:

(a) There are some uncontrollable variables that may have a significant influence upon the dependent variable, as mentioned in the limitations. These include the testers' competence and enthusiasm both in handling the test materials and the children, the children's pre-school preparation, and their attitude towards the testers.

(b) Language of test – English – the test was so designed so that children manipulate objects to produce the desired results. Verbal responses are very few. The test directions are brief but in certain cases, where a game has to be explained, long verbal directions are inevitable. Those who do not understand the game instructions may not respond, just because of the language. In the absence of any other language to be used in the testing, such children may not score marks in such items whereas they might have understood the game if explained in a language they understand.

(c) Intelligence – children differ in their measurable intelligence. This could have an effect on their performance in the test.

## 1.8 THE DATA GATHERING INSTRUMENT:

A number of test batteries were prepared to investigate concepts possessed by Kenya children of ages 4 – 6 years in Nairobi. They are standardised tests for U.S.A. prepared by the School Mathematics Study Group (SMSG), U.S.A. but changed a little to suit Kenya children, as far as possible, in Nairobi. The tests are reproduced in Appendix II.

The test batteries included items on classification, number concepts, vocabulary and visual memory.

Classification Subtests

Twenty four items were on matching, naming and identifying geometric shapes - circles, squares, triangles and rectangles; and colours - green, blue, orange, brown, red, yellow and black. The matching items required the child to point to the shape or the colour in his set that was like the one the tester was pointing to in her set. The naming section required the child to give names to shapes or colours as requested by the tester. The identification subtest required the child to identify and select a shape or colour requested by name from a displayed set.

The simple classification items required the child to select a shape using only one criterion, for example, shape, in sorting circles. In the multiple classification items, the child was required to select a shape or shapes using more than one attribute e.g. colour, shape and size in selecting the largest yellow rectangle. This was meant to make the children realise that an object can belong to more than one class at the same time.

The seriation items required the children to order circles and triangles in order of size.

The sorting items required the child to select same size shapes from a large set of different shapes, colours and sizes or smallest members of four different shapes from a set with shapes of different sizes, colours and shapes.

A comparison of two subsets of a set was required after the children had sorted shapes from a large set using one or two attributes.

Number Subtests

A number of questions assessed the children's cardinal counting ability. Each child was asked to count out a specified number of beans from a larger set of beans provided to him. The child was also asked to count the number of members in a set (pictures of familiar objects on a card). This revealed whether the child had just learned to memorize a sequence of sounds and was unable to match the number names with objects.

The children's rote counting ability from 1 up to 100 was tested by asking each child to count for the tester as far as he could.

The child's knowledge of ordinal number was measured. Ordinality was tested apart from cardinality by requesting the child to place marbles in specified (e.g. second), toy trucks which were lined up in front of him.

The child's ability to write numerals was tested by asking the child to write the number which shows how many beans were in a matchbox. Then later the child's ability to identify numerals was tested. In order to identify them, he must have a number name associated with the written symbols. The task required the child to locate the matchbox with the appropriate numeral printed on it when the tester requested, by numeral name, the matchbox with a particular number of beans inside.

The concept of equivalence of sets was also tested. The child was requested to form a set of beans equivalent to that represented by a group of pictured dots on a card. Then in another group of tests, the child's ability to recognize equalites and inequalities between two sets. The task required the child in this scale to determine in which of two rows on a card there was the same number in both rows. Other conservation tasks measured the child's ability to recognize equalities and inequalities of sets when conflicting perceptual cues were present. It also included a measure of the child's ability to disregard size as well as spatial arrangement and to utilize number only. In this scale, dots rather than flags and shields used earlier were used as test materials.

Vocabulary Subtests

The pre-number stage of mathematics is largely concerned with language. Inadequate, immature number language can be a stumbling block in a child's mathematical development. Some of the vocabulary tested which the children can use as labels for certain manipulations include: behind, above, bottom, between, each, tallest, remove, set, more than, as many as, fewer than, join, below, left, outside, inside, on, right, shorter than, top.

Visual Memory Subtests

These measure visual memory for familiar actual objects. The child was shown four familiar objects. One object was removed while the child's eyes were closed. The child was required to recall which object was removed. If he failed to recall three times was then shown another set of familiar objects, including the one removed from the first set. Recognition was then tested. Other items measured visual memory for pictured objects. The child was shown a page with four or five drawings of familiar objects on it. The child was then shown a second page with pictures all but one of the objects on the preceding page. The child had to recall which picture was absent on the second page that appeared on the first. If the child could not recall what picture was taken away, he was then shown page 3 which had a new set of pictures including the one removed. The child was then, expected to recognise the picture that was missing in page 2

1.9 HYPOTHESES IN THE NULL FORM:

1. There is no difference in comprehension of mathematical concepts between children from different types of schools in Nairobi.

2. There is no difference in comprehension of mathematical concepts between children from different types of schools in

    a) Classification
    b) Number
    c) Vocabulary
    d) Visual Memory.

3. There is no difference in comprehension of mathematical concepts between children of the age range four to six years.

4. There is no difference in comprehension of mathematical concepts between children of the age range four to six years in

    a) Classification
    b) Number
    c) Vocabulary
    d) Visual Memory

5. There is no difference in comprehension of mathematical concepts between boys and girls of pre-school age in Nairobi.

6. There is no difference in comprehension of mathematical concepts between boys and girls of pre-school age in

a) Classification
b) Number
c) Vocabulary
d) Visual Memory

10. There is no correlation between comprehension of classification skills and

a) Number
b) Vocabulary
c) Visual Memory

11. There is no correlation between comprehension of number skills and

a) Vocabulary
b) Visual Memory

12. There is no correlation between comprehension of vocabulary and visual memory.

13. There is no correlation between

a) writing and identifying numerals
b) naming and identifying colours
c) naming and identifying shapes
d) rote counting and counting of beans and pictures.

14. There is no correlation between vocabulary skills and the no-vocabulary skills.

15. There is no difference in conservation of number between 4, 5 and 6 year old children.

# CHAPTER TWO
# REVIEW OF THE LITERATURE

## 2.0 INTRODUCTION

This chapter is devoted to reviews of literature in many areas that are relevant to the present study on comprehension of mathematical concepts among pre-school children. It deals with views and empirical evidence mainly on concept and cognitive development of children from different types of schools, ages and sexes. Reviews on children's classificatory behaviour, understanding of number and short-term memory are highlighted in this chapter. Influence of language on cognitive development particularly of children from different socio-economic groups in the western countries has also been mentioned. Literature on the influence of a foreign language on cognitive development among African children as reviewed by various writers with experience mainly on West African children has also been included.

Some of the works that have been reviewed in this chapter suffer from serious shortcomings in the way they have been described in the literature. They do not deal adequately with the research designs so that the sample size, tests used and the methods of carrying out the researches are missing. Most descriptions are qualitative. Most of the studies mentioned in this chapter were conducted in western countries, a few in Africa and only one in Nairobi, Kenya.

Among the many writers whose works have been mentioned in this chapter, the works of Jean Piaget, a Swiss psychologist now in his eighties, figure prominently in this chapter and, indeed, his influence has contributed a lot to the whole study. A book written by Richard Copeland on "How children Learn Mathematics" in which he clearly explains the works of Jean Piaget on cognitive development and one written by Ernest Choat on "Pre-School and Primary Mathematics" in which she mentions the works of many other writers on children and their comprehension of mathematical concepts have been particularly useful for this purpose.

Included in this chapter are reviews, often brief, of studies that have been carried out on children under 10 years of age. Below is a guide as to what appears in different sections.

As introduction to the literature of children's comprehension of mathematical concepts, section 2.1 gives brief descriptions of concepts and concept formation as viewed by different writers. The role that language plays in concept formation is described in section 2.11. Various views, many of them based on experimental studies have been expressed on teaching of concepts and acceleration of progress. Some of these have been mentioned in section 2.12. Most researches on concept development have been done in western countries. Some of the concepts that pre-school children have been found to possess have been mentioned in section 2.2. Since the present study deals with four main tasks, literature on classification, number, vocabulary and visual memory is written in

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1. Copeland, R.W. How Children Learn Mathematics, (MacMillan Publishing Co. Inc., 2nd Ed., 1974).

2. Choat, E. ed. Pre-school and Primary Mathematics. (Ward Lock Educational, 1973).

section 2.3. The sample of children under study is drawn from three socio-economic groups. An outline of findings is given in section 2.4 while difference between age groups are written in section 2.5. Literature on sex difference is mentioned in section 2.6.

## 2.1 An outline of literature on concepts and concept formation:

Mathematics is the study of systematic patterns of relationships. As relationships are seen and discussed, concepts will form, and principles will emerge. As concept development is dependent upon the individual's ability to abstract from his environment, the quality of his mathematical thought is determined by his ability to see relationships, to recognize correspondence, to classify and to order, Hamley (1936)[1], Pictorial Representation (1967)[2], Mathematics Begins (1967)[3], Yardley (1970)[4], Dienes (1969)[5] and Lovell (1971)[6].

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1. Hamley H.R. "Formal Training : A Critical Survey of Experimental Work". British Jn. of Educational Psychology, Vol.6, (1936).

2. Nuffield Mathematics Project: Pictorial Representation: (Glasgow: W.R. Chambers and John Murray, [1967])

3. Nuffield Mathematics Project : Mathematics Begins (Glasgow : W.R. Chambers and John Murray, [1967])

4. Yardley, A. Discovering the Physical World, (London : Evans, 1970).

5. Dienes, Z.P. Introducing the Elements of Mathematics, (Sherbrooke, Canada: Sherbrooke University, 1969).

6. Lovell, K. The Growth of Understanding in Mathematics: Kindergarten Through Grade Three, (New York: Holt, Rinehart and Winston, 1971).

According to Piaget, a concept is a generalization about data which are related. He is of the view that Mathematical concepts arise out of the actions the child performs with objects and not from objects themselves. Yardley (1970)[1] states that they arise from the child's use of objects and his appreciation of the significance of the operations which he performs with them, and, as Churchill (1961)[2] adds, concept formation occurs because of the readiness of the individual to respond in certain ways rather than others. Concept formation is, according to Vygotsky (1962)[3], the result of a complex activity in which all the basic intellectual functions take part. The process cannot, however, be reduced to association, attention, imaginery, inference of determining tendencies. They are all indispensable, but they are insufficient without the use of the sign, or word, as the means by which we direct our mental operations, control their course, and channel them towards the solution of the problems confronting us. Memorizing words and connecting them with objects does not in itself lead to concept formation; for the process to begin, a problem must arise that cannot be solved otherwise than through the formation of new concepts.

1. Yardley, A. 1970 p.21 Ibid.
2. Churchill, E.M. Counting and Measuring (London : Routledge and Kegan Paul. 1961).
3. Vygotsky, L.S. Thought and Language (Cambridge Massachusetts : MIT Press 1962) pp.55-58 .

## 2.11 The role of language in concept development

As Thouless (1969)[1] points out, the process of conceptual development can be expressed in terms of the degree to which a child has acquired the ability to abstract, and is bound up with the acquisition of language. Language enables the child to interpret and communicate his findings to others and plays an important part in the organizing of experiences. Dienes (1969b)[2], too, remarks that one of the strengths of English infant school education was the ability of groups of children to interact and learn.

Piaget, as Furth (1969)[3] points out, is one of the few scholars, if not the only one, who does not think language is intrinsically necessary for operational thinking. He feels that there is a close relationship between language and thought at the highest operational level of development i.e. at around twelve years of age, but earlier than this, children do not achieve operational thinking or reasoning ability through words but must do so through their own operations on objects in the physical world, as in a laboratory setting. He had in mind children at the sensorimotor stage of intelligence at around one year old when a baby develops a way of getting a toy on a

1. Thouless, R.H. Map of Educational Research (Slough : N.F.E.R. 1969) pp.130 - 135.

2. Dienes, Z.P. Introductory talk given at the Dienes Maths Conference, April 1969.

3. Furth, H.G. Piaget and Knowledge, (Englewood Cliffs, N.J. Prentice-Hall, Inc., 1969), p.109.

blanket, such as pulling a blanket. He also had in mind children whose thinking is logical but do not have language available to them - the deaf and dumb. But, having possibly downplayed the importance of language, Piaget did say "without interchange of thought and co-operation with others the individual would never come to group his operations in a coherent whole".[1] This means that although language does not structure thought, it may provide direct attention to pertinent factors in a problem or give ideas for thought, which otherwise might not be considered, by asking, for example, "would this help"? Language may also control perceptual activities by saying "look at this". Thus language can prepare an operation but is neither sufficient nor necessary for the formation of thought at the concrete operational level.

The role of language in concept development is further exemplified by Churchill (1961)[2] who contends that we must give children the language to think and reason their experiences in particular ways, e.g. according to shape, size, position etc. and will occur only if the language acquired is a true language. Concrete experiences then become symbols for ordering experiences at mental level as well as at concrete level.

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1. Piaget, J. The Origins of Intelligence in Children, (New York: W.W. Norton & Company, Inc., 1963), p.193.

2. Churchill, E.M. (1961) Ibid p.54-69.

2.12 Views on Teaching of concepts and acceleration of progress:

On teaching concepts, Piaget does not believe it necessary since the logical structure is reached only through internal equilibration. In the foreword to Almy's book[1], Piaget restates his position: "In the area of logico-mathematical structures, children have real understanding only of that which they invent themselves, and each time we try to teach them something too quickly, we keep them from reinventing it themselves. Thus, there is no good reason to try to accelerate this development too much". Mildred Almy (1967)[2] confirms Piaget's conclusions. Wolhwill and Lowe (1962)[3] tried to teach kindergarten children that merely re-arranging a set of objects does not alter the numerical value of the set. They had a group of children count a set of objects before and after re-arrangement; this was done many times.

Wohlwill and Lowe came up with the conclusion that experience with concepts . . . is far more effective than sheer practice per se. When asked whether children's progress can be accelerated by outside factors such as creative teaching situations, Piaget replied, "It's possible to accelerate, but maximal acceleration is not desirable. There seems to be an optimal time. What this optimal time is will surely depend upon each individual and on the subject matter."

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1&2. Almy, M. Children's Thinking, (New York, Columbia University Teachers College Press, 1967) p.vi.

3. Wohlwill J.F., Lowe, R.C., "Experimental Analysis of the Conservation of Number", Child Development, 33, (1962). pp.153-169.

Paul Rosenbloom's[1] stance was that it is possible through creative teaching styles, to accelerate children's development. His experiments have led to the conclusion that it is not possible to accelerate the pace very much. The children must be biologically ready, just like Piaget believes when he says that education is confined by the children's developmental sequence. Professor Zaporozhets[2] and Dr. Robinson[3] also agree that it is possible to speed up cognitive development, but that there is some danger of forcing the child into the next stage of development before he is ready. "Stretching" children is better than "straining" them, they say.

Some studies have shown success in accelerating the achievement of specific concepts. In an experiment by Harper and Steffe (1968)[4] an attempt to increase ability to conserve number in kindergaten and first grade children was made.

1. Rosenbloom, P. Minnesota National Laboratory Evaluation SMSG, Grades 7 – 12, SMSG Newsletter, No. 10, (Stanford, California, SMSG Publications, 1961). pp.12-26.
2. Professor A. Zaporozhets. from the Academy of Pedagogical Sciences of the U.S.S.R.
3. Dr. Halbert B. Robinson from the University of Washington.
4. Harper E.H. and Steffe, L.P. – "The Effects of Selected Experience on the Ability of Kindergarten and 1st Grade Children to Conserve Numerousness," Technical Report, No.38, (Madison Wisconsin, The University of Winsconsin, 1968) pp.31-32.

Children were engaged in physical activities, manipulating concrete materials, and using semiconcrete examples on the flannel board. The results of the study indicated a significant gain by the experimental group of kindergateners in ability to conserve number but showed no apparent gain for the first grade children.

A more recent research that clearly shows that proper training and guidance of pre-school children leads to greater gains and a closing of the gap between the low and medium socio-economic groups was the one reported by Leiderman and Rosenthal - Hill, reported in more details in section 2.21. They used exactly the same tests used in this study on their five year kindergarten children. Both the low and medium socio-economic groups gained after one year's training in the kinder-garten but, although the medium group was still ahead at the end of the year, the differential pattern of gain over the school year is crucial to point out. While the middle group made significant gains on three tests - ordering geometric shapes, writing numerals and ordinal numbers, the low group made significant gains in five tests - identification of shapes and numerals, counting buttons, counting pictured sets, and equivalent sets. The conclusion to be drawn from such results was that a structured mathematics program in kindergarten may narrow the differences in achievement of the lower and middle socio-economic groups.

Schmalohr (1964-66).[1] with 149 kindergarten children between the ages of $3\frac{1}{2}$ - 6 years and with 68 children 7-13 years from a school for backward children, attempted to bring the children through practice to an understanding of conservation of quantity and substance - using glasses and beads as in Piaget. It showed that the constancy of number could be induced by purposeful training with fair success. In the case of the practice in the glasses and beads experiment, there was a relatively strong transfer to the similarly structured egg and egg-cup experiment with different quantities. However, it was only moderate in the case of the - in comparison different - plasticine experiment with constant quantities. A poor performance followed when there was a slight alteration in the conditions - from beads to plasticine - and the most important result was that the children had learnt not a logical operation but only an idea of solution as related to specific tasks.

Kohlberg (1968)[2] came to a similar conclusion when he had looked through the latest Americal work, and gave it as his opinion that training programs often produced only mechanical learning effects and not the formation of a stable concept of

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1. Schmalohr, E. "The Possibilities and Limitations of an Early Advancement of the Cognitive Faculties", EDUCATION Vol.2 (1979) p.119.
2. Kohlberg, L. "Early Education, a Cognitive Developmental View," Child Development, (1968).

constancy. Concepts of constancy which have been reached by specific instruction do not have the structural characteristics of this kind. Even less than specific training does a general formal schooling lead to the acquisition of the constancy concept, as appears from a comparison of schooled and unschooled children.

Influence on a speeding up of this development of conservation concepts always appear where the methods of instruction correspond to the principle of cognitive structure and where the children's thinking is stimulated by the introduction of conflicts and comparisons. Experiences especially useful are those which link up with the activity of the children in the transitional state between intuitive and operational thinking e.g. considering two dimensions at the same time or in forming double classifications. It is useful to learn many distinct tasks, which produce the same thought structure. It is important to develop the perception that different situations have something to do with one another.

So research into the conservation concept makes it clear that an ordinary general school program does not give sufficient stimulus for cognitive development. The attempt to speed up the process by training programs directed to definite ends brings only limited and specific results. It is also clear that the acquisition of a thinking structure is not strictly the result of maturation, but depends much more on a broad basis of experience, which comes about as the result of an interaction between the psychic structure and its environment.

Jerome Bruner's (1966)[1] famous statement that both shocked and challenged the educational world that "......... ............... any subject can be taught effectively in some intellectually honest form to any child at any stage of development" seems to contradict the views of the writers mentioned in this section. However, Bruner does not feel that his statement is contradictory to Piaget's developmental stages. It has been suggested that the principal difference between Bruner's theory and that of Piaget is that they do not employ the same criteria for determining when a child reaches a certain stage of development. Bruner, it must be mentioned, classified Piaget as "unquestionally the most impressive figure in the field of cognitive development".[2]

## 2.2 An outline of researches showing concepts possessed by children in western countries

According to various Piagetian interpreters e.g. Beard, (1969)[3] and Stones (1966)[4] children are not capable of forming "true concepts" during the pre-school stage. Describing the 'pre-conceptual' phase of development (2-4) years, Stones, for example, states that this is the phase where 'the child is beginning to develop concepts and before he is capable of

1&2 Bruner, J.S. Toward a Theory of Instruction. (Cambridge Mass : Belknap Press, 1966).

3&4 Cited by Povey and Hill.
Povey, R. and Hill, E. "Can Pre-school Children Form Concepts?" Christ Church College, Canteburry, Educational Research, Vo.17 No.3 (1975).

distinguishing between the specific concepts relating to an individual object and the generic concepts relating to a class of objects'. He gives as a common example of this 'the tendency of children of this age to call men generally "daddy". Similarly, Beard claims that children's verbal concepts in the pre-conceptual phase 'lack the generality of true concepts'.

Povey and Hill (1975)[1] in their article on "Can Pre-School children form concepts" list a number of comments selected from papers by B. Ed. and Teacher's Certificate students from different colleges on children and concepts. They have been read in answers of quite able students to questions on Piagetian researches.

These include:

Concepts can only be acquired from 4 years onwards.

Pre-conceptual (2-4) years where everything on four legs is a dog and any man is "daddy".

Not until the age of four or five will the child distinguish between the characteristics which mark "dog" and those which mark other animals. No distinction between generic and specific terms. Little point in teaching other than play. These extracts are fairly typical examples of a widely held belief that children at the pre-school level are not capable of forming 'true concepts' and, in particular, that they cannot form generic concepts.

1. Povey, R. and Hill, E.(1975) Ibid.

Other writers, however, such as Russel (1956)[1] claim that normally children have been discriminating, abstracting and generalizing about environmental data from infancy and that by the age of 3 or 4 years a child "knows literally hundreds of concepts". Welch (1940)[2] also claims quite explicity that pre-school children are capable of forming hierarchical concepts involving class inclusion. From straightforward observation of children's behaviour, most parents would probably attest that children between the ages of 2 and 4 tend to have a fairly secure grasp of concepts such as 'cups', 'spoon', 'ball', 'cat', 'dog' etc. These are specific concepts certainly and do not involve logical inclusion but they are nevertheless 'true concepts'.

Parents and nursery teachers may well wonder at Piaget's assertion that children in the pre-school stage are not admitted to an understanding of some generic concepts involving class inclusion, when they find their children using generic terms such as 'clothes' and 'food' in an appropriate manner and responding appropriately to the adult's us of such terms.

Such statements that children between the ages of 2-4 years are incapable of forming 'true concepts' is immensely misleading. Teachers of nursery school can seriously underestimate the capabilities of children in their school.

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1. Russel, D.H. Children's Thinking. (London : Ginn. 1956)

2. Welch, L. - 'A Preliminary Investigation of Some Aspects of the Hierarchical Development of Concepts's," J. Gen. Pschol., 22, (1940), pp.359-378.

Other studies, like the present one, begin with the assumption that pre-school children possess concepts and then go ahead and find out which concepts they possess.

2.21 Research on Kindergarten children reported by Leiderman and Rosenthal - Hill.[1]

This is the interim report on kindergarten year results carried out in 1966 as part of a four-year longitudinal study of mathematical learning in the primary grades in Stanford, California, U.S.A. This report is of particular interest in that the tests used in the present study are exactly the same as those used in the study under review. Although the primary purposes of that study was to assess children's progress in learning particular mathematical ideas during the beginning years, it nevertheless, shows mathematical concepts possessed by pre-school children. The initial test battery was given in September, 1966, and is referred to as K-01. It was planned as an evaluation of readiness for learning mathematical concepts. K-02, given in May, 1967, was planned to assess gain over the school year in the kindergarten.

1. Gloria F. Leiderman and Irene Rosenthal - Hill : The Elementary mathematics study. "An Interim Report on Kindergarten Year Results : School Mathematics Study Group (SMSG), Cedar Hall, Stanford University, Stanford, California, May, 1968.

(a) Description of the Sample and Research Design:

A sample of 2,022 five year old children entering kindergarten was drawn from selected schools of two large cities. The schools selected drew on residential areas which could readily be defined as either lower or middle income groups. Within one city, four cells were formed, two each from lower income areas and two from middle to higher income areas. In the second city, three cells were formed, omitting one middle income cell.

(b) Description of the Tests:

The tests were separated into tests identified as "Cognitive Process Variables" and "Mathematics Achievement Measurement". This separation was somewhat arbitrary; the two are clearly not disjoint sets. The major criterion for calling a specific task a measure of cognitive process was that in addition to being a learned relationship or understanding, its presence indicated a certain level of cognitive development.

(c) Cognitive Process Measures:

Several tasks within the K-01 and K-02 inventories were used as indices of cognitive process. These were matching, naming and identifying of colours and geometric shapes; classifying and ordering geometric shapes, vocabulary; Visual Memory; Conservation.

(d) Mathematics Achievement Measures:

These included counting objects and members of a given set, forming equivalent sets, numeral writing and identification, and ordinal number.

(e) Tests administration

Both K-01 and K-02 were individually administered inventories. Test administrators were carefully chosen for each battery from graduate students and primary teachers with course work or experience in psychological testing plus experience in working with younger children.

(f) Results on September, 1966 testing - the K-01 Test Batteries:

(i) Cognitive Process Measures:

Matching of colour performance was very good. only 1.9% children made an error in matching yellow and 4.2% made an error on green, the colour with the highest frequency of error.

Matching of geometric shapes was also very good. The circle and triangle were considerably easier for the children to match than were the square and the rectangle. Only 2% tested made an error on matching circles while 8% children tested made errors on squares, the most difficult shape.

Thus, most children in this group had the perceptual development necessary to disriminate colours and simple geometric shapes. Naming of colours was clearly more difficult than matching. Approximately $\frac{1}{3}$ of the children were unable to name "green" or"Blue", the most difficult as judged by the number of errors made. " Black", "red" and "orange" were considerably better named by between 83 - 89% of the children. Naming of geometric shapes was also more difficult than matching. 43.6% could correctly call a circular shape a "circle" and 41.6% could name a square shape.

Identifying of colours was known by between 83-85% of the children. Identifying of geometric shapes was better done than naming them. About 75% of the children could correctly identify a circle, 60% a square 50% a triangular shape and less than 33% a rectangle.

Classifying and ordering

Approximately 32% of the children were able to order the shapes from among other shapes. When asked to sort both shape and colour (e.g. triangles and red), only 43% of the children were able to do this correctly.

The most difficult items of the classifying and ordering tests were those of the type requiring comparison of two subsets of a set, e.g. more circles or blue rectangles, within a large set of shapes. Unfortunately no figures were given to show the performance level.

Vocabulary:

Performance on many of the words was excellent. More than 90% of the children were able to manipulate the blocks to show their understanding of such words as behind, tallest inside, on and top. The most difficult of the twenty words and phrases included were the expressions "as many as", with 48% of the children correct, and "fewer than", with approximately 30% correct. However, another comparative expression, "more than" was correctly defined by 80% of the children.

Visual Memory:

Betweem 78% and 96% of the children were able to name the removed object either through recall or recognition.

(ii) Mathematics Achievement Measures:

Counting: More than ½ of the children were able to count out 3, 4 or 5 buttons, also 4 or 5 pictures. The counting of objects was somewhat simpler than counting drawings on a card except for 4 and 7 pictures whose arrangement was patterned rather than being randomly placed. The following table explains this more clearly.

Table 2 : Results for the Total Sample on Count Objects and Pictured Sets : September, 1966 testing.

| Number asked | Percentage of Children able to count correctly | |
|---|---|---|
| | Buttons | Pictures |
| 3 | 84.3 | - |
| 4 | 64.8 | 71.5 |
| 5 | 61.5 | 58.7 |
| 6 | 52.7 | 43.1 |
| 7 | 44.9 | 47.4 |
| 8 | 44.2 | 38.4 |
| 9 | 37.0 | 30.5 |

Writing numerals:

Of the 61.5% who attempted to form the numeral "3", less than ⅓ were able to do it correctly.

Ordinal Numbers

The results showed that these children had little understanding of the concept of ordinality at the beginning of the kindergarten year. Only 12% were able to place a marble correctly in the fifth truck.

This study was better reported than many of the others that were available. An item analysis, however, of the whole study would have been useful for comparison purposes with the present study.

2.22 An outline of research reported by Wilbur H. Dutton (1963)[1]

Dutton (1963) reported a research carried out among kindergarten children in Los Angeles, California. Although the Metropolitan Readiness Tests used were devised to measure kindergarteners' traits and achievements that contribute to their readiness for first grade instruction it nevertheless, shows the mathematical concepts possessed by pre-school children.

(a) The Sample:

A sample of 236 children was given a pre-test at the entrance to kindergarten and then a post-test after one year in school.

(b) Test administration:

The tests were administered by regular kindergarten teachers.

1. Wilbur H. Dutton. "Growth in Number Readiness in Kindergarten Children". University of California, Los Angeles, California. The Arithmetic Teacher, May, 1963.

(c) The Test:

The test included number vocabulary, counting, ordinal numbers, recognition of written numerals, use of numbers in simple problems, writing numerals, interpreting number symbols, meaning of number terms, meaning of fractional parts, recognition of forms and telling time.

(d) The findings:

The findings of this test showed that kindergarten children come to school with wide and varied back-grounds in number experiences. At least one third of each entering class is mature enough and ready for systematic work involving the use of counting, enumerating, grouping, producing numerals and extending other mathematical concepts of size, shape, form and measurement.

This study's sample was rather small compared to Leiderman's study. The research design is not fully laid out. The test administration procedure is absent all together. The test and the findings are too summarized to be of great use but the conclusion is important in that it shows some concepts possessed by pre-school children.

2.23 An outline of research reported by Bjonerud (1960)[1]

Bjonerud (1960) reported specific number concepts possessed by the pre-school children at the time of kindergarten entrance.

1. Bjonerud, C.E. "Arithmetic Concepts Possessed by Pre-School Children". The Arithmetic Teacher VII, Nov. 1960 p.347 -350.

(a) The Sample:

To find out what number concepts a five year old possessed, a study was made of the Arithmetic concepts possessed by 100 beginning kindergarten children in the Livonia, Michigan, public schools in the fall of 1957. The study was repeated again in February 1960, with 27 pupils, an entire mid-year class of beginning kindergarten children in the demonstration school on the Campus of San Francisco State College in San Francisco, California.

(b) The Tests:

Two tests were developed to aid in securing the needed data. The first test was an individual oral interview containing 57 responses. Number knowledges tested included: abstract counting by ones and twos, number sequence, ordinal numbers, identification of number symbols, recognition of number quantities, ability to name and recognize common instruments of measurement, and recognition of coins in the monetary system. The second test was written-picture-test containing 45 responses. Arithmetical concepts that could be presented clearly in picture form were selected. These included premeasurement understandings, such as, largest, smallest, tallest, shortest, longest, under, inside, beside, nearest and farthest. Recognition of simple geometric figures, such as circle and square, was tested. Other parts of the test included counting less than ten items and recognizing the written symbol for the total; reading the number words to ten and recognizing their written symbol, fractional parts of a whole, simple addition and subtraction combinations in oral problem situations and to recognize the result in the written symbol. In all these tests, considerable effort was made to see that each item and picture were ones familiar to five year olds.

(c) The Findings:

Counting skills: Considerable variance in ability to do rote counting by one was evidenced, but every child displayed some facility in this number knowledge. 5 children, 4 of whom were boys could count up to 100. The majority of the children were unable to do rote counting by 10, but approximately 25% exhibited some ability to perform this arithmetic skill. There was a marked similarity between the ability of the children to do rational counting by one and rote counting by one. The mean for the group was 19. Few children displayed an understanding of number consequences other than the sequence of numbers by one. Less than 10% understood a sequence of odd numbers, 20% succeeded when a sequence of even numbers less than 10 was used.

Ordinal numbers:

Approximately 95% understood the ordinal number first, while slightly more than 75% knew middle and last. At least 50% displayed a knowledge of the ordinal numbers second and fourth.

Number selection skills:

These children were able to recognise a quantity of items numbering less than 4 immediately. Some were able to recognize more than four items, but less than 9 items. All the children were able to select quantities of 3 or less.

Ability to estimate:

In situations where flash cards with a variety of pictured items were used, some enlightening ability to estimate was evidenced. 93% of the children immediately recognized two items when flashed, but this percentage dropped quite drastically after four items had been flashed. When 8 items, the maximum number used was flashed, the percentage of children responding accurately was 21%.

Premeasurement Concepts:

A large percentage of beginning kindergarten children possess a high degree of understanding of terms describing premeasurement concepts as was evident in this test. Approximately 80% or more of the children responded accurately to situations requiring an understanding of largest, smallest, tallest, most, inside, beside, closest and farthest. About 50% recognized situations describing the terms shortest, few, underneath and some. When asked to recognize common instruments used in measurement, 89% were able to name the clock, 51% could name the calendar while $\frac{1}{3}$ could name the yardstick, foot (ruler), scale and thermometer.

Money:

When given different coins to be recognised, some thought this was too much. Many didn't have ideas on what to do with it except play with it.

Recognition of geometric figures:

91% recognised the circle while 76% recognised a square.

Fractional concepts:

50% of the children were able to recognize $\frac{1}{2}$ of one item, 89% could recognize an item divided into thirds, 68% responded accurately to $\frac{1}{4}$ of an item while only 33% recognized $\frac{1}{2}$ of a group of items.

Addition and subtraction concepts:

90% successfully solved addition combinations while 75% successfully solved subtraction combinations.

This research consists of many mathematical concepts also included in the present study. The pre-measurement concepts are included in the present study's vocabulary section, while the counting skills and ordinal numbers are included in the number section in this study. The recognition of geometric figures is also included in the classification tasks in the present study but only the results of the circle and square are given. There is no indication as to the other geometric figures used. The actual test used and an item analysis were not available but it is possible to compare the performance with the present study through the many percentagesgiven.

2.24 An outline of research reported by Povey and Hill (1975)[1].

Povey and Hill reported 'specific' and 'generic' concepts possessed by children between the ages of two years four months and four years, ten months.

(a) The Sample: The sample was drawn from fifty-six British children in the 'pre-conceptual' age range (viz. 2-4 years) 32 were boys and 24 of them were girls. The youngest child was two years, four months and the oldest child was four years and ten months. The mean chronological age was 3 years and 9 months. These children were attending a play group which drew upon a catchment area having a good representation from the different socio-economic groupings. Using the father's occupation as the criterion indicating the socio-economic level, three groups were identified. 14 children (25% of the total sample) were drawn from Group 1 made of Professional/Managerial fathers. 28 children (50% of total sample were drawn from Group 11 made of Clerical/skilled Manual fathers. 14 children were also drawn from Group 111 made of semi and unskilled manual fathers.

(b) The Tests:

All children were given sets of test items, the Peabody Picture Vocabulary Test (PPVT) and the Hill and Povey Concept Acquisition Tests (HAPCAT). In addition 29

1. Povey, R. and Hill, E., (1975) Ibid.

children were given some of the Piagetian test questions (Piaget and Inhelder, 1964).

To assess the child's grasp of specific concepts he was asked to identify pictures of various objects e.g. "egg", 'girl', 'spoon'); and to assess the degree to which a child had acquired a generic concept he was asked to select the pictures which depicted a certain concept (e.g. 'food) from amongst a number of 'distractors'.

(c) Test procedure:

Every child took part in two testing sessions. On the first occasion the children were given the HAPCAT items and on the second, the PPVT. These test sessions were spaced one week apart. All the testing was carried out on an individual basis by the two authors during the normal play group sessions. In addition to this basic test programme they were able to test 29 children on the Piagetian questions four weeks after the first test session.

(d) Results:

The PPVT scores resembled very closely to the pattern on standardised scores in the test manual - which resemble a normal curve. The HAPCAT items in relation to the specific and generic concepts showed a clear increase in capacity for correct identification with age. Comparing the ages of children giving correct responses on both tests for at least one of the concepts one finds a highly significant relationship between age (four years and over as compares with under four years of age) and accurate test performance $P < 0.001$ on a $X^2$ 2x2 test of association.

## 2.3 An outline of findings of research studies done on the four main tasks chosen for the present study.

### (a) Classification:

Classification is a very important concept in beginning mathematics. Eshiwani (1974)[1] suggests that since classification serves as a basis for the development of mathematical concepts, it should be the first mathematical idea taught to children. Bruner (1963)[2] wonders whether "it might be interesting to devote the first two years of school to a series of exercises in manipulating, classifying and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial ordering and the like ........ Such an early science and mathematics pre-curriculum might go a long way toward ........ the kind of intuitive and inductive understanding that could give embodiment later in formal courses in mathematics and science". More recently, Copeland (1974)[3] has observed that classification serves as a basis, psychologically speaking, for the development of both logical and mathematical concepts. New Mathematics is characterised by use of sets. The logical conclusion of sorting and classifying is

1. Eshiwani, G.S. "The Teaching of Mathematics to Primary School Children," Article, (Nov. 20th, 1974) p.1.

2. Bruner, J., Process of Education, (Cambridge, Mass Harvard Univ., Press, 1963), p.46.

3. Copeland, R.W. (1974) Ibid, p.51.

sets, says Frobisher and Gloyn (1975)[1].

Classification and number have been found in many studies, to be age dependent. More literature on age differences on these two variables is described in section. 2.5.

Number:

On number, Piaget (1952)[2] suggests that the construction of number involves a synthesis of classification and seriation. Piaget suggests that earlier than the advent of number concept the children may be taught to count, but experiments reveal that the verbal use of the names of numbers has little connection with numerical operations as such. According to Piaget, a true concept of number evolves only after the child has began to "conserve" quantity. The number concept involves both cardination and ordination both which are aspects of classification and seriation, respectively. If one enumerates a set of objects and therereby arrives at its cardinal number value (there are ten objects here), one is in effect treating the objects as if they were all alike, just as one would do if one assigned them to a common class. In the process of discovering their cardinal value by enumeration, one has to order the objects - one, two, three etc. This is ordination. For Piaget, number "is at the same time a class and an asymmetrical relation, the units of which it is being composed being simultaneously added because they are equivalent, and seriated because they are different from one another[3].

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1. Frobisher, B. & Gloyn, S., 1975, Ibid

2. Piaget J., 1952, Ibid, p.184.

3. Ibid.

Vocabulary:

Since the present study is carried out in a foreign language, and since one of the main tasks in the study is vocabulary, it seems necessary to mention some of the studies done on language. Most studies mentioned in the literature show the influence of a foreign language on cognitive development and the significance of the mother tongue.

In Kenya, like in many ex-colonial countries of Africa, many children are made to learn in a language other than their mother tongue. In their study in Nigeria, Fafunwa and Bliss (1973)[1] found that children whose language was Yoruba but forced to study in English were able to recall better in their mother tongue Yoruba. This led to the assumption that, "a child is likely to benefit more cognitively, socially, culturally and linguistically through the use of the mother tongue as the language of instruction throughout the primary school course and thus bridge the gap between home and school ...... Such an education will yield greater surrender value to the child and his society".[2]

The use of the mother tongue was further emphasised in the UNESCO Conference of 1953 and in the International Labour Report in 1972. The mother tongue is "psychologically the system of meaningful signs that in his mind works automatically for expression and understanding .... . Educationally, he

1. Fafunwa, A.B. & Bliss, E. "The Effect of Bilingualism on the Abstract and Concrete Thinking of Yoruba Children" University of Ife, 1967 (mimeo.)

2. Ibid.

learns more quickly through it than through an unfamiliar medium". Gay and Cole (1967)[1] among the Kpelle of Liberia found out that many school children will parrot a great deal of mathematical material in English which they do not comprehend or which they cannot apply to specific situations – so that their knowledge is not functional. This use of a foreign language disturbs the child's cognitive equilibrium and this abnormal situation tends to retard the cognitive process in terms of the anticipated outcomes of the western form of education.

Visual Memory:

One of the few psychological investigations of memory among African tribal people was carried out by Bartlett (1932)[2] and is reported in his famous monograph, 'Remembering'. Having heard of the "marvelous word-perfect" memory of the Swazi from his childhood up, Bartlett[3] set out to find out when this phenomenal memory manifested itself. First he asked a young boy to carry a message to someone else in the village and found that recall was good. Then he tested a cattle herder's memory for a series of transactions involving cattle sold the year before. In this case, Bartlett found that the herder's memory was phenomenally accurate. More recently, Gay and Cole (1974)[4] interested

1. Gay J. and Cole M. The New Mathematics and an Old Culture, Study of learning among the Kpelle of Liberia, (N.Y. Holt, Rinehart and Winston, 1967).

2. Bartlett, F.C., Remembering, (London :Cambridge University Press, 1932).

3. Ibid p.248.

4. Cole, M. & Gay.J. "Culture and Memory", American Anthropologist Vol.74. No.5, (Oct.1974).

themselves in the area of memory when they found that the traditional habit of memorizing things impeded the education of tribal children in the western oriented government schools in the interior of Liberia. Like other observers e.g. Levy-Bruhl (1966)[1], they maintained that primitives manifested a decided distaste for reasoning, for what logicians call the 'discursive operations of thought'. At the same time they have remarked that this distaste did not arise out of any radical incapability or any inherent defect in their understanding, but was rather to be accounted for by their general methods of thought. Hence, memory and culture are related. While the westerners complain of the African's essentially mystic prelogical mentality, the African finds it odd that a westerner adult would fail to memorise things that an African child does. Bowen (1964)[2] recounts the displeasure and consternation of her Nigerian hosts when she was unable to learn the names of local plants which every six year old in the village had long since committed to memory.

Corsini et al (1969)[3] examined pre-school children's memory of words and pictures using a recognition-memory task in the U.S.A. The results indicated that pictures were better retained than words. Some older children (3rd, 6th and 9th grades) were tested in visual and oral memory tests of 2 analogous lists of words, numbers, and letters from Choynowsky's and Meili's picture memory tests. A 4x3x2x2 factorial design which was used in analysing the results showed that the visual modality was more effective than the auditory. Age was a

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1. Bruhl, L. Primitive Mentality. (New York: Beacon Press, 1966).

2. Bowen, E.S., 1964, Return to Laughter, (New York: Doubleday, 1964) p.16.

3. Corsini, D.A. Jacobus, K.A. and Leonard, S.D. "Recognition Memory of Pre-School Children for Pictures and Words". Psychonomic Science, 16, (1969), pp.192 - 193.

highly significant factor in relation to ability. Girls showed better retention than boys ($p < .05$) and interstimulus differences were marked, suggesting that retention is very dependent upon the nature of stimulus used. Interesting results in recall and recognition are expected among pre-school Kenyan Children in Nairobi.

## 2.4 An outline of findings of research studies on differences between socio-economic groups.

Many researches done in Western countries show differences in cognitive development of children from different socio-economic status. In the present study, one of the purposes of the study is to find out whether differences occur in the comprehension of mathematical concepts between children from the three categories of pre-schools - high cost, medium cost and low cost.

The stratification of the experiences which children take to school is often referred to in terms of social class. Kohn (1963)[1] indicates that social class refers to more than educational level, or occupation, or any number of correlated variables. Social class relates the interplay of all possible variables which create different basic conditions of life at different levels of the social order. Members of different social classes, by virtue of enjoying (or suffering) different conditions of life, see the world differently - to develop different conceptions of social reality, different aspirations, hopes and fears, and different ideas of the desirable. These outlooks have an adverse effect on the children of the lower classes before school entry.

1. Kohn, M.L. "Social Class and Parent-Child Relationships" American Jn. of Sociology LXIX, (Jan. 1963).

In the Western countries, much literature has been written on this issue. "Middletown" (Lynd and Lynd, 1929)[1] in the late twenties, "Who shall Be Educated" (Warner et al, 1944)[2] in the early forties, "Social Class Influences upon Learning (Davis, 1948)[3] in the late forties all dealt with this issue. Proposals for doing something special for the lower class school child were not lacking. But these proposals were remedial rather than preventive. The dilemma was, the significance of the impact of early experience when the child not only acquired a characteristic set of value, language, and fund of information but he literally learns to learn. The tools he acquires for meeting the problems he will face in school are different from those that the middle class child acquires.

The study by Lynds showed a cognitive deficit in lower over upper class children. Other studies emphasising on the effect of environment on learning to learn include:

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1. Lynd, R.S. and Lynd, H.M. Middletown, (New York : Harcourt, Brace and World, Inc., 1929).
2. Warner, W. Haringhurst, R.J. and M.B. Loeb. Who shall be Educated (New York : Harper & Row, 1944).
3. Davis, A. Social Class Influence upon Learning (Cambridge, Mass : Harvard University Press, 1948).

Irwin (1948)[1] found a systematic relationship between mastery of speech sounds in infants 1 to 30 months of age and the occupational status of the family; Milner (1951)[2] found a significant relationship between the reading readiness of first grade children and the "verbal environment" at home; Montague (1964)[3] found a similar relationship between the arithmetic concepts of kindergarten children and the socio-economic status of their families; and in a notable series of studies, Deutsch and his colleagues (1964)[4] have gone a step further in specific city and shown that not only are there differences in cognitive performance between social-class and race groups but with the groups, "particular level of cognitive performance reflects certain specific environmental characteristics, "Hess (1964)[5] has shown the same relationship for the acquisition of language and the nature of the mother/child interaction. In short, numerous studies attest to the view that the development of both general and specific cognitive abilities - the abilities required for success in school - is determined in many critical ways by the availability of relevant experiences in the pre-school environment.

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1. Irwin, D.C. "In fant Speech: the Effect of Family Occupational Status and of Age on Use of Sound Types." J Sp. H. Disord., 13, (1948) pp.224-226.
2. Milner, "A Study of The Relationship Between Reading Readiness in Grade One School Children and Patterns of Parent - Child Interactions" Child Dev.,22, (1951), pp.95-122.
3. Montague, D.O. "Arithmetic Concepts of Kindergarten Children in Contrasting Socio-Economic areas," Elem. Sch.J. 64, (1964), pp.393-397.
4. Deutsch, "Facilitating Development in the Pre-School Child Social and Psychological Perspectives, Merrill-Palmer Quart.10, (july, 1964), pp.249-263.
5. Hess, R."Education and Rehabilitation: Future of theWelfare Class." J. Marriage and the family,26, No.(1954).pp.422-429.

## 2.41 A local study on different categories of pre-schools

The only local project that was available was a pre-test which was administered in February, 1975, by the Pre-school Education Project, K.I.E. Unfortunately the results of the post test were not available. A standardised test for early childhood education in Jamaica called the Cadwell Pre-school inventory was given. Although it is not culture free, it "permits educators to highlight the degree of disadvantage which a child from a deprived background has at the time of his entering school in order to help eliminate any observed deficits." It was also found easy to change and adapt some of the items to suit the local environment.

The Sample:

A sample of 113 children whose ages ranged between 4 years, 10 months and 5 years, 8 months was tested. This sample was drawn from low cost and high cost day care centres served by the Pre-school project, day care centres not served by the project, Harambee (self-help) day nursery and pre-schools attached to primary schools served by the project.

The Instrument:

The test was made up of four subtests each measuring some different aspects of the curriculum, namely: Personal -social responsiveness, involving the child's knowledge of his personal world as represented by his name, where he lives, parts of his body and ability to respond to verbal instructions by an adult with appropriate actions, e.g. show me your neck etc.

Associative vocabulary, including types of behaviour demonstrating awareness of word meanings and verbal concepts e.g. which jar has most water?

Which way does water come out of a tap?

Concept - Activation - numerical, involving responses to ordinal and numerical concepts e.g.

How many eyes do you have?

How many wheels does a car have?

Concept activation - sensory, involving reactions to such attributes as form, colour, size, shape and motion e.g.

What colour is this? (red crayon shown)

Which is heavier a spoon or a feather?

Language of instruction

The testers were free to use any language that the child understood. Languages used were English, Kiswahili and Vernaculars. The test was translated into Kiswahili but not into the vernaculars so that the depth of probing for the right answers in the vernaculars was not controlled for.

Procedure

All children were tested individually by two trainees under the supervision of the Project staff, one would ask the question while the other would record the response.

Results

An analysis of variance was used on the total scores showing each child's overall performance to verify the consistency of differences between means.

No significant differences were found between the different types of day care centres - low cost, high cost served or not served by the project, pre-schools or harambee day nurseries.

No significant differences were found between the sexes.

Comment on above study

An item analysis would have shown the level of comprehension of the various concepts and would have been useful for comparison purposes with the present study.

The fact that the test directions were not written out in the vernaculars used and were, therefore, not uniform can cause serious differences in the depth of probing by the testers. This can influence the results considerably.

2.42 Report by Montague (1964)[1] on performance by kindergarten children of different socio-economic status.

The Sample:

Montague administered checks to 51 low and 31 high socio-economic status kindergarten children.

The Test:

A test on numeration, quantitative relationships, symbol recognition, social usage, and problem solving.

The findings:

He found a significant difference between the social classes with low socio-economic children gaining poor scores on the concept checks.

1. D.O. Montague, 1964, Ibid.

This report gives no details of the research design which is a serious shortcoming, but it shows that differences occur in performance of the test between the high and low socio-economic children.

2.43 A study by Abiola (1966)[1] on Nigerian children from different groups.

The Sample

Abiola in his study of 1-5 year olds compared two groups of children selected randomly, matched for age, sex and location in a Yoruba township. One group was from a traditional Nigerian community, called OJE, and the other from an elite or western-oriented group.

The Test:

The materials consisted of an interview schedule regarding the effective environment and habit patterns of the children; an observed behaviour schedule regarding the situation/motor, language, social and emotional behaviour of the children; a perceptual/motor test utilizing local adaptations of materials on location, form and spatial characteristics of objects in children's environment derived from Gessel and Merill-Palmer scales; a conceptual verbal test on words and work groups; identification and simple characteristics of objects and their functional descriptions, names of parts of the body, counting and identification of numerical character of objects.

1. Abiola, E.T. The Intelligent Behaviour of Nigerian children, (African Education Press, Ibadan, 1966), p.44

The Findings

Abiola found that the elite group of children were superior to OJE group of children on perceptual and conceptual tests.

2.44 Factors mentioned in the literature that could cause these differences between socio-economic groups.

These differences in performance between socio-economic groups, with the low socio-economic group proving inferior each time, are linked with the role of experience that has not been adequately assessed by Piaget (1963)[1] although he does acknowledge the significance of environment as a stimulant when he says: "Naturally, the ages at which different children reach the stages may vary. In some social environments the stages are accelerated, whereas in others they are more or less systematically retarded. The differential development shows that stages are not purely a question of the maturation of the nervous system but they are dependent upon interactions with the social environment and with experience in general. The order, however, remains constant".

Differences between socio-economic groups related to rearing practices.

Macauley (1972)[2] observed that the traditional child rearing practices among Africans do not aid the cognitive learning process of the African child when he enters the Western oriented

1. Piaget, J. (1963). Ibid.

2. Macauley, J.I., Motherhood and Child Care, (Ethiope Publishing Corporation, Benin City, 1972), p.144.

school environment and the habits between home and school confuses the child initially and possibly retards his 'progress' as measured by western instrument.

Uka (1966)[1] and Hake (1972)[2] in their own studies reached similar conclusions on child rearing practices both in Northern and Southern Nigeria and their effect on the formal education of the child.

In Symbol play, Sara Smilansky (1968)[3] describes a study comparing the play of Israeli nursery-school children from middle and high socio-cultural back-grounds. She reports, "Our observations indicate the culturally deprived children aged from 3-7 years in spite of their development in the language learning process do not develop the ability to engage in symbol play". The 'advantaged' children's parents were found to join the make-believe games of their children and even to play, while the parents of the 'disadvantaged' children did not join their children's games or teach them how to play. Sutton-Smith has pointed out that "Smilansky's findings contribute considerably

1. Uka, N. "Growing Up in Nigerian Culture," Occasional Paper No. 6, Institute of Education, University of Ibadan, (1966) p.110.

2. Hake, J.M. Child-Rearing Practices in Northern Nigeria, (Ibadan, University Press, 1972), p.142.

3. Smilansky, S. - referred to by Fjellman (1971)

. to the view of D. El 'Konin (1971)[1] that the member of the adult culture play a determining role in children's play.

Hess et al (1965)[2] with groups composed of middle class, upper working class and lower working class negro mothers and their four year old children, tested how the mothers taught their children to sort toys. "While love and affection were found to be the same for all groups, teaching style was different, the upper class being superior in early cognitive relationships between mother and child. Other children started with deprivation giving them a major handicap in their exploration of the environment".

2.45 A Study on Zambian Children of two different socio-economic groups by M.O. Okonji.[3]

The aim of the study was to attempt to find out the extent to which the pattern of the early classificatory behaviour described by Inhelder and Piaget (1964) was observable among African children of two different socio-economic background.

The Sample

A total of 128 children were included in the study. Their ages ranged from about 3 years to about 6 years. Of the total number, 41 boys and 30 girls were recruited from private Nursery schools in various part of the city. The private nurseries char-

1. El'Konin, D. Symbolies and its Functions in the Play of Children in R. Herron and B. Sulton-Smith (eds). "Child's Play,"(New York, John Wiley and Sons 1971).

2. Hess, R.D., Shipman, V. and Jackson, D. Early experience and the socialization of cognitive modes in children". Child Development. (Dec. 1965).

3. Okonji, M.O. The Development of Logical Thinking in Pre-school Zambian Children: Classification; Lusaka, University of Zambia, H.D.R.U., 1972

ged such high fees that only quite well off parents could afford to send their children there.

Apparatus

The objects for sorting were 36 cut out pieces of plywood in three different geometric shapes - circles, triangles and squares. Each shape was represented in two sizes (small and large) and in three different colours (yellow, green and red).

Procedure

All the children were tested individually by experienced female research assistants. The instructions were translated from English to the local tongue, Chinyanja. Sorting was done under two conditions - free sorting and guided sorting, using one, two or three attributes - colour, size or shape.

Results

Among nursery school children, 'unclassifiable' groupings predominate with 50% or more of all groupings falling into this category. The proportion of "unclassifiable groupings" dropped sharply from 76.93% at age 3 to 27.78% at age 6. The graphic collections at all ages was very low. In free sorting, more children at ages 4 and 6 years sorted on the basis of colour than any other criteria.

In the guided section, the results of the sorting done by children did not indicate that the children were able to form classes even when provided with cues. The best performance appeared in the completion of the strings which suggested sorting by colour.

Discussion

The overall pattern of results did agree with Piaget's general view that children were not able to form classes until about the ages of 7-8 years. No real differences emerged between the children who had some nursery school experience and those who live in a relatively poorer environment without any nursery school experience. It might be that the precursors of classificatory ability were the simple sensorimotor acts described by Inhelder and Piaget (1964)[1]. The opportunities for the optimum performance of these acts were likely to be the same for the children from those two different social settings.

## 2.5 AN OUTLINE OF FINDINGS OF RESEARCH ON AGE DIFFERENCES

Jean Piaget is perhaps the person who has done most work on age differences and stages of intellectual development. He identifies four basic stages in the development of mental structures:

(i) The Sensorimotor stage - from birth to about 18 months. This is the pre-verbal, pre-symbolic period.

(ii) The Pre-operational stage - from about 2 to 7 years. This he calls the representational stage.

(iii) The Stage of Concrete operations - from 7 to 11 years. Here, the child can manipulate the operations only when he is dealing with the properties of the immediately present object world.

1. Inhelder, B. and Piaget, J. The Early Growth of Logic in the Child: Classification and Seriation. Translated from the French by E.A. Lunzer and D. Papert. (Routledge and Kegan Paul, London. 1964)

(iv) <u>The stage of formal operations</u> - 11 years onwards. Now, the operations are no longer applied solely to manipulations of concrete objects, but now cover hypotheses and formal propositions.

Although Piaget sets down usual ages for each period, he does not assert that these are absolutely fixed. He simply states that the periods are ordered, that they will in all cases succeed one another, as described. Possibly more intelligent children attain each stage at an earlier age than do the less intelligent.

According to Piaget, then, the children dealt with in this study are in the pre-operational or representational stage. To be more precise, the 4 to 6 years old under study are in the transitional stage where characteristics of the pre-operational stage progressively change towards those of the concrete operations stage. A clear understanding of these children, for this study, is important.

In this stage, because of symbolic functions and the advent of language, it becomes possible for the child to invoke objects that are not present perceptually, to reconstruct the past, or to make projects, plans for the future, to think of objects not present but distant in space. The child participates in symbolic play, representing something by means of something else. He is also capable of delayed imitations, an imitation that takes place not in the presence of the original object but in its absence. The child at this stage is able, in short, "to span spatio-temporal distances much greater than before."[1]

In answering the questions, the pre-operational child shows a greater reliance on present perception than does the operational child. The perception on which he relies tends to be partial, that is, it focuses on a single dimension of the problem. Piaget came to this conclusion after doing many experiments with continuous and discontinuous quantities,e.g. the liquid and different sizes of glasses, bottles and glasses, beads in jars, counters and matches arranged differently etc.

According to Piaget, conservation, one-to-one correspondence, seriation, classification are all age dependent. Their development of understanding follows three stages where the child at first shows no understanding, in the next stage the child shows partial understanding and then later shows full understanding.

After many experiments, Piaget came to the conclusion that children must grasp the principle of conservation of quantity before they can develop the concept of number. For the average child, this happens at around 6½ to 7 years of age. In seriation, children in the pre-operational stage are unable to construct a series. When they are given a set of objects to arrange in order of size, they begin at random and try to

1. Piaget, J. 1962, p.124. Ibid.

rearrange in order of size only when very noticeable discrepancies occur. The operation of serializing appears around age 7 or 8 years. In sorting, Piaget says that the method of sorting used by children follows an age progression. The youngest less than 5 years old, make more sort of graphic or geometric display of the objects. They are unable to classify the objects in accordance with some property, such as colour, shape or size. In classification, the first stage is when the child sorts a collection of objects on the basis of attribute similarity, but is soon distracted by the configurational aspects of the formation. He may begin to classify objects into categories, as asked, but he soon forgets the attribute defining each of the classes and begin to miss the shapes.

Class inclusion operations relate to the child's ability to manipulate part-whole relationships within a set of categories. The simplest operation is concerned with classifying objects according to their similarity and their difference. This is accomplished by including subclasses within larger and more inclusive general classes, a process that implies logical inclusion. According to Piaget, such a classification is not acquired until around 7 or 8 years of age. Before that age, at the pre-operational level, logical inclusion is not evident. Piaget gave the experience of a test he had given using some white and brown all wooden beads. Most beads were brown. The child was asked whether there were more wooden beads or brown beads. The pre-operational child answered more brown beads.

Piaget attributes this inability to the fact that the pre-operational child reasons either on the basis of the whole or of the parts. He cannot understand that the part is complementary to the rest, and he thus says there are more brown beads than wooden beads.

To study the growth of classificatory system the child is given [Inhelder and Piaget (1964)[1], Lovell, Mitchell and Everett (1962)[2]] a collection of geometric figures, letters of the alphabet, etc., made of differing materials and of different colours. He is told to sort and classify them. From 2½ to 5 years of age, the child makes what Piaget calls graphic collections. No kind of plan can be observed. Between 5 - 7 years of age, objects are now grouped on the basis of similar properties but the child is inconsistent suggesting an inadequate. grasp of the inclusion relationship. Between 7-8 years, the child can now make true classification.

A number of people have done tests on conservation. These include Piaget (1962), Hyde (1959), Price-Williams (1961); and (1962), Etuk, (1967) and Otaala (1972), some of these have already been mentioned in this study.

1. Piaget, J. and Inhelder, B. (1964), Ibid.

2. Lovell, K., Mitchell, B. and Everett, I. "An experimental study of the growth of some logical structure", Brit. J. Psych., 53.( 1962), pp.175-88.

Piaget (1962)[1] observed three stages in the development of understanding, pre-operational transitional and operational as mentioned earlier. A child at the pre-operational level does not at first assume conservation of either continuous or discontinuous quantities when the perceptual configuration is changed. He cannot understand that when there is a change in the distribution of the parts, the number of the elements remains invariant. During the transitional stage, the child is still restricted to sensory intuition and remains prelogical although on the practical plane it allows of qualitative correspondence. In some instances the child maintains conservation but not in others. The operational stage is the stage of lasting equivalence. The sets are now assumed to be equivalent, whatever the configuration or the distribution of the elements. This comes at around $6\frac{1}{2}$ to 7 years 8 months.

A number of cross-cultural researchers confirm most of Piaget's findings, mainly on the sequence of the stages of mental understanding and the fact that number, like classification, is age dependent.

Elkind (1962)[2] administered tests of conservation of number of continuous and discontinuous quantity to American children aged 4 to 7 years and confirmed Piaget's findings.

1. Jean Piaget, 1962, Ibid.

2. Elkind D., "The Development of Quantitative Thinking," Jn. of Genetic Psychology, 98, (1961), pp.36-46.

Hyde (1959)[1] carried out her study in Aden on a multi-racial group of subjects aged 6 to 8 years (48 Arabs, 48 Europeans, 24 Indians, and 24 Somali children). She presented several Piagetian tasks using such local materials as shells and beads, and obtained results similar to Piaget's. Tasks involving seriation and class inclusion were difficult for all subjects in general, and for non-European subjects in particular. She found classification to be age dependent.

1. Hyde, D.M. "An Investigation of Piaget's Theories of the Development of the concept of Number". (Ph.D. Thesis : Univ. of London, 1959).

## 2.6 AN OUTLINE OF FINDINGS OF RESEARCH STUDIES ON SEX DIFFERENCES:

Many research studies mainly conducted in the West have shown that boys and girls differ from each other in many ways. They differ physically, psychologically as well as in some behavioural aspects and in certain areas of cognitive functioning. Summarizing a number of researches, Hochschild (1973)[1] explains, "the sexes differ in the way they think (Maccoby, 1966)[2], perceive (Bieri et al, 1958), aspire (Horner, 1968; Turner, 1964), experience anxiety (Sinnick, 1956), daydream (Singer, 1968) and play competitive games (Vesugi and Vinachke, (1963). Men tend to have an exploitative strategy, women an accommodative one, which even wins some games."

Most studies on sex differences have been carried out in children or adults older than the children under study. The person who has, perhaps, carried out most researches on sex differences is Maccoby (1966). According to her, in the area of verbal ability, sex differences up to the elementary school age were slight, but the trend was for the differences if found to be in favour of girls.

Most studies show no consistent sex differences. On verbal skills, Maccoby suggests that there may be distinct stages in the development of verbal skills, one before the age of three and another at about the age of eleven, with very little sex difference in between the ages of 3-11 years on verbal skills.

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1. Hochschild, A.R., "A Review of Sex Role Research" in Changing womenin a Changing Society, Ed. by Joan Huber (Chicago and London: Univ. of Chicago Press, 1973), p.253.
2. Maccoby, E.E. ed. Sex Differences in Intellectual Functioning in The Development of sex Differences, Stanford University Press, Stanford, 1966.

On number among pre-school children, Maccoby's review of literature on Mathematics ability showed no sex difference on performance on number conservation tasks or on enumeration. During the early school years as well, no sex differences are found in the mastery of numerical operations and mathematical concepts.

On the whole, Maccoby concludes that there is very little sex difference in variability prior to adulthood.

Singhal and Crago, (1971)[1] tested children of the age range 5-6 years from New York State. These children came from economically disadvantaged homes of migrant families. Their findings showed that girls obtained higher mean grade scores in both reading and the arithmetic pretests at most of the grade levels.

Recently in his review of literature on sex differences in mathematics achievement, Fennema (1974)[2] reported that at the pre-school level, $\frac{3}{4}$ of the investigators reported no significant differences between boys and girls.

1. Singhal, S. & Crago, P.H. "Sex Differences in the School Gains of Migrant Children," Jn. of Educational Research, Vol.64, (1971), pp.417-419.

2. Fennema, E., "Mathematics Learning and the Sexes: A review," Jn. of Research in Mathematics Education, (1974), p.128.

# CHAPTER THREE
# DESIGN OF THE STUDY

## 3.0 INTRODUCTION

Section 3.1 of this chapter gives a description of the test batteries used. Certain changes which were made in these test batteries are explained in section 3.2. While section 3.3 describes the test administrators, section 3.4 describes the student questionnaire. Section 3.5 deals with the pilot study, its aims, purposes, item and scale analysis data results and the major and other findings. Section 3.6 gives a description of the main study - the research sample and its selection, a description of the sample of children tested, methods and procedure of the administration and the methods used for sorting the test and coding the responses.

## 3.1 The Test Batteries

The test batteries used in this study are a combination of K-01 and K-02 scales used for kindergarten children in California, U.S.A. in 1966 by the School Mathematics Study Group (SMSG). This group embarked upon a four year longitudinal study of mathematical learning in the primary grades, the Elementary Mathematics Project (ELMA). The K-01 Scales were given in September, 1966. They were planned as an evaluation of readiness for learning mathematical concepts. The K-02 scales were given in May 1967, as the end-of-year test battery. This was planned primarily to assess gain in mathematics over the school year.

The test batteries were devised so that the children responded, in most tasks, to concrete materials. When printed drawings were employed as test materials, they were as parallel forms to those tests utilizing concrete objects. Verbal responses were necessary in only a few of the test items. For those items requiring the children to make verbal responses, a single word or short phrase was sufficient.

These test batteries were organised into four main groups. Classification, number, vocabulary and visual memory and were the same as described in chapter one.

### 3.2 Changes made in the K-01 and K-02 Scales for this study

Changes were made in a few items to make the objects and pictures used by the children in Nairobi as familiar as possible. Counting buttons was changed to counting beans which were familiar and easily available. In counting of members of a given set - pictures, new, bigger pictures were drawn, resembling as closely as possible the original pictures. Non familiar original pictures like kite, apple, boots, coniferous trees, yatcht, cone, boat and gloves were replaced with pictures of more familiar objects. Some pictures like pictures of girl, boy, bird, flag, cat and dog were re-drawn in a more familiar way. In the conservation pictures, Kenya flags and Kenya shields were used instead of the USA flags and shields.

## 3.3 The test administrators

Test administrators were carefully chosen for the test batteries. All of them had to be women since the pre-school children in Nairobi are used to women teachers only. Five of them were pre-school teachers who had been trained as pre-school teachers at K.I.E. and had had experience in testing and working with young children. These tested the 4 and 5 year olds in day nurseries in Nairobi. Of the other two testers, one was an 'A' level school leaver and the other an 'O' level school leaver both of whom love children and are very patient with them. These tested the older children – 5 and 6 year olds in pre-schools attached to primary schools and in standard one classes of primary schools. All these testers attended a training session in early December, 1976 just before embarking on a pilot study which gave them their first experience in handling the children and materials for this study.

## 3.4 The Student Questionnaire

Each child was given an identification number. The children's sex, type of school and age were filled in first. The age was checked in the class register or the school admission forms. Each child was asked whether his father owned a car, how he goes to school, where he lives, whether the father is employed and whether the mother is employed. These questions were supposed to help in clearly defining the socio-economic status (SES) of each child. Since most fathers owned a car and were employed, the SES used was only that of type of school attended.

## 3.5 The Pilot Study

In December, 1976, a pilot study was carried out in the NCC day nurseries. The primary purpose of the pilot study was to test the appropriateness of the scales to be used in the main study and to try out the materials selected. The study was also used to review the problems likely to be encountered in the main study like – the time taken with each child, the actual words to use in the directions, statistical analysis and also to help estimate the costs of the study.

There were very few children attending the day nurseries in December as most of them had taken leave to be with the older siblings who were on holiday or to accompany the family to the rural areas. Where numbers allowed, children were chosen randomly, otherwise those available and were of the ages four to six were the ones tested. A sample of 33 children was tested. These included 12 boys and 4 girls from the high cost pre-schools and 6 boys and 11 girls from the low cost schools. There were no children in the medium cost schools during the time of the pilot study.

The Test Batteries and the student questionnaire were as described in sections 3.3 and 3.4 respectively.

### Methods and Procedure

After a training session, all the testers were sent to the day nurseries for the pilot study. Where possible, the testers sat in one room with the child, facing each other on either side of the table. Play houses in the day nurseries proved quite useful for this purpose.

The tests were mainly done in the mornings. Each child was tested on a few items per day depending on his level of concentration and co-operation. Each task was treated as a game. Where the tester got no response, she passed on to another game. A positively reinforcing attitude was adupted by each tester throughout the testing period.

Item and Scale Analysis of the Test Batteries used in the pilot study

The mean, standard deviation and reliability co-efficient for the test batteries were computed. These are shown on the table below -

Table 3: SCALE STATISTICS FOR THE TEST BATTERIES

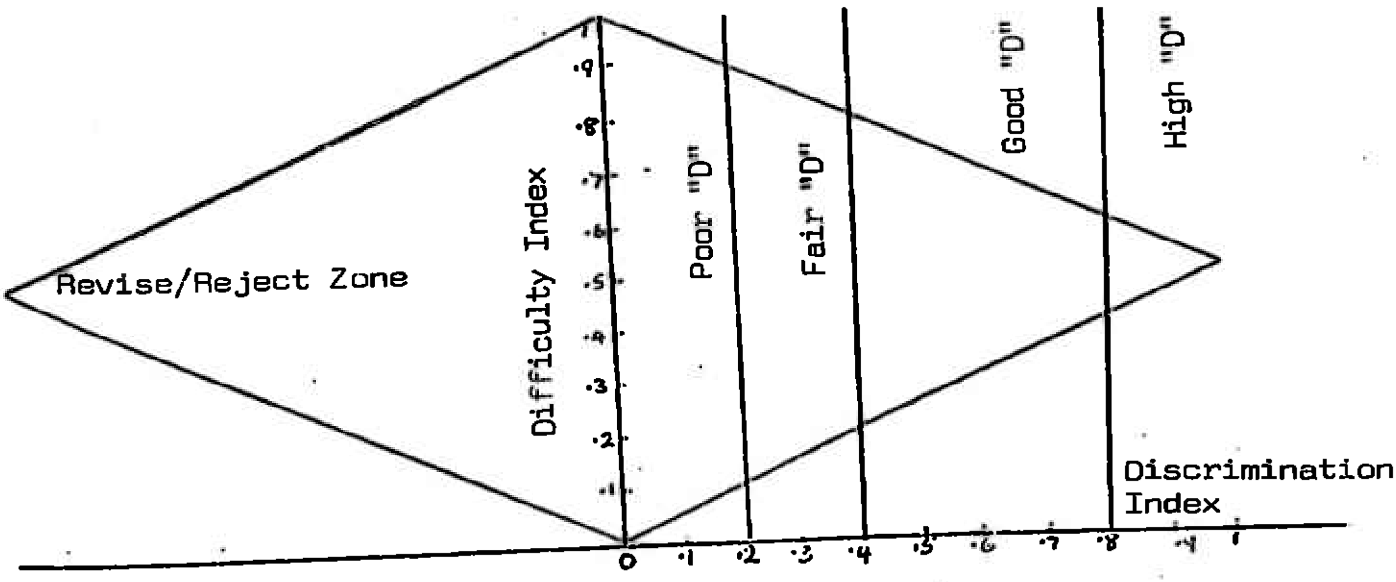
| | | |
|---|---|---|
| Sample | = | 33 |
| Number of items | = | 145 |
| Mean | = | 64.4 |
| Standard Deviation | = | 26.6 |
| Reliability Co-efficient | = | 0.96 |

For each of the items in the test batteries, the item means, item standard deviation and item difficulty and discrimination indices were computed.

On the basis of the values of the item statistics analysed, decisions were made as to whether an item was to be retained, revised or rejected. As a rough guide, a diagram by Kryspin et al[1] was used. For ease of reference, this diagram is reproduced below -

1. Kryspin W.J. et al. Developing Classroom Tests : A Guide for Writing and Evaluating Test Items. Minneapolis Burgess Pub., 1974.

Figure 1 : Showing the quality of difficulty and discrimination indices.




Difficulty and discrimination indices were plotted on the above diagram. Although most items were in the poor and fair "D" sections, none of the items fell on the Revise and Reject Zone. None of the items, therefore, were revised or rejected.

Analysis of Pilot Study Data on the Test Batteries

Since one of the purposes of the pilot study was to help in gaining insight into the nature of the statistical involved in the testing of the hypotheses as set out in the proposal, an analysis of the data from the pilot study sample was carried out. This analysis was, however, not meant to prove or disaprove any hypothesis as such. In view of the small size of sample used and the fact that there were no children from the MC. type of schools, a one-way ANOVA proved useful in tests of no difference in mathematical concepts acquired by children in the age range four to six years. The t-test was useful in tests of no difference in comprehension of mathematical concepts between boys and girls and between the HC and LC types of School children. Each of the hypotheses were tested at .05 level of significance.

The Findings of the Pilot Study

The major conclusions drawn from the pilot study were:

1. There is a significant difference in comprehension of mathematical concepts betweeen children from different types of Schools when tested at .05 level of significance in classification, vocabulary and visual memory but not in number. Each time the HC children performed better than the LC children.
2. There is no significant difference in mathematical concepts acquired by children in the age range four to six in classification, vocabulary or visual memory.
3. There is a significant difference in mathematical concepts acquired by children in the age range four to six in number. A difference between means test showed that the five year olds do significantly better than the four year olds but although the 6 year olds perform better than the 5 year olds, the difference was not statistically significant.
4. There is no significant difference in comprehension of mathematical concepts between girls and boys in classification, number, vocabulary or visual memory.

Other findings of the Pilot Study

Due to much guesswork and arbitrary decisions on the logical connectives and the conservation tasks, the author decided that for th emain study, these items' scores would not be considered in the overall performance. They were to be used only in showing classification or conservation level of Nairobi children.

A few changes were made in the commands given to the children for example,instead of using the word 'equivalent', we used 'same'.

The language to be used in the testing was to be strictly adhered to. This was because some testers felt they wouldn't get much information from the many LC schools where children didn't understand English.

In the Visual Memory- objects, tasks, there was no practice set. Those children who did not understand English were to be given practise in the visual memory game so that they understand what was required.

## 3.6 THE MAIN STUDY

### (a) The research sample and its selection:

The sample used in the main study consisted of a random stratified sample of 9 day nurseries in Nairobi. This is a stratified sample by administration since there are only 15 day nursery schools under the NCC and 4 of them had already been used in the pilot study. The Sample was also drawn from 5 primary schools with pre-schools attached to them. Out of the 105 primary schools run by the NCC, only 15 have pre-schools attached to them. Of these 15, 3 are HC, 1 is MC and 11 are LC. The research sample was taken from 2 HC, 1 MC and 2 LC schools. 2 LC and 2 HC schools were selected because the LC schools have more children than the HC schools.

In each school, children of ages 4,5 and 6 were randomly selected and tested. A total of 408 children were tested. 8 scripts were thrown away because of some sections which were incomplete due to the irregular attendance of some children.

b) <u>Description of the sample of children tested</u>

All the children tested were asked a few questions at the beginning of the testing session about themselves and their parents. These questions were meant to help in understanding the background of the sample of children being studied.

Out of a sample of 400 children 205 or 51.3% of the total sample were boys while 195 or 48.8% of the total sample were girls

Table '4' below shows the number of boys and girls in each type of school and the percentages.

Table '4': Distribution of boys and girls in the different types of schools.

| | LC | | MC | | HC | | Row Total | |
|---|---|---|---|---|---|---|---|---|
| Sex | N | % | N | % | N | % | N | % |
| Boys | 116 | 54.5 | 40 | 46.0 | 49 | 49.0 | 205 | 51.3 |
| Girls | 97 | 45.5 | 47 | 54.0 | 51 | 51.0 | 195 | 48.8 |
| Column Total | 213 | 100 | 87 | 100 | 100 | 100 | 400 | 100 |

Three age groups of children were tested in this study. These were 4, 5 and 6 year olds.

Table 5 shows clearly the number of girls and boys in each age group.

Table 5: Distribution of boys and girls in different age groups

| | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|
| Sex | N | % | N | % | N | % |
| Boys | 55 | 45.8 | 63 | 45.7 | 87 | 61.3 |
| Girls | 65 | 54.2 | 75 | 54.3 | 55 | 38.7 |
| Column Total | 120 | 100 | 138 | 100 | 142 | 100 |

All the 4 year old children and most 5 year olds were found in the nursery schools. All the 6 year olds and some 5 year olds were found in the pre-primary classes attached to primary schools and standard one classes in those schools with pre-schools attached to them.

Just in case the distribution of age groups in the different types of schools prove useful when the analysis is done later on, the table below was included.

Table 6 : Distribution of age groups in different types of Schools

| | LC | | | MC | | | HC | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | N | % | Age | N | % | Age | N | % | Total | % |
| 4 | 64 | 16 | 4 | 33 | 8.3 | 4 | 23 | 5.8 | 120 | 30 |
| 5 | 71 | 17.8 | 5 | 26 | 6.5 | 5 | 41 | 10.3 | 138 | 34 |
| 6 | 78 | 19.5 | 6 | 28 | 7.0 | 6 | 36 | 9.0 | 142 | 35.5 |
| TOTAL | 213 | 53.3 | | 87 | 21.8 | | 100 | 25.1 | 400 | |

When the children were asked whether their fathers owned a car or not 145 or 36.3% of the total sample said their fathers owned cars. But when asked how many are taken to school by car 167 or 41.8% of the children said they are taken to school by car.

In the city of Nairobi, children go to school either by walking or by car or by bus. Most of the children who walk live close to the school and/or their parents do not have cars. Those who go by bus live far from the schools and their parents either do not have cars or prefer their children to go by bus. Most car owners are in the HC and MC groups as Table 7 shows.

Table 7: How Children go to School in different types of Schools:

| | LC | | MC | | HC | | ROW TOTAL | |
|---|---|---|---|---|---|---|---|---|
| Transport | N | % | N | % | N | % | N | % |
| Walk | 155 | 71.8 | 36 | 41.4 | 24 | 24.0 | 215 | 53.3 |
| Car | 47 | 22.1 | 51 | 58.6 | 69 | 69.0 | 167 | 41.8 |
| Bus | 11 | 5.2 | 0 | 0 | 7 | 7.0 | 18 | 4.5 |

It is mainly the older children who walk to school as table shows:

Table 8: How Children of different age groups go to School:

| | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|
| Transport | N | % | N | % | N | % |
| Walk | 46 | 38.3 | 75 | 52.9 | 94 | 66.2 |
| Car | 68 | 56.7 | 58 | 42.0 | 41 | 28.9 |
| Bus | 6 | 5.0 | 5 | 3.6 | 7 | 4.9 |

95.8% of the fathers are employed either privately or by the many bodies that employ people in the city. The 4.2% of the children who said their fathers were not employed did not seem to know what their fathers did for a living. Some didn't live with their fathers. Most of these children go to the LC type of school as table 9 shows.

Table 9 : Fathers working or not working with children in different schools

| | LC | | MC | | HC | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Works | 199 | 93.43 | 86 | 98.9 | 98 | 98.0 |
| Doesn't work | 14 | 6.6 | 1 | 1.1 | 2 | 2.0 |

65.8% of the mothers work. Most of those who do not work take their children to the LC type of school as table 10 shows.

Table 10: Mothers working or not working with children in different types of schools:

| | LC | | MC | | HC | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Works | 120 | 56.3 | 61 | 70.1 | 82 | 82.0 |
| Doesn't work | 93 | 43.7 | 26 | 29.9 | 18 | 18.0 |

Tables 9 and 10 show that the bigger percentage of parents who are both working take their children to the HC schools.

49.3% of all the children tested live in the LC residential areas of the city, while 24.4% live in MC and 19.4% live in HC residential areas of the city. Table 11 shows the numbers and percentages of children living in the main areas.

Table 11: Different categories of residential areas where children tested live

| LC | | | MC | | | HC | | |
|---|---|---|---|---|---|---|---|---|
| Areas | N | % | Areas | N | % | Areas | N | % |
| Eastlands | 132 | 33 | Langata-Ngei | 7 | 1.8 | Kilimani | 51 | 12.8 |
| Kibera | 9 | 2.3 | Nairobi West | 69 | 17.3 | Kileleshwa-Lavington | 21 | 5.3 |
| Riruta – Kangemi | 52 | 13 | Woodley-Jamhuri | 21 | 5.3 | Parklands-Westlands | 5 | 1.3 |
| Total | 193 | 48.3 | Total | 97 | 24.4 | Total | [illegible] | 19.4 |

8.2% of the children live outside the city boundaries and could, therefore, not be placed into any of the three categories of residential areas.

c) Test Scoring and Data Coding:

The most common type of data in this test is the sort where the possible values were "correct", "incorrect"and "no respon[s]
All such items were encoded 0 for incorrect, 1 for correct and 9 for no response. The questionnaire consisted of some general information at the top of the first page, followed by 145 items. For most items, there was one piece of information to be encoded, but for some there was more information and hence for these, more than one column of information was encoded per item. For still others, there was no information to be encoded.

d) General Information:

Results for each candidate were recorded in three cards. Card 1, card 2 and card 3. The first three columns of card 1, indicated the candidate's identification number, column 4 signified whether this was card 1,2 or 3. The rest of the general information was coded on card 1 where in column 5, 1 was coded for male, 2 for female, column 6 showed age in years - this was either 4, 5 or 6. Columns 7-8 showed number of months above the number of years given e.g. if pupil's age was 4 years, 3 months, the data in columns 6-7-8 would be "403". Column 9 signified the school type where 1 is for the Low Cost schools, 2 for Medium Cost school and 3 for HC. Column 10 signified whether the father owned a car, 0 was coded for "no" and 1 for "yes". Column 11 signified how children go to school - codes used were 1 for walk, 2 for taken by car and 3 for other which meant mainly "bus".

A two-digit code was used for showing where children live and was recorded on columns 12-13. 01 signified those who live in Eastlands, 02 those who live in Langata - Ngei area, 03 for Nairobi West Area, 04 for Woodley - Jamhuri area, 05 for Kibera, 06 for Kilimani area, 07 for Kileleshwa-Lavington area, 08 for Riruta-Dagoretti-Kangemi area, 09 for Parklands-Westlands area and 10 for areas outside Nairobi. Finally, columns 14-15 signified whether father and mother were employed. 0 stood for "no", 1 for "yes".

e) Classification skills score and code:

One mark was awarded for each of the following items for which the student's coded reply was "1". Items 1-12 and item 90. In the sorting items 88, 91 and 93(squares), 93(circles), and 94, a maximum of 4 marks was awarded for any 4 shapes sorted correctly. If only 2 shapes were correctly sorted, only 2 marks were awarded etc. In these items, numbers 4,3,2,1 or 0 were encoded to signify the number of shapes sorted. In items 95 and 96 which were on multiple classification a maximum of 4 marks per item was awarded 4 marks for the overall correct responses of shape, size or colour. This was encoded "1". If the response was incorrect, a "0" was encoded. Where the code was "0" the next three columns were used to describe what his error was. This would show whether his error was in shape, size or colour. For the shape selected, a 1 was encoded for rectangle, 2 for square, 3 for circle and 4 for triangle. For the size selected, a 1 was encoded smallest, 2 for small, 3 for medium-sized and 4 for largest. For the colour selected a 1 was encoded for red, 2 for yellow, 3 for blue and 4 for grey. This was necessary in order to give partial credit for items 95 and 96, 1 mark for correct shape, 1 for correct size, one mark for correct colour.

In the colour inventory items, one mark for each of the items 115–133 was awarded for all correct responses coded "1".

In the ordering items 89 and 92, the first response was encoded 1, the second 2 and the third 3. One mark was awarded if the coded reply was "2" which was the correct way of ordering.

The total possible marks for classification tasks was 62.

f) <u>Number skills - score and code</u>

One mark was awarded for each correct reply in the following items for which the student's coded reply was "1" – Items 13–42, 68, 70, 72, 74, 76, 80–87 giving a maximum of 44 marks. In the rote counting items 99–108, half a mark was awarded for each multiple of ten successfully counted. In coding, only the highest number that the pupil counted to without an error was entered in the coding sheets. Three columns were used for this purpose. A maximum of 5 marks was awarded any child who could count up to 100. The total possible marks for number skills was 49.

g) <u>Vocabulary Skills - Score and Code</u>

There were 20 items, items 48–67, for which each correct response was coded "1" and was awarded one mark. The total possible marks here was 20.

h) <u>Visual Memory score and code</u>

In the visual memory items 43–47 and practice set to 114, there were 5 possible responses - 1st, 2nd and 3rd recall using the original set and correct and incorrect responses using the new set. A code of 1 for 1st recall, 2 for 2nd, 3 for 3rd and 4 for correct and 5 for incorrect was given. 5 marks were awarded if code "1" was recorded, 3 if "2", 2 if "3", 1 if "4" and 0 if "5". For the 10 visual memory items, the total possible marks was 50.

i) Coding of Items not used in the total score

Items 97 and 98 on logical connectives were coded - 1 for correct, 0 for incorrect and 9 for no response.

Items 134-145 were on conservation. A code of 1 was used for the response "top", 2 for "bottom" 3 for "same" and 9 for "no attempt". Because of the arbitrary responses given, a decision not to use them for computing the total score in the main study was made after the experience in the pilot study.

j) Total Score for the test

This was computed as a weighted average of the four scores - classification, number, vocabulary and visual memory, so that the maximum contribution of each partial score was 25 marks, making the maximum possible value of the total score equal to 100. The formular used was

25 x (classification/62 + number/49 + visual memory/50 + vocabulary/20).

k) Other Scores computed

In addition to the five basic scores described, viz, classification, number, vocabulary, visual memory and total score, the following scores were also computed for use in various analysis:

1. Visual memory - objects - score
2. " " - pictures -- score
3. Rote counting score
4. Score for writing numerals
5. Identification of numerals score
6. Naming geometric shapes score
7. Identifying geometric shapes score
8. Naming colours score
9. Identifying colours score
10. Counting beans score
11. Counting members of a given set
12. Total counting score for beans and members of a given set
13. Conservation of number score.

# CHAPTER FOUR

## ANALYSIS OF THE FINDINGS

### 4.0 Introduction

This chapter gives an outline of the findings of the test as described in section 1.6.

Since the main purpose of the study was to show what mathematical concepts Kenyan pre-school children in Nairobi know, the findings of the test were subjected to an item analysis in section 4.1. This shows the level of comprehension in each concept. The classification items are described in section 4.11, the number items in section 4.12, the vocabulary items in section 4,13 and the visual memory items in section 4.14.

A number of statistical techniques were used to test differences between types of schools, age groups, sex and various relationships as this was the other purpose of the study. The analysis of variance (ANOVA) is described in section 4.21. This was performed to test the null hypothesis of no difference between the three different types of schools. The -t- test which was used to test the difference between means after an ANOVA test was found significant is also described in this section. The same difference between means test using the test statistic -t- was used to show differences between comprehension of various variables and subtests between different types of schools, age groups and sexes.

The mean is the statistical measure that was calculated to indicate the typical or average values of the observations while the standard deviation shows the extent to which these observations differ from one another or the spread or diversity of the values of those observations. The difficulty index is the proportion of individuals who answer the item correctly. This proportion "passing" the item is also the item mean and so the item mean serves as the index of difficulty for an item. An average item difficulty should be .50. As the item difficulty approaches 1, the item becomes too easy. The discrimination index is a measure of how well the item separates two groups. It compares the responses in the top 27% of the test with those in the lowest 27%. This was demonstrated by Kelly (1927) when he found that when the high and low groups were made up of the top and bottom 50%, those papers clustering about the median had little influence on the discrimination index. Good discrimination indices range between .4 and .8 as the diagram in section 3·5 page 91 showing the relationship between the difficulty and discrimination indices shows.

1. Kelly, T.L. Interpretation of Educational Measurements. (Tarrytown-on-Hudson, N.Y. : World, 1927), p.210.

A reliability coefficient was also calculated for the subtests in the test batteries. Generally, to be sufficiently reliable for discriminating between individuals, a test should have a reliability coefficient of at least .80 to .94[1]. The reliability coefficient used was Kuder Richardson (K-R) formula 20.

The K-R methods for estimating reliability call for certain assumptions - for items of equal, or nearly equal, difficulty and intercorrelation. The K-R formula 20 was used in subtests which were scored by giving credit of +1 for a correct response to each item and a weight of 0 for each wrong answer or omission.

## 4.11 The Classification Items

The classification items included matching, naming and identifying geometric shapes and colours, sorting shapes by size, shape and colour, ordering circles and triangles and logical connectives. There was great variation in the performance of the classification items as is shown by a standard variation of 17.09 where the mean was 33.912. The total maximum marks for the classification items was 62 although for the item analysis purposes, each item assumed a mark of 1 for correct and 0 for incorrect. The range in the number of children who did not respond to classification items was large. It ranged from about 6% in the matching items to about 14% in identification items and 36% in the logical connectives. The findings are shown on the tables below.

1. Guilford, J.P. Fundamental Statistics in Psychology and Education (McGraw-Hill Book Coy. New York. 1965), p.104.

Table 12 : Item analysis on matching shapes

| | | |
|---|---|---|
| Number of items | = | 4 |
| Total Marks worth | = | 4 |
| Mean | = | 3.342 |
| SD | = | 1.442 |
| Reliability Coefficient | = | .9813 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent (%) Not Tried (NT) |
|---|---|---|---|---|
| Circle | .842 | .365 | .3425 | 7.5 |
| Square | .840 | .367 | .3333 | 7.5 |
| Triangle | .840 | .367 | .3240 | 7.8 |
| Rectangle | .820 | .385 | .3888 | 7.5 |

Table 13 : Item analysis on matching colours

| | | |
|---|---|---|
| No. of items | = | 6 |
| Total marks worth | = | 6 |
| Mean | = | 5.332 |
| SD | = | 1.745 |
| Reliability Coefficient | = | .9664 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Green | .893 | .310 | .3333 | 6.7 |
| Blue | .900 | .300 | .3055 | 6.3 |
| Orange | .870 | .337 | .3518 | 6.5 |
| Brown | .890 | .316 | .3425 | 6.5 |
| Red | .890 | .313 | .3055 | 6.0 |
| Yellow | .890 | .310 | .3055 | 6.0 |

The matching items were, on the whole the best done items in these test batteries, with over 80% of the children giving correct responses. The discrimination indices were fair but not poor as they lie between .3055 and .388 (see figure 1 on page 91). The shapes were a little more difficult than the colours as the difficulty indices show.

Table 14 : Items analysis on naming shapes

| | | |
|---|---|---|
| Number of items | = | 4 |
| Total marks worth | = | 4 |
| Mean | = | 1.867 |
| Standard Deviation | = | 1.605 |
| Reliability Coefficient | = | .8332 |

| Item | Mean & Difficulty Indices | SD | Discrimination Indices | Percent NT |
|---|---|---|---|---|
| Square | .415 | .493 | .6944 | 23.0 |
| Triangle | .530 | .500 | .6296 | 20.8 |
| Rectangle | .355 | .479 | .5925 | 28.5 |
| Circle | .568 | .496 | .6296 | 19.3 |

Table 15 : Item analysis on naming colours

Number of items = 7

Total marks worth = 7

Mean = 3.367

Standard Deviation = 2.960

Reliability Coefficient = .9350

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Orange | .420 | .494 | .8518 | 18.0 |
| Blue | .483 | .500 | .9074 | 19.0 |
| Red | .520 | .500 | .7222 | 17.3 |
| Black | .503 | .501 | .9166 | 19.8 |
| Brown | .440 | .497 | .8796 | 22.5 |
| Yellow | .498 | .501 | .8611 | 19.3 |
| Green | .508 | .501 | .7777 | 19.8 |

The naming items were clearly more difficult than the matching items as the means and the difficulty indices show. Of the four shapes, the circle and the triangle were the easiest to name with difficulty indices of just above average. The square and the rectangle were much more difficult with only 41.5% naming the square correctly and only 35.5% of the children naming the rectangle correctly. The number of children who did not respond to naming shapes was higher than those who did not respond to naming colours or the matching skills. The reliability coefficient in this subtest was rather low compared to the matching skills.

The naming of colours was also more difficult than the matching with an even wider variation than the matching of shapes. While red, green and black colours were the easiest to name, with about average difficulty indices, orange was, like in matching, the most difficult colour with only 42% of the children naming it correctly.

The discrimination indices of naming colours were higher than those for naming shapes. The naming colours subtest had also a higher reliability coefficient than the naming of shapes. There were fewer cases of no response than in naming of shapes.

Table 16 : Item analysis on identifying shapes

| | | |
|---|---|---|
| Number of items | = | 4 |
| Total marks worth | = | 4 |
| Mean | = | 2.370 |
| Standard Deviation | = | 1.661 |
| Reliability Coefficient | = | .8371 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Triangle | .620 | .486 | .5555 | 13.5 |
| Rectangle | .530 | .500 | .6388 | 14.8 |
| Circle | .673 | .470 | .5925 | 12.3 |
| Square | .548 | .498 | .6388 | 13.8 |

Table 17 : Item analysis on identifying colours

| | | |
|---|---|---|
| Number of items | = | 6 |
| Total marks worth | = | 6 |
| Mean | = | 3.047 |
| Standard Deviation | = | 2.638 |
| Reliability Coefficient | = | .9423 |

| Item | Mean & Difficulty Indices | SD | Discrimination Indices | Percent NT |
|---|---|---|---|---|
| Red | .555 | .497 | .8888 | 14.0 |
| Brown | .490 | .500 | .9074 | 14.5 |
| Green | .483 | .500 | .8888 | 13.5 |
| Orange | .480 | .500 | .9074 | 14.5 |
| Yellow | .535 | .499 | .8333 | 14.0 |
| Blue | .503 | .501 | .8703 | 14.5 |

Identification of geometic shapes was better done than naming although not as well as matching as the means of 3.342 for matching, 1.867 for naming and 2.370 for identifying indicate. The variation indicated by the standard deviations of the subtests is greater in identification items than in naming and matching. The more difficult shapes, the rectangle and the square discriminate better than the easier shapes, the triangles and the circle. The circle, just like in matching and naming was the easiest shape to identify.

The identification of colours was generally of average difficulty. Red and Orange, like in naming are the easiest and the most difficult colours to identify, respectively.

The reliability coefficient (.9423) for identifying colours was higher than that for identifying shapes (.8371). The colours items discriminated better between the good and the poor students than the shapes. The number of no response cases was just about the same both in shapes and colours.

Table 10: Item analysis on sorting shapes

| | | |
|---|---|---|
| Number of items | = | 14 |
| Total marks worth | = | 33 |
| Mean | = | 14.282 |
| Standard Deviation | = | 8,914 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Circles | .568 | .496 | .7407 | 3.8 |
| Smallest Circle | .568 | .496 | .8518 | 5.5 |
| Red triangles | .500 | .501 | .7592 | 2.8 |
| Squares)same<br>Circles)size | .285<br>.233 | .452<br>.423 | .5648<br>.4722 | |
| Smallest members | .238 | .426 | .5833 | 2.5 |
| Smallest red circle | .515 | .500 | .8611 | 4.5 |
| Largest yellow rectangle | .263 | .441 | .3981 | 4.0 |
| Circles smallest to largest | .163 | .369 | .3703 | 17.6 |
| Triangles largest to smallest | .140 | .347 | .2870 | 15.2 |
| More triangles or red squares | .170 | .376 | .3796 | 35.3 |
| More circles or blue rectangles | .150 | .358 | .3333 | 36.3 |

Simple classification - using one attribute

In item 88, the children were required to use only one attribute - shape - in selecting circles. From a randomly displayed set of three rectangles, four circles and three triangles, of different sizes but all of them blue, the children were asked to sort all the round shapes. 56.8% of the Nairobi children did so correctly while 3.8% did not respond. The children were not penalised for including shapes other than circles but they were only awarded marks depending on the number of correct circles sorted as explained in section 3.64.

12.7%, 12.6% and 11% of the children from LC, MC and HC schools, respectively, included shapes other than the circles asked for. Most children included one type of shape alone e.g. 3.8%, 2.0%, 2.5% of the children included triangles and squares, respectively. Others included two or three different types of shapes.

When the results of other shapes included were analysed by age, 17.5%, 10.9% and 9.1% of the 4, 5 and 6 year olds respectively, were found to include shapes other than circles, either one type of shape or two or all three.

The 4 year old children tended to include shapes not asked for more than others.

Multiple classification - using two attributes

From a multi-coloured set of one red circle, three squares - blue, red and gray, one blue rectangle, nine triangles - two yellow, four red, two grey and one blue, and one yellow L - shape, the children were asked to sort all the red triangles, thus using two attributes - colour and shape. 50% of Nairobi children sorted red triangles correctly. Some included other shapes and colours not asked for.

In item 93, the children were expected to select four circles and four squares all of the same size from a multi-coloured set of seven circles four of which were the same size but different colours, nine squares, four of which were the same size but different colours, five rectangles all of them different sizes but two yellow, two grey and one red, and two triangles, different sizes and colours and finally one red L-shape. 28.5% and 23.3% of the children selected squares and circles, respectively, of the same sizes correctly without being prompted to do so. Often after prompting, children tended to choose shapes not of the same size but sometimes of the same colour or same shape.

In item 94, the children were expected to sort all the smallest members of four different shapes - circles, rectangles, squares and triangles. The tester could point to these different shapes if the child seemed not to understand the question. This required the child to use two dimensions - size and shape - and select smallest. members from a multi-coloured set of three circles - one smallest, one small, one large size; four squares, one smallest, two small, one large; five rectangles - one smallest, two small, two large; and four triangles - one smallest, two small and one large. The smallest members were not of the same size but they were the smallest members of each shape. This sorting proved quite difficult for the children. Only 23.8% of the children were able to choose all four smallest members correctly. Often the smallest circle, triangle, and square were easier to contrast with the other shapes than the rectangles. Many children could not discriminate between sizes of each shape and included shapes other than the smallest members. Others picked one or two smallest members and considered the mission accomplished even after the four different shapes had been pointed to by the tester at the beginning. Further prompting tended to bring more confusion. No clear strategy was evident while choosing the smallest members, for example, even when the children were asked to make separate piles for each shape, very few did so. When the results of those including shapes and sizes not asked for were analysed, the LC group was found to include more shapes and sizes other than those asked for more than the MC and HC groups. When the analysis was done by age the 4 year olds were found to include fewer wrong shapes and sizes than the 5 and 6 year olds but more 4 year than 5 or 6 year olds did not respond in this item.

Multiple classification - using three attibutes

Items 95 and 96 were on multiple classification where the children were required to use three attributes - size, colour and shape to select the smallest red circle and the largest yellow rectangle from the multi-coloured set used for item 94 for smallest members. Choosing the smallest red circle was much easier than choosing the largest yellow rectangle as only 51.5% and 26.3% of the children could sort the smallest red circle and the largest yellow rectangles, respectively. These percentages represent only those who scored the whole item correct and does not include those who were given partial credit for correct size or shape or colour. Various cross tabulations of those answers that were not completely correct but for which partial credit was given for items 95 and 96 could have been done to highlight the problem areas - whether they were in shape, size or colour. An example of one such cross tabulation was done for item 95 by types of schools and by age and is shown on table 19.

Table 19 - Shapes, sizes and colours sorting by children who did not get the whole of item 95 correct by types of schools and age groups - (percentages)

| | School type | | | Age | | | Total |
|---|---|---|---|---|---|---|---|
| Shape-circle correct | LC | MC | HC | 4 | 5 | 6 | |
| Rectangle | 6.1 | 2.3 | 3.0 | 7.5 | 2.9 | 3.5 | 4.5 |
| Square | 2.3 | 2.3 | 1.0 | 0.8 | 3.6 | 1.4 | 2.0 |
| Triangle | 4.2 | 6.9 | 2.0 | 2.5 | 2.9 | 7.0 | 4.3 |
| Total | 12.6 | 11.4 | 7.0 | 10.8 | 9.4 | 11.9 | |
| Size-smallest correct | | | | | | | |
| Small | 1.4 | 2.3 | 3.0 | 1.7 | 1.4 | 2.8 | 2.0 |
| Medium | 9.9 | 2.3 | 1.0 | 4.2 | 5.1 | 8.5 | 6.0 |
| Largest | 16.4 | 8.0 | 1.0 | 13.3 | 8.7 | 10.6 | 10.8 |
| Total | 27.7 | 12.6 | 5.0 | 19.2 | 15.2 | 21.9 | |
| Colour - red colour correct | | | | | | | |
| Yellow | 9.4 | 2.3 | 5.0 | 2.5 | 8.7 | 8.5 | 6.8 |
| Blue | 4.7 | 5.7 | 0 | 5.8 | 2.2 | 3.5 | 3.8 |
| Grey | 0.9 | 1.1 | 1.0 | 0.8 | 2.2 | 0 | 1.0 |
| Total | 15.0 | 9.1 | 6.0 | 9.1 | 13.2 | 12.0 | |

The column totals on table 19 indicate those who made an errpr either in shape or size or in colour. These results show that it is the LC type of school child that made most errors in shape, size and colour. The MC school children made more errors than the HC school children. The analysis by age does not give such a hierarchical arrangement. The 6 year olds sometimes make more errors than 5 or 4 year olds.

These findings show that the bigger weakness among the Nairobi children as far as shape, size and colour are concerned, is in size, followed by colour and then shape. Other items dealing with size like item 93 for same size and item 94 for smallest members were also done very poorly. This reflects poor comprehension of pre-measurement concepts which is further emphasised by the poor performance in the vocabulary items.

Seriation Items

Two types of tasks tested the children's ability to seriate. In items 89 and 91, the children were expected to sort all circles and red triangles and then order them. The testers helped the children to sort all the shapes for the ordering sections. The circles were supposed to be ordered from the smallest to the largest. 10.8% ordered them from largest to smallest, 55.3% ordered them randomly while only 16.3% of the children could correctly order the circles as requested. The triangles were supposed to be ordered from the largest to the smallest. This proved even more difficult. 9.0% ordered them from smallest to largest, 61.8% ordered them randomly while only 14% could correctly order them from largest to smallest. The standard deviations of these two items were higher than their means and they discriminate rather poorly. They were too difficult even for the good students.

Comparison of two subsets of a set

Together with seriation items, the logical connectives items 97 and 98 were the most difficult items in the whole test. These required a comparison of two subsets of a set - more circles or blue rectangles, more triangles or red squares - within a larger set of shapes - set VII, the same ones used for item 94. Some children who did not respond at first and were, therefore, advised to put all triangles together and all red squares together in item 97, when asked which were more - the triangles or the red squares they replied it was the red squares. There were only two red squares while there were four triangles. But the red squares were large and when spread out on the table occupied more room than the four little triangles. Children who were often guided by perception answered there were more red squares than triangles. Most children who could not even sort the triangles and red squares could not answer the question correctly. The highest percentage of no response cases were in these two items, as can be seen on table 18.

4.12 Number items

The number items included counting of beans and members of a given set (pictures), rote counting up to 100, writing and identifying of numerals, making equivalent sets, ordinal numbers and conservation of number. With a mean of 25.261 and a standard deviation of 15.924, about $\frac{2}{3}$ of the total sample of children obtained marks within the limits of about 9 and 41 in a test where the total possible marks was 49. This was based on the percentage of cases included within the range from one standard deviation below the mean to one standard deviation above the mean as 68.27% in a normal distribution, which was assumed in this study. The high reliability coefficient of .9763 of the number tasks indicates the items are more or less of equal difficulty where the item intercorrelations can be at a maximum. The high discrimination indices suggest that most items are of average difficulty. Only a small percentage of the children - about 2% did not respond in the counting items, about 5% and 6% in the ordinal numbers and equivalent sets respectively while about 10 - 15% did not respond in the writing and identification of numerals and in the conservation of number.

The analysis on each sub-test is given in the following tables:-

Table 20 - Item analysis on counting beans

| | | |
|---|---|---|
| Number of items | = | 7 |
| Total marks worth | = | 7 |
| Mean | = | 4.267 |
| Standard Deviation | = | 3.078 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| 3 beans | .723 | .448 | .6944 | 2.3 |
| 4 " | .655 | .476 | .8425 | 2.0 |
| 5 " | .645 | .479 | .8148 | 1.8 |
| 6 " | .595 | .492 | .8981 | 2.0 |
| 7 " | .553 | .498 | .8796 | 2.5 |
| 8 " | .555 | .498 | .9074 | 2.3 |
| 9 " | .543 | .499 | .9259 | 2.3 |

The counting of beans items involved counting of a specified set of beans from a larger set. 72.3% of the children could count 3, the smallest number asked for. As the numbers increased, the percentage of children who could count the beans correctly was progressively reduced until only 54.3% could count 9 beans. Most items were of average difficulty and except for 3 which was the easiest number of beans to count, the other items had high discrimination indices of over .80.

Table 21 : Item analysis on counting members of a given set

| | | |
|---|---|---|
| Number of items | = | 8 |
| Total marks worth | = | 8 |
| Mean | = | 5.832 |
| Standard Deviation | = | 2.968 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| 4 pictures | .805 | .397 | .4629 | 4.0 |
| 5 " | .785 | .411 | .5000 | 4.0 |
| 5 " | .778 | .416 | .5092 | 4.5 |
| 6 " | .745 | .436 | .5370 | 4.0 |
| 7 " | .730 | .445 | .6203 | 4.3 |
| 7 " | .685 | .465 | .6018 | 5.0 |
| 8 " | .708 | .455 | .5925 | 5.0 |
| 9 " | .598 | .491 | .4814 | 5.3 |

Except for one of the cards with 7 pictures, the pattern was more or less the same as in the counting of beans where the bigger the number of pictures to be counted, the more errors in counting.

Table 22: Item analysis on writing numerals

| | | |
|---|---|---|
| Number of items | = | 7 |
| Total marks worth | = | 7 |
| Mean | = | 3.240 |
| Standard Deviation | = | 3.070 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Writing 3 | .535 | .499 | .8796 | 10.8 |
| " 4 | .520 | .500 | .8425 | 13.5 |
| " 5 | .475 | .500 | .8425 | 13.5 |
| " 6 | .463 | .499 | .8240 | 16.8 |
| " 7 | .413 | .493 | .8425 | 20.3 |
| " 8 | .460 | .499 | .8703 | 19.8 |
| " 9 | .375 | .485 | .8611 | 20.5 |

The same pattern as was observed in counting of beans is again repeated here except for writing 7 and 8. The larger numbers are more difficult to write. There was a tendency for most children to write numerals the wrong way round, Γ for 7, P for 9 and ɥ for 4. The mean was much lower than the counting of beans, for the same number of items, but the variation was the same as in counting of beans.

Table 23: Item analysis on identification of numerals

| | | |
|---|---|---|
| Number of items | = | 8 |
| Total marks worth | = | 8 |
| Mean | = | 4.360 |
| Standard Deviation | = | 3.540 |

| Item | | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|---|
| Identification of | 0 | .470 | .500 | .8611 | 16.8 |
| " | 1 | .655 | .476 | .8240 | 11.0 |
| " | 3 | .600 | .491 | .8703 | 13.0 |
| " | 4 | .575 | .495 | .8796 | 12.3 |
| " | 5 | .558 | .497 | .9074 | 13.0 |
| " | 7 | .513 | .500 | .9351 | 14.8 |
| " | 8 | .498 | .501 | .9259 | 15.0 |
| " | 9 | .493 | .501 | .9351 | 15.5 |

While 1 was the easiest number to identify with 65.5% of the children doing it correctly, only 47% could identify 0, the most difficult numeral. Many children called 0 a ball and would not recognize it as a number even when placed among other numbers. The highest number of children who did not respond refused to do so in 0 and the larger numbers 8 and 9. From 1 to 9, the same pattern as observed in the counting of beans is repeated again. The larger the numeral is, the more difficult it is to identify. All the items had high discrimination indices.

Table 24: Item analysis on equivalent sets

| | | |
|---|---|---|
| Number of items | = | 6 |
| Total marks worth | = | 6 |
| Mean | = | 3.455 |
| Standard Deviation | = | 2.662 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Item 68 with 5 dots | .545 | .499 | .7592 | 7.3 |
| " 70 " 4 " | .643 | .480 | .7407 | 7.3 |
| " 72 " 8 " | .585 | .493 | .7129 | 7.3 |
| " 74 " 6 " | .558 | .497 | .7222 | 7.5 |
| " 76 " 6 " | .600 | .491 | .7870 | 8.0 |
| " 78 " 9 " | .525 | .500 | .7685 | 7.8 |

More than half the number of children tested could make one-to-one correspondence and make sets of beans the same as sets of dots drawn on cards. The arrangement and size of the dots in the cards were different. The patterning of the dots was symmetrical on some cards and asymetrical on others. Some dots were big while others were of medium or small size. What was found interesting here was the methods the children used to make "same" sets of beans as dots. Most children tended to copy the pattern of the dots on the cards, others counted the dots and then the beans, others counted the dots and beans and then copied the pattern while others used methods that were not easy to describe and were recorded as "other" on the score sheets. Some LC and 4 year old children would heap any number of beans sometimes trying to make heaps of different sizes just like the dots shown on the cards. The highest percentage of no response case were with these two groups. Many did not seem to understand the game as explained in English.

Of the two popular methods of making equivalent sets, that is, copying the pattern and counting, a very interesting pattern was observed. Most children from the MC schools preferred to count than copy the pattern as table 25 which shows the methods used by the highest percentages of children from the different categories of schools and age groups indicates.

Table 25: Methods used for making equivalent sets by most children from different types of schools and ages

| Item | Types of Schools: Copying Pattern | Types of Schools: Counting | Age groups: Copying pattern | Age groups: Counting |
|---|---|---|---|---|
| 68 | LC & HC | MC | 4 & 5 | 6 |
| 70 | LC & HC | MC | 4,5 & 6 | |
| 72 | LC & HC | MC | 4,5 & 6 | |
| 74 | LC,MC & HC | | 4,5 & 6 | |
| 76 | LC & HC | MC | 4,5 & 6 | |
| 78 | LC & HC | MC | 4,5 & 6 | |

Table 26 : Item analysis on ordinal numbers

| | | |
|---|---|---|
| Number of items | = | 8 |
| Total marks worth | = | 8 |
| Mean | = | 2.587 |
| Standard Deviation | = | 2.733 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Item 80 - First | .648 | .478 | .7777 | 5.8 |
| " 81 - Third | .208 | .406 | .5833 | 5.8 |
| " 82 - Fifth | .178 | .383 | .5555 | 5.8 |
| " 83 - Fourth | .278 | .448 | .6944 | 6.5 |
| " 84 - First | .395 | .489 | .8425 | 6.0 |
| " 85 - Last | .360 | .481 | .7870 | 6.3 |
| " 86 - Second | .310 | .463 | .7500 | 6.7 |
| " 87 - Fourth | .213 | .410 | .6203 | 6.3 |

On the whole, the ordinal numbers were very poorly done. Five trucks were arranged in a row and the children were told to put marbles in each truck as requested. Many children enjoyed playing with the marbles and the trucks hence the low percent - not tried (NT). Some were so enthusiatic that even before they understood the request, they started putting marbles from the first truck to the last. Many children responded in such an arbitrary fashion that it was clear the concept of ordinality had not been mastered. This is clear on table 28 where there are different means for first in items 80 and 84, fourth in items 83 and 87, fifth in item 82 and last in item 87 because there were only 5 trucks. It did not matter which end the child started with provided the right order was followed. This explains the higher mean in item 80 than item 84 for first. The first "fourth" in item 83 is higher because some children followed the order 1, 2, 3, 4 etc. and put marbles in the trucks irrespective of the truck asked for. The first "fourth" then in the item 83 would be fourth in the case where the order of the trucks was followed by the child who did not particularly respond to the request. The concept of fifth was the poorest with only 17.8% of the children responding to it correctly.

Table 27: Rote counting ability displayed by Nairobi Children

| Number counted upto | Frequency | Percentage | Cumulative Frequency |
|---|---|---|---|
| 1 - 9 | 73 | 18.3 | 100 |
| 1 - 19 | 132 | 33.0 | 81.9 |
| 1 - 29 | 50 | 12.5 | 48.9 |
| 1 - 39 | 38 | 9.5 | 36.4 |
| 1 - 49 | 17 | 4.3 | 26.9 |
| 1 - 59 | 10 | 2.5 | 22.6 |
| 1 - 69 | 6 | 1.5 | 20.1 |
| 1 - 79 | 3 | 0.8 | 18.6 |
| 1 - 89 | 7 | 1.8 | 17.8 |
| 1 - 99 | 2 | 0.5 | 16.0 |
| 1 - 100 | 62 | 15.5 | 15.5 |

The children in this study were required to do rote counting by one and count as far as they could go up to 100. There was no question of right or wrong and therefore no discrimination indices or reliability coefficients were calculated for this subtest. Out of a maximum mark of 5, the mean was 1.519 while the standard deviation was 1.712.

Considerable variance in ability to do rote counting by one was evidenced as table 27 shows. Only 15.5% of the four to six year old children in Nairobi could count up to 100 while 22.6% could count up to 50.

## The Conservation items

The conservation items in this study are not strictly like Piaget's conservation items. In Piagetian conservation items, the subject first ascertains equivalence not by counting but by one-to-one correpondence. It is only after the child accepts numbers are the same that the arrangement is changed. In the conservation items in this study, the child could answer the question asked only by counting or by one-to-one correspondence.

The children were expected to recognize equalities and inequalities between two sets. To achieve correct answers, the child had to disregard spatial arrangement which sometimes conflicted perceptually with number and to utilize number only. The pictures of Kenya flags and shields used were all of the same size and were arranged in two straight rows but spaced and numbered differently. The dots were also in two straight rows but spaced differently. In cards 1, 2 and 3 dots were of the same size while in cards 4, 5 and 6 they were of different sizes. The child had to determine in which of two rows on each card there were more pictures or dots, - the top or the bottom or whether there was the same number in both rows.

The responses given by the children were recorded. The standard deviation and the discrimination indices were calculated only on the correct responses. To understand these responses, the reader has to refer to the tests in the appendix to see the arrangement of the pictures and the dots.

Table 28 : Item analysis on conservation items – pictures:

| | | |
|---|---|---|
| Number of items | = | 6 |
| Total marks worth | = | 6 |
| Mean | = | 2.132 |
| Standard Deviation | = | 1.935 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Card 1 | | | | |
| top+ | .380 | | | |
| bottom* | .175 | | | |
| same | .163 | .369 | .4351 | 28.3 |
| Card 2 | | | | |
| top+ | .230 | | | |
| bottom | .328 | .774 | .3910 | 28.5 |
| same* | .158 | | | |
| Card 3 | | | | |
| top* | .210 | | | |
| bottom+ | .480 | | | |
| same | .025 | .075 | .0802 | 25.6 |
| Card 4 | | | | |
| top+ | .253 | | | |
| bottom | .453 | .498 | .4444 | 27.0 |
| same* | .025 | | | |
| Card 5 | | | | |
| top | .445 | .498 | .4722 | 27.8 |
| bottom* | .235 | | | |
| same+ | .050 | | | |
| Card 6 | | | | |
| top | .435 | .496 | .4537 | 27.8 |
| bottom+ | .270 | | | |
| same* | .018 | | | |

Key: + spatial responses due to arrangement

* random responses.

Table 29 : Item analysis on conservation items - dots

| | | |
|---|---|---|
| Number of items | = | 6 |
| Total marks worth | = | 6 |
| Mean | = | 1.830 |
| Standard Deviation | = | 1.783 |

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| **Card 1** | | | | |
| top | .480 | .500 | .5277 | 29.3 |
| bottom .1 | .205 | | | |
| same * | .023 | | | |
| **Card 2** | | | | |
| top .1 | .195 | | | |
| bottom | .498 | .501 | .6111 | 28.5 |
| same * | .023 | | | |
| **Card 3** | | | | |
| top * | .205 | | | |
| bottom .1 | .348 | | | |
| same | .158 | .365 | .4074 | 29.0 |
| **Card 4** | | | | |
| top .2 | .255 | | | |
| bottom | .430 | .496 | .6296 | 28.8 |
| same * | .028 | | | |
| **Card 5** | | | | |
| top .1 | .385 | | | |
| bottom * | .225 | | | |
| same | .100 | .300 | .2407 | 29.0 |
| **Card 6** | | | | |
| top .2 | .315 | | | |
| bottom * | .225 | | | |
| same | .165 | .372 | .4629 | 29.5 |

Key:
- .1 spatial responses due to arrangement
- .2 " " " " size
- * random responses

The conservation items were very poorly done as a mean of 3.962 and a standard deviation of 3.558 indicates for all the 12 conservation items worth 12 marks. The six pictures were better done than the six dots with means of 2.132 and 1.830 respectively. The reliability co-efficient for all the conservation items was .8871. A high percentage of the children did not respond - about 28%. These were mainly children from the LC type of schools and the 4 year old children who found it difficult to follow instructions so that they could understand the game.

Many children seemed to just point to any row and say "more" or "same". This was often done in such an arbitrary fashion that the researcher got the impression that the children had either not understood the game or were just guessing or were tired of the game and wanted to do it quickly and get over with it irrespective of whether they answered the question asked or not.

Two wrong responses were given. Spatial responses either due to the arrangement of the pictures and dots or due to the size and arrangement of the dots. These showed that the children giving such responses were mainly guided by perception. Those who gave random responses were rather difficult to understand. The researcher got the impression that the problem may have been in the use of the pre-measurement vocabulary of "more" and "same". The experience the researcher had had in testing the comprehension of such premeasurement vocabulary in section 4.13 made her feel that the language may have influenced performance in this section quite considerably. This section did not seem to make sense if the vocabulary was not acquired.

Comprehension was poorest in cards 1 and 2 for pictures and cards 3, 5 and 6 for dots as tables 30 and 31 show. All these cards had pictures or dots the same number but the arrangement was different - some were more spread out than others, other cards had bigger dots than others. Judging from these results, the pre-school children in Nairobi showed that many of them - more than half of them could not conserve number. They could not disregard spatial arrangement which sometimes conflicted perceptually with number.

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## 4.13 Findings on Vocabulary

In the vocabulary subtest, the children were asked to manipulate blocks to show comprehension of twenty words or phrases whose understanding is very important in mathematics. This subtest proved to be one of the most difficult in the whole test..

Table 30 : Item analysis on Vocabulary

Number of items = 20

Total marks worth = 20

mean = 5.822

Standard Deviation = 5.878

Reliability Coefficient = .9346

| Item | Mean & Difficulty Indices | SD | Discrimination Index | Percent NT |
|---|---|---|---|---|
| Behind | .388 | .488 | .8240 | 15.0 |
| Above | .035 | .184 | .0925 | 15.0 |
| Bottom | .233 | .423 | .5648 | 15.3 |
| Between | .203 | .402 | .4444 | 15.3 |
| Each | .168 | .374 | .4629 | 16.3 |
| Tallest | .368 | .483 | .6666 | 16.3 |
| Remove | .378 | .485 | .7962 | 17.3 |
| Set | .105 | .307 | .2592 | 28.8 |
| More than | .278 | .448 | .7685 | 16.5 |
| As many as | .243 | .429 | .4722 | 16.8 |
| Fewer than | .163 | .369 | .4351 | 16.8 |
| Join | .275 | .447 | .6851 | 16.3 |
| Below | .240 | .428 | .5648 | 17.0 |
| Left | .350 | .478 | .7685 | 16.8 |
| Outside | .423 | .495 | .7962 | 16.5 |
| Inside | .503 | .501 | .9629 | 16.5 |
| On | .440 | .497 | .8240 | 16.5 |
| Right | .370 | .483 | .7592 | 16.8 |
| Shorter than | .298 | .458 | .7685 | 16.8 |
| Top | .368 | .483 | .7592 | 16.5 |

As the means on table 30 show, comprehension of these words was very low. Except for the word inside where 50.3% of the children could correctly manipulate the blocks to show understanding of the word, all the other means are way below average. The word with the highest frequency of error was "above" with only 3.5% of the children showing comprehension of it. When children were asked to hold a block above their heads, most of them put the block on their heads - and they were satisfied they were correct. When children were asked to form a set of any objects that they liked which were on the table, many of them just looked at the tester puzzled, hence the large percentage of no response and correct responses by only 10.5% of the children. Some children made the wrong responses by manipulating the blocks in any way hoping any of them would be correct. Three equal towers were built with the blocks by the child with the help of the tester. When children were asked to touch each tower, most of them touched one and considered the matter finished.

The comparative expressions "more than", "as many as", "fewer than" and "shorter than" also proved quite difficult with around 28% of the children getting them correct except for fewer than where only 16.3% were correct.

On the whole, the vocabulary subtest was the one most poorly done compared to classification, number and visual memory. The children, however, enjoyed playing with the blocks but the manipulation displayed was often not the required response.

## 4.14 Findings on Visual Memory Subtest

### Objects

This scale measured visual memory for familiar objects. The child was shown a set of four objects. One object was removed while the child had his eyes closed. He was required to recall which object was taken away. If the child was correct the first time the question was asked, the score sheet was marked under first recall. If he could not recall, the question was asked again and the second recall section was marked and so on. If after the third recall the child could not recall, a new set of objects was given where the object removed in the first set was included. Recognition was then tested. If the child was correct or incorrect, the score sheet was marked.

The figures shown on table 31 below show the percentages of children who recalled correctly through first, second and third recall, and who recognised the removed object having failed to recall it.

Table 31 : Findings on visual memory - objects - (Percentages)

| | | |
|---|---|---|
| Number of items | = | 5 |
| Total marks worth | = | 25 |
| Mean | = | 13.367 |
| Standard deviation | = | 10.499 |

| Removed Object | Original set Recalls 1st | 2nd | 3rd | New set Correct | Incorrect | NT |
|---|---|---|---|---|---|---|
| bird | 49.8 | 5.3 | 5.0 | 3.0 | 19.5 | 17.6 |
| key | 47.3 | 5.3 | 1.8 | 5.0 | 22.3 | 18.6 |
| watch | 46.3 | 5.3 | 3.5 | 3.8 | 22.5 | 18.8 |
| car | 54.3 | 4.8 | 2.3 | 2.0 | 18.3 | 18.6 |
| crayon | 44.0 | 6.3 | 3.5 | 3.3 | 24.5 | 18.3 |

the car was recalled better than the others with 54.3% of the children getting it right by first recall. Crayon, the least recalled object was recalled by 44% of the children.

Pictures

The same procedure was followed for pictures as for objects. The findings were as follows:-

Table 32 : Findings on Visual Memory - Pictures - (Percentages)

| | | |
|---|---|---|
| Number of items | = | 5 |
| Total marks worth | = | 25 |
| Mean | = | 10.777 |
| Standard Deviation | = | 9.650 |

| Removed Pictures | Original set Recalls 1st | 2nd | 3rd | New set Recognition Correct | Incorrect | NT |
|---|---|---|---|---|---|---|
| Engine | 40.5 | 7.5 | 11.8 | 4.0 | 21.0 | 15.3 |
| Car | 43.3 | 6.3 | 5.0 | 3.0 | 25.8 | 16.8 |
| Bird | 34.8 | 6.3 | 5.3 | 4.8 | 31.0 | 18.0 |
| Lion | 32.0 | 6.5 | 5.0 | 6.5 | 31.8 | 18.3 |
| Ball | 28.0 | 6.0 | 5.3 | 7.5 | 35.3 | 18.0 |

The general performance was much lower in the pictures than in the objects with subtest means of 7.27 and 9.42 respectively. The best recall was on car and the train engine while the poorest recall was on ball. The second and third recalls were low compared to the first recall, just like in objects, but the proportion of incorrect responses with the new set was much higher than the objects.

The percentage of children who did not respond was generally 18%. Those who did not respond were mainly from the low cost schools where children did not understand the rather lengthy explanations of the game. In each case, a few examples were given just for practice. Some children who did not understand English got the idea of the game from the examples given and they responded well. Those who did not get the idea tended to give up and were, therefore, not pushed.

The reliability coefficient for the whole visual memory subtest was .95145.

After this item analysis, various hypotheses were tested using the ANOVA, regression analysis and correlation coefficient.

## 4.21 The analysis of variance (ANOVA)

The technique of statistical analysis which permits researchers to overcome the ambiguity involved in assessing significant differences when more than one comparison is made is the ANOVA. It has its greatest usefulness when two or more independent variables are studied. This technique was performed to test the null hypotheses of no difference between the different types of schools.

The ANOVA consists of obtaining two independent estimates of variance, one based upon variability between groups called the between-group variance and the other upon variability within groups called the within-group variance. The between group variance estimate reflects the magnitude of the difference between and/or among the group means. The larger the difference between means, the larger the difference between group variance. The within-group variance estimate reflects the dispersion of scores within each treatment group. The significance of the difference between these two variance estimates is provided by Fisher's F-distribution.

The F-distribution is used to test for hypothesis concerning the equality of the means. There are three basic assumptions for the use of an F-distribution in testing the null hypothesis of no difference between the means of the samples. These are;

(a) observations are drawn from a normally distributed population;

(b) observations represent independent random samples from populations;

(c) variance of the population are equal.

The difference between means test was used after F in the ANOVA was found significant. This test was also used to test for significance of difference between the means of boys and girls.

4.22 <u>The Regression Analysis</u>

The regression technique was used in this study to test the null hypothesis of no difference between the different age groups. Since age is a continuous process, and a difference of a few months is likely to be quite significant in the all round development of children, the regression technique was found to be the most appropriate analysis for prediction purposes of performance between the different age groups. For prediction problems, "the notion of regression is both logically prior and theoretically more important than that of correlation".[1]

1. Blalock, H.M. Jr. Social Statistics. (Mc.Graw-Hill Book Coy. Inc., New York., 1960),p.273.

It is the usual practice to designate the independent variable by the symbol X and the dependent one by Y. In this study, age is the independent variable while comprehension of the various tasks of the test is the dependent variable. The assumptions associated with regression are

(a) that the form of the regression equation is linear

(b) that the distributions of the Y values for each X are normal and

(c) that the variance of the Y distributions are the same for each value of X.

If the regression of Y on X is linear, the equation can be written as $Y = \alpha + \beta X$ where both $\alpha$ and $\beta$ are constants. Where $X = 0$, then $Y = \alpha$ and therefore $\alpha$ represents the points where the regression line crosses the Y axis. The slope of the regression line is given by $\beta$ since this constant indicates the magnitude of the change in Y for a given change in X.

In this study, the regression analysis was calculated with the independent variable, age, given in months. The youngest child was 48 months and the oldest child was 83 months.

4.23 <u>The Correlation Coefficient</u>

The correlation coefficient technique was used in this study for testing the null hypotheses of no relationship between various variables.

A coefficient of correlation is a single number that shows to what extent two variables are related, to what extent variations in the one go with variations in the other. It does not only give the form or nature of relationship of two variaoles but the degree or strength of the relationships as well. These relationships, however, do not necessarily imply that one is the cause of the other. This may or may not be the case. In some situations, it is found that two variables are related because they are both related to, or caused by, a third variable.

When two variables are posivetly related, as one increases, the other also increases. Negatively related variables are inversely related. As one increases, the other decreases. Hence, in different situations, r, the coefficient of correlation can vary from a value of + 1.00, which means perfect positive correlation, through zero, which means complete independence or no correlation whatever, on down to - 1.00 which means perfect negative correlation.

The correlation coefficient r which is used in this study was introduced by Kerl Pearson and is also referred to as product - moment correlation. The most important requirement for the legitimate use of the Pearson r is that the trend of relationship between the two variables be rectilinear, that is, a straight line. Correlation is essentially a measure of spread about the regression line.

Unless the correlation is reasonably high (say .7 or above), it may be rather misleading to make use of prediction equations. Most correlations in the social sciences are less than .7. Therefore, exact prediction becomes out of the question. The r formula used in this study is

$$r = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{[\sum (x-\bar{x})^2][\sum (y-\bar{y})^2]}} = \frac{\sum xy}{\sqrt{(\sum x^2)(\sum y^2)}}$$

Since this measure involves both variances and co-variances, it is highly affected by a few extreme values of either variable.

4.30 THE RESULTS OF THE DATA ANALYSIS:

Before any data is analysed and results are reported, various statistical procedures must be followed. These are described below:-

4.31 Introduction:

Very often, researchers are called upon to make decisions about populations on the basis of sample information. In attempting to reach decisions, it is useful to make assumptions or guesses about the populations involved. Such assumptions, which may or many not be true,are called statistical hypotheses and in general are statements about the probability distributions of the populations. In many instances, statistical hypotheses are formulated for the sole purpose of rejecting or nullifying them. Such hypotheses are called Null hypotheses or hypotheses of no significance and are denoted by Ho. Any hypotheses which differ from a given hypothesis are called alternative hypotheses and each one is denoted by $H_1$.

In testing a given hypothesis, the maximum probability with which a researcher would be willing to risk a type 1 error, that is, to reject a true hypothesis, is called the level of significance of the test. The level of significance chosen for all the Ho in this study is .05 or 5%. This means that there are about 5 chances in 100 that a hypothesis would be rejected when it should be accepted, so that the researcher is only about 95% confident that the right decision has been made. In such case, the hypothesis is rejected or accepted at .05 level of significance, which means that the researcher could be wrong with probability .05.

The researcher then sets a criterion which shows when he is going to accept or reject a hypothesis. This criterion depends on which test statistic is being used and the confidence limits. If the results calculated fall on the rejection region, it is the Ho that is rejected and the $H_1$ is accepted. This would mean that there is insufficient evidence to show that the means of the different samples under study are not different and that the samples may have been drawn from a population with the same variance. If the results fall on the acceptance region, it is the Ho hypothesis that is accepted showing differences that occur between the samples being studied.

One of the purposes of this study as stated in section 1.7 was to find out what mathematical concepts pre-school children in Nairobi know. This was shown in section 4.1 where each of the items was analysed.

The other purpose of this study was to find out whether differences occur in three major areas:

(a) The different types of schools;

(b) The different age groups

(c) The sexes.

Hypotheses formulated to show differences or no differences and the statistical tests and the results obtained are shown in the sections that follow.

The other purpose is to find out the relationship between the many variables dealt with in this study. At the pre-school level, categorisation of subjects is impracticable and the interdependence of subjects is much more than in later years of primary education. In view of this, the extent to which the scoring of one variable affects the total score or the relationship of one variable with the other, and the strength of this relationship is of interest in this study.

4.32 DIFFERENCES IN TYPES OF SCHOOLS:

In view of the differences shown in Chapter 1, table 1, of the percentages of children admitted to secondary schools in the last six years from different categories of schools in Nairobi and the differences between socio-economic groups found in other countries and reported in Chapter two, one of the purposes of this study is to find out whether differences in comprehension of mathematical concepts exist at the pre-school level as well between the three categories of schools in Nairobi. These children, like the primary school children, attend different types of schools.

When reviewing the related literature in chapter two, the researcher did not come across researches done in different types of schools; only in different socio-economic groups. As mentioned in the limitations of this study in chapter one, the high, medium and low cost types of schools were considered as high, medium and low socio economic groups respectively.

Many researches have shown differences between medium and low socio-economic groups and between high and low socio-economic groups as reported in section 2.4 But the researcher did not come across any that compared three groups as in the present study.

To test the differences between different types of schools, the statistical test used was the ANOVA.

Hypothesis 1

Ho: There is no differance in comprehension of mathematical concepts between children from different types of schools in Nairobi.

Results:

The following ANOVA results were computed:

Table 33 : Computations for ANOVA based on total scores

| Source of Variation | DF | Sum of Squares | Mean squares | F |
|---|---|---|---|---|
| Between groups | 2 | 68391.0625 | 34195.5313 | 54.697 |
| Within groups | 397 | 248198.3750 | 625.1848 | |
| Total | 399 | 316589.4375 | | |

Hypothesis 2

Ho: There is no difference in comprehension of mathematical concepts between children from different types of schools in

2.1 : Classification.

2.2 : Number

2.3 : Vocabulary

2.4 : Visual Memory

While hypothesis 1 is based on the total scores, that is, scores of all the variables combined, hypothesis 2 is based on the scores of each variable on its own.

Table 34 : Computations for ANOVA based on Classification Scores

| Source of Variation | DF | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between groups | 2 | 13580.4375 | 6790.2188 | 26.182 |
| Within groups | 397 | 102959.6250 | 259.3440 | |
| Total | 399 | 116540.0625 | | |

Table 35 : Computation for ANOVA based on Number Scores

| Source of Variation | DF | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between groups | 2 | 9989.4375 | 4994.7188 | 21.744 |
| Within groups | 397 | 91192.5625 | 229.7042 | |
| Total | 399 | 101182.0000 | | |

Table 36 : Computation for ANOVA based on Vocabulary Scores

| Source of Variation | DF | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between groups | 2 | 4193.5547 | 2096.7773 | 86.775 |
| Within groups | 397 | 9592.8477 | 24.1633 | |
| Total | 399 | 13786.4023 | | |

Table 37 : Computation for ANOVA based on Visual Memory Scores

| Source of Variation | DF | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between groups | 2 | 28198.1250 | 14099.0625 | 51.833 |
| Within groups | 397 | 107987.6250 | 272.0090 | |
| Total | 399 | 136185.7500 | | |

Subsequent to a significant F in ANOVA results for hypotheses 1 and 2, it meant that at least one of the means from the three samples was different. But the ANOVA technique did not show which one. A test of difference between means was done to show which means were different. This involved taking two means at a time, each from different types of schools. These results are shown on table 38.

Table 38 : Mean scores of test for the main variables by different types of schools

| | LC(N=213) | | MC(N=87) | | (HC(N=100) | | t-values for difference between means | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | LC–MC | LC–HC | MC–HC |
| Classification | 28.46 | 17.11 | 39.66 | 15.08 | 40.53 | 14.67 | –5.32* | –6.08* | –0.40 |
| Number | 20.80 | 15.07 | 27.96 | 16.12 | 32.42 | 14.46 | –3.66* | –6.44* | –1.99* |
| Vocabulary | 2.94 | 4.22 | 7.53 | 4.53 | 10.48 | 6.40 | –8.36* | –12.40* | –3.59* |
| Visual Memory | 16.69 | 17.48 | 28.40 | 17.45 | 36.11 | 13.11 | –5.27* | – 9.98* | –3.46* |
| Total Score | 34.11 | 25.09 | 53.87 | 3.68 | 64.14 | 24.80 | –6.19* | – 9.91* | –2.81* |

*t – values significant at .05

the minus signs mean the first mean is less than the second and is ignored when considering the t – values.

The t-values in table 38 clearly show that differences were found between all means except the mean in classification between the MC and the HC types of schools. Although the HC mean was greater than the MC mean, the difference was not statistically significant at .05 level of significance.

To show whether the MC types of schools were closer to the LC or HC types of schools in their comprehension of the identified mathematical concepts, the 95% confidence intervals for the means were calculated, both for the total scores and for the variables. These are shown on table 39.

Table 39 : 95% confidence intervals for the means in the total score and the variables between types of schools.

| Variables | 95% Confidence | Intervals | |
|---|---|---|---|
| | LC | MC | HC |
| Total scrore | 30.7188 to 37.4975 | 48.5364 to 59.1974 | 59.2137 to 69.0567 |
| Classification | 26.1489 to 30.7713 | 36.4403 to 42.8700 | 37.6184 to 43.4416 |
| Number | 18.7649 to 22.8360 | 24.5244 to 31.3951 | 29.5460 to 35.2840 |
| Vocabulary | 2.3691 to 3.5089 | 6.5625 to 8.4950 | 9.2107 to 11.7493 |
| Visual Memory | 14.3339 to 19.0558 | 24.6833 to 32.1212 | 33.7079 to 38.9121 |

The total scores, vocabulary and the visual memory variables show that at no point do the different types of schools overlap but in each case, the gap between the MC and HC groups is much less than the gap between the LC and MC groups. In classification and number, the LC and MC groups are clearly distinct and the gap between the groups is larger in classification than in number. The MC and HC groups overlap more in classification than in number so that the t-values for the difference between means on tables 38 & 40 serve to emphasise the no difference in classification only between MC and HC types of schools.

The differences between the different types of schools in the various variables shown on tables 38 and 39 led to a further analysis. The t-values for the difference between means for all the subtests.were calculated to show exactly where differences were found. The means scores for the subtests are shown on table 40.

Table 40 : Mean scores for the subtests by types of schools

| Subtest | LC(N=213) | | MC(N=87) | | HC(N=100) | | t-Values for diff. between Means | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | LC–MC | LC–HC | MC–HC |
| Geom.shape name | 1.81 | 1.65 | 2.08 | 1.56 | 1.78 | 1.55 | -1.25 | 0.21 | 1.32 |
| Geom shape-Ident. | 2.33 | 1.72 | 2.60 | 1.59 | 2.26 | 1.60 | -1.26 | 0.34 | 1.44 |
| Colour-name | 2.39 | 2.66 | 4.48 | 2.77 | 4.48 | 3.01 | -6.11* | 6.21* | 0.01 |
| Colours-Ident. | 2.22 | 2.48 | 3.94 | 2.47 | 4.03 | 2.54 | -5.46* | -5.97* | -0.24 |
| Geom.shape-matching | 3.11 | 1.61 | 3.21 | 1.59 | 3.95 | 0.33 | -0.46 | -5.14* | -4.56* |
| Matching Colours | 5.05 | 2.01 | 5.29 | 1.85 | 5.97 | 0.22 | -0.94 | -4.55* | -3.66* |
| Ordering | 0.30 | 0.63 | 0.26 | 0.58 | 0.35 | 0.66 | 0.40 | -0.70 | -0,94 |
| Logical connectives | 0.18 | 0.53 | 0.41 | 0.77 | 0.53 | 0.80 | -2.97* | -4.55* | -1.01 |
| Sorting | 11.24 | 8.90 | 17.79 | 7.42 | 17.71 | 7.75 | -6.06* | -6.24* | 0.07 |
| Writing numerals | 2.54 | 2.95 | 3.70 | 3.04 | 4.32 | 2.99 | -3.05* | -4.95* | -1.40 |
| Ident. numerals | 3.45 | 3.50 | 4.92 | 3.49 | 5.81 | 3.11 | -3.31* | -5.76* | -1.85* |
| Bean count. | 3.62 | 3.11 | 4.69 | 3.04 | 5.29 | 2.71 | -2.73* | -4.63* | -1.43 |
| Set Count | 5.54 | 3.02 | 6.07 | 3.11 | 6.26 | 2.68 | -1.38 | -2.05* | -0.45 |
| Vocabulary | 2.94 | 4.22 | 7.53 | 4.53 | 10.48 | 6.40 | -8.36* | -12.40* | -3.59* |
| Equiv. Sets | 2.84 | 2.67 | 3.87 | 2.74 | 4,40 | 2.21 | -3.02* | -5.08* | -1.45 |
| Ordinal numbers | 1.84 | 2.20 | 3.11 | 2.91 | 4.15 | 2.79 | -4.79* | -8.63* | -2.48* |
| Conserv. dots | 1.20 | 1.44 | 2.29 | 1.81 | 2.77 | 1.89 | -5.47* | -8.09* | -1.78* |
| Conserv. Pictures | 1.48 | 1.64 | 2.67 | 1.8 | 3.06 | 1.98 | -5.36* | -6.94 | -1.36 |
| Rote Counting | 1.18 | 1.44 | 1.59 | 1.82 | 2.19 | 1.94 | -2.09* | -5.14* | -2.15* |
| [1]V.M. Objects | 9.42 | 10.45 | 16.77 | 10.02 | 18.81 | 7.05 | -5.59* | -8.15* | -1.63 |
| [2]V.M. Pictures | 7.27 | 8.73 | 11.63 | 9.65 | 17.50 | 7.66 | -3.81* | -10.04* | -4.63* |

* t - values significant at .05.

In classification, there were no significant differences between the different types of schools in the naming and identifying of geometric shapes and in the ordering of geometric shapes. In the naming and identifying of geometric shapes, the MC group performed better than the LC and the HC groups as the means on table 40 show. In both these subtests, the LC group performed better than the HC group. In ordering, the LC group was better than the MC group but the HC group was the best.

1+2 Visual Memory

No significant differences were found between the LC and MC groups in matching of geometric shapes and colours and in counting members of a given set.

No significant differences were found between the MC and HC groups in naming and identifying colours, logical connectives, sorting, writing numerals, counting beans and members of a given set, making equivalent sets, conservation of number using pictures and in visual memory using objects.

This analysis of the subtests emphasises the differences found earlier between the different types of schools. Differences are greater between the LC and MC groups than between MC and HC groups.

4.33 DIFFERENCES BETWEEN AGE GROUPS

The research studies reported in section 2.5 confirm Piaget's studies and findings that the understanding of number and classification highly depends on the age of the child. Since the children being studied here are in, according to Piaget, the pre-operational stage, they are generally in one generalised group of intellectual development. But since the child's understanding of various concepts is a function of age, differences between 4, 5 and 6 year olds are expected in their comprehension of mathematical concepts as revealed by the total score, classification score, number score, vocabulary score and visual memory score.

To test the null hypothesis of no difference between the different age groups, the regression technique was used where the age was considered in months and not in years.

HYPOTHESIS 3

HO : There is no difference in comprehension of mathematical concepts between children of the age range four to six years.

Results

Table 41 : Results of the regression analysis based on total score .

| | |
|---|---|
| R | 0.50499 |
| R Square | 0.25502 |
| Variable B – Age | 1.46872 |
| Standard Error B | 0.12583 |
| Beta | 0.50499 |
| Constant | -50.79481 |

Hypothesis 3 is based on the total score of the variables treated separately in hypothesis 4.

HYPOTHESIS 4

Ho: There is no difference in comprehension of mathematical concepts between children of the age range four to six years in : 1 Classification

: 2 Number

: 3 Vocabulary

: 4 Visual Memory

RESULTS

The results of the regression analysis based on age in months of the various variables are shwon on table 42.

Table 42 : Results of the regression analysis based on classification, number, vocabulary and visual memory scores.

| | Classification | Number | Vocabulary | Visual Memory |
|---|---|---|---|---|
| R | .47226 | 0.61400 | 0.32015 | 0.39285 |
| R Square | .22303 | 0.37700 | 0.10249 | 0.15433 |
| Variable B - Age | 0.83338 | 1.00959 | 0.19431 | 0.74940 |
| Standard error B | 0.07797 | 0.06505 | 0.02882 | 0.08793 |
| Beta | 0.47226 | 0.61400 | 0.32015 | 0.39285 |
| Constant | -20.96112 | -41.21504 | -6.97195 | -25.19951 |

To verify the regression analysis results, the t-values for difference between means were calculated between the three age groups in years. These results are shown on table 43.

Table 4.3 : Mean scores and t-values for difference between means for the total and the four main variables.

| | 4(N=120) | | 5(N=138) | | 6(N=142) | | t-values for difference between means | | |
|---|---|---|---|---|---|---|---|---|---|
| Task | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | 4-5 | 4-6 | 5-6 |
| Total | 28.73 | 23.35 | 43.28 | 25.68 | 62.99 | 24.34 | -4.74* | -11.57* | -6.59 |
| Classification | 24.20 | 15.77 | 32.91 | 15.05 | 43.09 | 15.18 | -4.54* | - 9.86* | -5.63 |
| Number | 13.91 | 12.41 | 22.64 | 14.04 | 37.39 | 11.46 | -5.26* | -15.90* | -9.64 |
| Vocabulary | 3.55 | 4.65 | 5.54 | 5.81 | 8.02 | 6.12 | -3.00* | - 6.56* | -3.48 |
| Visual Memory | 14.87 | 16.75 | 23.08 | 18.36 | 33.02 | 15.75 | -3.75* | - 9.03* | -4.87 |

*t-values significant at .05.

the minus sign means the first mean is less than the second.

the minus sign is ignored when considering the t-values.

The findings shown on table 43 above clearly show that the older children in each case perform better than the younger children and that the differences between the means are statistically significant at .05.

To show whether the 5 year olds were close to the 4 or to 6 year olds in their comprehension of mathematical concepts, the 95% confidence intervals for the means were calculated, both for the total scores and for each of the variables. The results are shown on table 44.

Table 44 : 95% confidence intervals for the total score and the variables between age groups

| Variables | 95% confidence intervals | | |
|---|---|---|---|
| | 4 years | 5 years | 6 years |
| Total score | 24.5069 to 32.9471 | 38.9612 to 47.6079 | 58.9522 to 67.0283 |
| Classification | 21.3496 to 27.0504 | 30.3801 to 35.4460 | 40.5726 to 45.6105 |
| Number | 11.6690 to 16.1560 | 20.2812 to 25.0086 | 35.4924 to 39.2964 |
| Vocabulary | 2,7104 to 4.3896 | 4.5591 to 6.5134 | 7.0054 to 9.0368 |
| Visual Memory | 11.8390 to 17.8943 | 19.9899 to 26.1695 | 30.4086 to 35.6336 |

The above 95% confidence intervals for scores between age groups indicate that the confidence intervals between age groups are clearly distinct and at no point do they overlap. These differences are even clearer than the type of school differences analysed earlier. In each case, the gap between the 5 and 6 year olds is greater than the gap between the 4 and 5 year olds. This means that in comprehension of mathematical concepts, the 5 year old children are closer to the 4 year olds than to the 6 year olds.

In order to show whether there are any areas in the various subtests where there are no differences between the age groups, t-values for the difference between means of the subtests by age groups were analysed and are shown on table 45.

Table 45 : Mean scores for subtests by age in years

| Subtests | 4(N=120) | | 5(N=138) | | 6(N=142) | | t-values for difference between means | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | σ | $\bar{x}$ | σ | $\bar{x}$ | σ | 4–5 | 4–6 | 5–6 |
| Geom. Shape Name | 1.13 | 1.46 | 1.66 | 1.60 | 2.70 | 1.35 | –2.79* | –9.06* | –5.89* |
| Geom. Shape Indent. | 1.55 | 1.66 | 2.15 | 1.66 | 3.27 | 1.17 | –2.91* | –9.84* | –6.56* |
| Colours–Name | 2.02 | 2.69 | 3.13 | 2.89 | 4.74 | 2.66 | –3.91* | –8.21* | –4.85* |
| Colours Indent | 1.83 | 2.42 | 2.87 | 2.59 | 4.25 | 2.34 | –3.30* | –8.18* | –8.18* |
| Geom. Shape match | 3.04 | 1.64 | 3.34 | 1.45 | 3.60 | 1.20 | –1.55 | –3.17* | –1.62 |
| Colours match | 4.69 | 2.37 | 5.51 | 1.38 | 5.70 | 1.24 | –3.44* | –4.44* | –1.26 |
| Ordering | 0.14 | 0.42 | 0.22 | 0.55 | 0.52 | 0.77 | –1.23 | –4.84* | –3.79* |
| Comparison of subsets of a set | 0.23 | 0.55 | 0.28 | 0.66 | 0.44 | 0.78 | –0.55 | –2.41* | –1.87* |
| Sorting | 9.80 | 8.45 | 14.04 | 8.29 | 18.31 | 8.02 | –4.06* | –8.35* | –4.38* |
| Writing numerals | 1.09 | 2.04 | 2.42 | 2.73 | 5.85 | 2.12 | –4.38* | –18.45* | –11.78* |
| Ident. numerals | 2.05 | 2.90 | 3.72 | 3.34 | 6.94 | 2.42 | –4.24* | –14.86* | –9.25* |
| Bean count | 2.20 | 2.83 | 4.02 | 2.97 | 6.25 | 1.95 | –5.02* | –13.66* | –7.45* |
| Set count | 4.28 | 3.43 | 5.89 | 2.96 | 7.08 | 1.71 | –4.05* | –8.57* | –4.15* |
| Equiv. sets | 2.43 | 2.72 | 3.17 | 2.68 | 4.60 | 2.14 | –2.23* | –7.25* | –4.93* |
| Ordinal numbers | 1.32 | 1.91 | 2.28 | 2.46 | 3.96 | 2.97 | –3.48* | –8.39* | –5.13* |
| Conserv. dots | 1.30 | 1.45 | 1.59 | 1.33 | 2.51 | 2.18 | –1.66 | –5.21* | –4.28* |
| Conserv. pictures | 1.49 | 1.59 | 2.12 | 1.59 | 2.68 | 2.31 | –3.18* | –4.77* | –2.35* |
| Rote count | 0.55 | 0.71 | 1.14 | 1.37 | 2.71 | 1.92 | –4.28* | –11.71* | –7.89* |
| Visual M. Objects | 8.64 | 10.21 | 12.81 | 10.59 | 17.90 | 8.66 | –3.21* | –7.94* | –4.41* |
| Visual M. Pictures | 6.23 | 8.34 | 10.27 | 9.76 | 15.12 | 8.68 | –3.55* | –8.41* | –4.40* |
| Vocabulary | 3.55 | 4.65 | 5.54 | 5.81 | 8.02 | 6.12 | –3.00* | –6.56* | –3.48* |

* t-values significant at .05

Table 45 shows that although in each case the older children comprehend mathematical concepts better than the younger children, in matching geometric shapes, in ordering, in the logical connectives and in conservation using dots, the difference between the 4 and 5 year olds is not statistically significant at .05. Only in two subtests were there no significant differences between the 5 and 6 years olds, that is, in the matching of geometric shapes and colours. The means between the 4 and 6 year olds are all statistically significant at .05.

## 4.34 Differences between sexes

The outline of findings of research studies on sex differences reported in section 2.6 indicated no significant differences between boys and girls of pre-school age. Where differences were found which were not significant, they were often in favour of girls. The following hypotheses test the null hypotheses of no difference between sexes among pre-school Nairobi children -

Hypotheses 5

Ho: There is no difference in comprehension of mathematical concepts between boys and girls of pre-school age in Nairobi.

Results

Table 46: Mean scores and t-values for difference between sexes based on the total scores:

| Boys (N-205) | | Girls (N-195) | | |
|---|---|---|---|---|
| $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | t-value |
| 45.5676 | 28.370 | 46.2750 | 28.023 | - 0.25 |

Hypothesis 5 is based on the total score of the variable treated separately in hypothesis 6

Hypothesis 6

Ho : There is no difference in comprehension of mathematical concepts between boys and girls of pre-school age in

1 Classification

2 Number

3 Vocabulary

4 Visual Memory

Results:

The results of the difference between means test between boys and girls are shown on table 47.

Table 47: Mean scores and t-values for difference between sexes:

| Variable | Boys | | Girls | | |
|---|---|---|---|---|---|
| | $\bar{X}$ | $\sigma$ | $\bar{X}$ | $\sigma$ | t-value |
| Classification | 33.2341 | 17.190 | 34.6256 | 17.000 | -0.81 |
| Number | 25.1585 | 16.254 | 25.3692 | 15.611 | -0.13 |
| Vocabulary | 5.9707 | 5.862 | 5.6667 | 5.906 | 0.52 |
| Visual Memory | 23.7366 | 18.576 | 24.5744 | 18.406 | -0.45 |

Differences between some subtests

These show whether performance in tests which are related is different or not.

Hypothesis 7

Ho: There is no difference between counting of beans and counting of pictures.

Results:

The t-value for the difference between the means of counting beans and counting members of a given set was - 11.78.

Hypothesis 8

Ho: There is no difference in visual memory between objects and pictures.

Results:

The t-value for the difference between the means of visual memory objects and pictures was 6.41.

## 4.35 Relationships of variables used in this study

As mentioned in section 1.7 one of the purposes of the present study was to show whether there are any relationships between various variables used in the study and also to show the strength of the relationships. These relationships are important at the pre-school level where categorisation of subjects is impossible and where the interdependence of subjects is great. The extent to which the comprehension of one task affects the comprehension of another task calls for a test to find out the significance of the relationships. In each case, the Pearson's correlation coefficient was used.

### Hypothesis 9

Ho: There is no correlation between the total score and

1 Classification

2 Number

3 Vocabulary

4 Visual memory

### Results

The correlation coefficient for 1 is r = .91272

2 is r = .90431

3 is r = .86633

4 is r = .88388

### Hypothesis 10

Ho: There is no correlation between comprehension of classification skills and

1 Number

2 Vocabulary

3 Visual Memory

Results

The correlation coefficient for 1 is r = .82232

" " " " 2 is r = .74776

" " " " 3 is r = .71906

Hypothesis 11

Ho: There is no correlation between comprehension of number skills and

11: 1 Vocabulary

11: 2 Visual memory

Results

The correlation coefficient for 11:1 is r = .69914

" " " " 11:2 is r = .70837

Hypothesis 12

Ho: There is no correlation between comprehension of vocabulary and visual memory.

Results:

The correlation coefficient for H.12 is r = .67349

Hypothesis 13

The relationships of various subtests was also tested.

Ho: There is no correlation between

1 writing and identifying numerals

2 naming and identifying colours

3 naming and identifying shapes

4 rete counting and counting of beans and pictures

Results

| | | | | | |
|---|---|---|---|---|---|
| The correlation | coefficient | for | 1 is r | = | .8715 |
| " | " | " | " 2 is r | = | .9317 |
| " | " | " | " 3 is r | = | .7647 |
| " | " | " | " 4 is r | = | .5159 |

Hypothesis 14

Ho : There is no correlation between vocabulary skills and the no-vocabulary skills.

Results

The correlation coefficient between vocabulary and the non-vocabulary skills in the test batteries is r = .7713.

Hypothesis 15

Ho: There is no difference in conservation of number between 4, 5 and 6 year old children.

Results:

Multiple R = 0.29000

R square = 0.08410

Variable B - Age = 0.10670

Standard Error B = 0.01765

Beta = 0.29000

Constant = 3.06395.

# CHAPTER FIVE

## SUMMARY AND CONCLUSIONS

### 5.0 INTRODUCTION

As the final chapter of this study, chapter five aims to summarise the whole study and in the conclusions of the results highlight some implications and recommendations as viewed by the author.

Section 5.1 presents an outline of the objectives and aims of the study and of the methods and procedures used for data collection and analysis. Section 5.11 gives a summary of the background of the sample of children in the study. Section 5.2 presents the conclusions, implications and recommendations on the mathematical concepts tested. This includes classification in section 5.21, Number in section 5.22, Vocabulary in section 5.23 and Visual Memory in section 5.24. Some general recommendations based on the mathematical concepts are mentioned in section 5.25. Conclusions on the hypotheses tested are found in section 5.26. In section 5.3, some implications for further research are outlined followed by the concluding remarks in section 5.4.

### 5.1 Summary

The main purpose of this study was to find out pre-school children's comprehension of some identified mathematical concepts. Once these were confirmed, various statistical tests were done to show whether or not there were differences between the three types of schools, high, medium and low cost; the three age groups, four, five and six year olds and the boys and girls. The relationship between various variables was also tested.

A number of test batteries previously used for kindergarten children in U.S.A. by the School Mathematics Study Group (SMSG), were used but were changed a little to suit Kenyan Children in Nairobi. These were divided into classification, number, vocabulary and visual memory skills. A pilot study was done and the necessary adjustment to the test directions were made.

Seven women test administrators were chosen and trained by the writer to test the children. Each tester and the child would sit facing each other across a table in a room all by themselves, the tester generally adopting a positively reinforcing attitude towards the child. Unlike Piaget's clinical method of testing, the testers were not allowed to probe beyond what the test directions allowed. This would have required more experienced testers than were available.

All the tests were treated as games during which test materials varied quite a lot. A number of sessions were held each day with different children to avoid taking them over the long test. Very few verbal responses were needed. But all the instructions were clearly written and executed in English, the Schools' medium of instruction.

A sample of 400 children from different types of schools and age groups were randomly chosen and tested. Each child's response was marked on the scoring sheets. A scoring grid and a coding system were prepared. The Statistical Package for Social Sciences (SPSS) was used with the IBM computer at the Ministry of Finance and Economic Planning. The frequencies, means and standard deviation, the ANOVA, the regression analysis, the correlation coefficients and the difference between means tests were all calculated. The discrimination indices and the reliability coefficients were calculated manually.

5.11 <u>Background of the children in the study</u>

Most of the children in the sample were in the Nairobi City Council pre-schools but most of the six year olds were in standard one classes of primary schools. Both the pre-schools and the primary schools are categorised into HC, MC and LC schools. Since these differences in types of schools figure prominently in the whole study, a short description of these types of schools showing differences, other than in comprehension of mathematical concepts, is given.

There are three large HC day nurseries charging K.Shs.250 per month per child. Most children are taken to school by car and have parents both of whom are in paid employment. These schools are better equipped with play, writing and reading. materials than others. Their food is cooked in the school kitchen and is of a higher quality than in other types of nursery schools. In addition to the main meals, the children are provided with plenty of milk and fruits. The schools are situated in generally HC residential areas.

There are four MC day nurseries charging K.Shs.200 per month per child. These are very much like the HC nurseries with classrooms for different age groups but each school does not have its own kitchen. The food is centrally cooked, together with food for the LC schools and is of a lower quality than that cooked in the HC schools. These are generally located in MC residential areas.

There are eight LC day nurseries all of which are located in the LC residential areas of the city. They charge K. Shs.75 per month per child. These day nurseries do not have separate classrooms for different age groups as the HC and MC ones do. They use one big hall with teachers and their classes at particular corners of the hall. Disturbance is inevitable. They have fewer play, writing and reading materials. Their food does not often arrive on time for lunch. The children do not have an afternoon drink after the siesta as children in the HC and MC schools did.

All the day nurseries are administered by the Nairobi City Council. The teachers are of the same grades and qualifications. The official medium of instruction in all of them is English. While English is used in the HC nurseries and a little in the MC nurseries but with occasional vernacular of Kiswahili to new children who have not picked the English language yet, it is not so in the LC schools as it should be. Here, a mixture of many languages with a predominance of Kiswahili, is used. English is taught as a subject. Surprisingly, most of the songs and rhymes used in all the day nurseries are in English. They do not seem to make much sense to the children, nor to a large number of the teachers. Rote learning is quite prevalent.

Most standard one teachers practise streaming within the class - this is the homogeneous grouping of students within a single class. The children in the poorest groups were usually those who had not been to nursery schools or those who attended the very poor ones. The nursery schools, therefore, help to classify children at at a very early age.

## 5.2 CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS ON THE MATHEMATICAL CONCEPTS TESTED.

The level of comprehension of the mathematical concepts that I set out to ascertain was shown in the item analysis in chapter four. What follows is a discussion on the results in each of the main areas of operation.

### .21 Classification

The idea of sorting or classification is based on the idea of a relation. The ability to grasp the relation or relationships of ideas is fundamental to reasoning. The inability of children to grasp the relationships of notions or ideas is a principal obstacle to the development of their reasoning. Classification serves as a basis for the development of mathematical concepts. In this test, the assumption is that abstract concepts develop partly through awareness of certain regularities. At the level of the four to six year old, such physical attributes of objects as size, shape and colour are used to systematize and categorise a wide range of perceptual experiences.

The matching portions of the colours and geometric shapes' tasks were employed solely as perceptual tests to ascertain whether the children were able to match two cards or shapes embedded within two displayed sets of cards or shapes on the basis of colour or shape alone. Most children enjoyed the game and had no problem in displaying their knowledge of the concept of matching. Between 82% and 90% of the children could do this correctly.

The naming portions of these same tasks required the children to give names to specific colours and simple geometric shapes. Accurate performance on these items depended upon the children's experience in having had a particular lable, for example, circle shape or red colour, consistently attached to a particular hue or shape, and being able to say that word when the appropriate perceptual stimulus was presented. The ability of the children to do these tasks ranged from 35% to 55%. The naming section was always given before the identifying so that the children would have to provide the colour and shape names. The identifying portions of the colour and geometric shapes tasks required the children to identify and select a colour or shape requested by the tester from a displayed set. This task demanded, in addition to having the particular colour or shape name attached to certain perceptual stimuli, that the child "keep in mind" the requested object while scanning the presented set to locate the appropriate object, whose only property differentiating it from the others was its colour or shape, according to the specific task. Between 48% and 67% of the children could do this task.

The naming and the identifying sections were poorly done. The sorting parts which required, among other things, knowledge of the names of colours and shapes were also poorly done. This is not surprising. For those children who were new in the nursery school, they hadn't learnt these in school yet. At home, they wouldn't have learnt the names of colours like green, orange, blue, yellow or shapes like triangles, squares and rectangles because there are no names for them in the mother tongues. In Kiswahili, there are no names for them either except green colour which is described as a leaf which is not dry. This is one of the areas where nursery school education has got to complement for what is lacking from home.

Although the NCC pre-schools are well supplied with geometric shapes, counters and paints of different colours, the constant use of the names of the shapes and colours need to be stressed more, not by formally teaching children "this is red colour, say red colour" etc. but by making the children aware of the shapes and colours around them everyday. This would call for more interaction between teachers and children where the teacher would discuss the children's work deliberately bringing in the colour and shape names. Constant references of these shapes and colours can be made during the various activities,like, cutting out shapes, colouring and painting, nature walks, even in number work where counters of different colours and shapes can be used. The correlation between naming and identifying colours was $r = .9317$ while the correlation between naming and identifying shapes was $r = .7647$. Pre-school teachers should try and do these tasks together as they are highly related.

When the children were asked to sort all the red triangles out of a multi-coloured set of geometric shapes, only 50% could choose all the four red triangles present. Many of these included triangles not red showing they were just thinking about the shape, others included other shapes which were red showing they were just thinking about colour. Others included shapes that were neither triangles, nor red. Some children rarely seemed to stop to think about what they were doing or were expected to do. For some of them, the exercise seemed merely to require the physical shuffling of the geometric shapes during which they would hopefully achieve what the tester wanted.

56% of the children could sort all the four circles from a set of geometric shapes of the same colour. Some included other shapes in addition to the circles. Their ability to do this could be due to perceptual structures which Piaget says are sufficient to solve a simple classification problem. "Sensory cues may allow the children to put the same shapes together or the same colours together". These pre-operational children in this study showed a great reliance on present perception. The perception on which they relied on tended to be partial, that is, it focussed on a single dimension of the problem.

Classification using size proved very difficult. Same size shapes and smallest members had just about a quarter of the children sorting them correctly. The strategy the children used to judge the sizes was not clear - some would just pick any shapes which perceptually looked the same showing poor discrimination ability. Very few were keen to exhaust all possibilities. Most would pick one or two or three shapes and consider the matter finished. Any prompting usually led to confusion and the children forgetting the criterion they were using so that they would randomly choose any shapes whether they were the ones asked for or not.

The classificatory behaviour is similar to that observed by Inhelder and Piaget (1964), Lovell, Mitchell and Everett (1962) and others where graphic collections were observed and children did not seem to have a plan in classifying objects.

The very poor comprehension of the operation of serializing agrees with Piaget when he says that children in the pre-operation stage are unable to construct a series. When they are given a set of objects to arrange in order of sizes, they begin at random and try to rearrange in order only when very noticeable discrepancies occur. The fact that the largest number of children in ordering both circles and triangles did so randomly, 55.5% for circles and 61.8% for triangles - shows this inability to seriate. Seriation requires the mathematical idea of the transitive property - if B is bigger than A and C is bigger than B, then logically C is bigger than A. Only 16.3% and 14.0% of the children could arrange circles and triangles respectively in order as asked. Piaget says that this system of operation appears around age 7 or 8 years. But at the pre-schools where children are below age 7 or 8 years, constant references to objects of different sizes and to numbers of objects arranged in order of "one more than" the previous number can provide useful pre-measurement readiness activities so that children will be able to understand the meaning of numbers e.g. that 4 is a number greater than 3 but less than 5.

Two tasks tested the relationship where two sub-classes of a whole were compared. The fact that only 15% and 17% could do them correctly agree with Piaget when he says many children below the age of 9 years do not have the necessary mental operations involved in this logical and arithmetical operation. The 'figural' collection of objects during classification of the shapes into two classes - triangles, and red squares, was quite evident here. Some children sorted the shapes on the basis of attribute similarity - triangles and then red squares, but were distracted by configurational aspects of the formation when the two big red squares appeared more than the four little triangles.

There are many ways in which classificatory behaviour can be introduced. Sorting opportunities must be encouraged. Pre-school children often sort many things into sets of their own choice, and the teacher can provide articles specifically for this purpose. A variety of objects can be used - buttons, small pictures, beads, cars, animal pictures or toys, beans, bottle-tops etc. The teacher can interact with the children by finding out the criteria the children use to sort things. This provides an opportunity for the teacher to suggest other ways in which the child can sort the objects. The teacher could structure the situation by getting the children to look for a particular attribute e.g. all the things that you can eat, all the animals, all the beans or beads etc. This provides experience in inclusion relations. Progressively, the teacher can ask for objects using two or three attributes. This provides experience in common elements in sets.

Most children eat lunch in the schools. In preparation for a meal time, the children should be allowed to participate, where one-to-one relationships can be experienced. This is also a time when number can be introduced. The teacher must remember that, to the young nursery school child, the fact that if six children each have one spoon we need six spoons, is not a foregone conclusion. This is something that children must learn by personal experience.

5.22 Number

Children are naturally interested in numbers and comparisons of quantity. If, as a group, they are given sweets, they want to know whether the sweets were distributed to them equally or whether some children were favoured. They learn to count by imitating an ordered pattern of words. They have already used number words in their play. Probably some have seen number symbols before coming to school. However, unless the teacher makes it very obvious, it can happen that some children may not realise that each number name refers to a set of that many things, not the single object he may be touching or looking at. This can be overcome by the physical manipulation of objects during counting.

Two tasks assessed the cardinal counting ability. The children were asked to count out a specified number of beans from a larger set of beans provided to them. Then they were required to count the number of members in a set (pictures of familiar objects on a card). Between 54% and 72% of the children could count beans while between 59% and 80% could count pictures. The results on the two separate counting tasks were very similar. 3, 4 or 5 beans or pictures were readily counted by the children although the counting of a fixed number of pictures was somewhat simpler than the counting of beans from a larger set. As the items to count increased towards 9, the ability to count progressively decreased.

The same pattern was observed in the identification of numerals. Here, the children were shown a matchbox, each with a numeral printed on the front. Inside the matchbox was the number of beans represented by the numeral, and the children were requested to hand the tester the matchbox with 3, then 1, 4, 5, 0, 8, 7 and 9 beans inside. The small numbers 3, 1, 4 and 5 were easier to identify than the bigger numbers. Between 47% and 65% of the children could identify numerals correctly. The number 0 was, however, the most difficult.

62 children or 15.5% could count by rote up to 100 while 73 or 18.3% could not count up to 10. The correlation between cardinal counting ability and rote counting was not very strong r = .5159. There were swings in many of the nursery schools in Nairobi. If the teachers actively participate in children's free play, they could easily do rote counting on the swings as the children swing and count the number of times they have swung. They could also count in twos or threes etc. which is a good introduction to multiplication. Songs and games that deal with numbers can provide excellent opportunities to learn number names and values. These number values will make sense only if objects are manipulated to give meaning to the number names the children learn. There are many things in a classroom to be counted. Teachers must make use of them and teach cardinal counting during play situations.

Manipulation of set materials prior to operations on numbers is the approach recommended in the "New Maths". Among the activities included is that of set comparison which is employed to establish the concpet of equivalence.

For the equivalent sets task, the children were requested to form a set of beans equivalent to the set of dots on a series of cards. The first card had 5 large black dots drawn on it; the second had 4; and the fourth had 6 dots. The largest percentage of correct responses, across the three population groups, was on the equivalent set card with four dots, the smallest number included within this particular test. This latter finding appeared consistent with the results on the two counting tasks which suggested that the task became increasingly difficult for the pre-school children as they have to deal with numbers larger than five. The fact that while making equivalent sets most children copied the pattern, some even tried to put more beans to represent bigger dots, agree with Piaget when he says that for the child, "as many" merely means a set similar to the model with respect to its overall qualities (size and shape). They are not equipped by their intellectual structure to consider the set as being a union of units which would imply that they already possessed the notion of whole number.

The three number concepts which were most difficult for the majority of pre-school children, regardless of type of school or age were ordinal numbers, writing numerals and conservation of number using dots.

Out of 7 writing numerals items, the mean was 3.240. This means that on the whole less than 50% could write the numerals. Like the counting items and identification of numerals, the numbers 3, 4 and 5 were easier than the others. Only 37.5% of the children could write numeral 9. The ability to write numerals is a clear pre-requisite for work in mathematics. A certain amount of eye-hand co-ordination is necessary for a

To compare sets and arrange them by the number of members within each set, it is useful, though not imperative, for the child to have some concept of ordinal number. The vocabulary of ordinality is part of the everyday language of the pre-school teacher, e.g. taking turns, the first child in line, and references to the sequencing of activities during the school day. The meaning of "first", "fourth", etc., may be more explicitly taught through the ordering of sets by the number of members contained within each set or through establishing and naming positions of objects within a set.

The findings of this study showed clearly that pre-school children in Nairobi have little understanding of the concept of ordinality. 39.5% knew first, 31% second, 20% third, 21% fourth and only 17.9% fifth. The pre-school teachers have many opportunities when this concept can be developed in classroom and play situations. For example, the children in Nairobi pre-schools were made to line up when going to the toilets and many children would fight for the first position. This is an opportunity the teachers can exploit by deliberately making the children aware of their position on the line. Groups of five can be arranged so that children learn first to fifth positions.

Conservation is a necessary condition for all rational activity. In Arithmetic, a number is only intelligible if it remains identical with itself, whatever the distribution of the units of which it is composed. Conservation of number is a necessary condition for any mathematical understanding.

The conservation tasks in this study reflected the same characteristics of the pre-operational child as those ones observed by Piaget (1962), Hyde (1959), Price Williams (1961 and 1962), Etuk (1967) and Otaala (1972). The children were still restricted to sensory intuition because they did not realise that when there was a change in the distribution of the parts, the number of the elements remained invariant. Conservation was found to be age dependent through the regression analysis thus agreeing with other studies. A Mean of 3.962 and 1.830 on six pictures and six dots respectively shows that more than half the number of pre-school children in Nairobi cannot conserve number. For the age groups, the means were 1.3, 1.59, 2.59, for 4, 5 and 6 year olds in dots and 1.49, 2.12 and 2.68 for 4, 5 and 6 year olds in pictures respectively. Out of a total mark of 6 in each case, the means by age groups clearly show that even for the 6 year olds most of whom were already in standard one, less than half can conserve number. After many experiments, Piaget came to the conclusion that children must grasp the principle of conservation of quantity before they can develop the concept of number. Judging from Piaget's findings, this implies that most standard one children in Nairobi Primary Schools do not understand the concept of number and may, therefore, not be ready to meaningfully deal with the present standard one mathematics syllabus, Since, so far, there is no evidence that these children do not understand the concept of number, the problem may be in the method of testing conservation which is not exactly what Piaget used.

## Vocabulary

Although there are many facets of language learning relevant to cognitive development, the most relevant for this study is the vocabulary necessary for understanding mathematical concepts and relationships. At the pre-school level, perhaps more important than the precise language of mathematics, is some vocabulary which the children can use as labels for certain manipulations. In developing the concept of sets, for example, such expressions as "more than","fewer than", and "as many as" are crucial. For the early pre-geometry ideas, such words as "inside", "outside", and "on" are critical. The ability to understand these words as shown by manipulating blocks appropriately was the means used to assess the vocabulary of the pre-school children in Nairobi.

The fact that only 3.5% of the children knew the meaning of above, 10% of set, 16.3% of fewer than and for bottom, between, each, more than, as many as, join, below and shorter than, less than 30% knew their meaning in schools where English is the medium of instruction is not surprising. Language use and language policy, in this country, have been very confusing. In the early 1960s, "English Medium" was started in rural and urban schools. This was hopelessly confused with the New Primary Approach (NPA) whose emphasis was also new. Instead of the NPA being the discovery and activity method in teaching as it was supposed to be, it turned out that only the "English Medium" classes were using the NPA. The classes using vernaculars would not use NPA. The "English Medium" enthusiasm which had spread like bush fire in the late 1960s died down in the rural schools which are now back to vernacular as the medium of instruction in the first few classes of the primary school. After about three years, English, still studied as a subject replaces the vernacular as medium of instruction. The vernacular is not continued to be studied separately as a subject. For the majority of school entrants, the first and only contact with English is in school.

The Ministry of Education explains the language policy in a recent circular thus, "the present language policy allows schools to use the mother tongue in the vast majority of lower primary schools, Swahili where there is no common mother tongue and English where the above two options are not feasible (Bowman, (1976)[1]. This seemingly very accommodating policy is paradoxically very restricting to urban low cost schools, not to mention the rural schools, which, while realising the practical need of teaching in Kiswahili have to remember that all the subjects at C.P.E. level are examined in English and all the text books and visual aids are in English. Kiswahili, although taught in class as a subject is not examined at C.P.E. level. The teachers have been trained to teach in English. Teachers, then, tend to rush their students on an English medium in an attempt to help them better their chances of doing well in C.P.E.

Because of the past educational history of this country, many primary schools teachers are not confidently conversant in Kiswahili to be able to explain the concepts to be taught in Kiswahili while they have been written in English. Although the official medium of instruction in Nairobi City Council pre-schools

1. Bowman, G. "Use of Language in Lower and Upper Primary". (Ministry of Education Circular INS/C/1/1 Vol.II/175, 1976).

and primary schools is "English", many teachers use Kiswahili and English in the classroom in such a way that the pupils neither get used to one particular language, nor both. The pupils' text books are written in English. This confusion in the language to be used in the schools both inside and outside the classroom slows down the pace of acquiring the subject matter of pre-school and primary education which cannot be effectively conveyed until the "channel" is ready. In a subject like mathematics which uses very precise language, greater mastery of language is imperative - otherwise the child will spend the better part of his pre-school and primary school years trying to master a language instead of learning through it. He will parrot a great deal of mathematical material, as Gay and Cole found among the Kpelle of Liberia, which he does not comprehend or which he cannot apply to specific situations so that his knowledge is not functional. Researches done in West Africa by Fafunwa and Bliss (1967)[1] and Fafunwa (1973)[2] have found that the child's cognitive equilibrium is disturbed, when he is made to learn concepts in a language he does not understand, and this abnormal situation tends to retard the cognitive process in terms of the anticipated outcomes of the western form of education.

1. Fafunwa, A.B. & Bliss, E. (1967) Ibid.

2. Fafunwa, A.B. & Others, "A Midway Report on the Six-Year Primary Project", (Institute of Education, University of Ife, Ile-Ife, 1973).

From the beginning, the necessary language should be introduced for without the appropriate language the knowledge the child gains from his activities will remain at a sensory level. Special attention should be paid to those children who come from homes where the language of instruction used in schools is unknown. This may be even more important than the special attention given to children from linguistically impoverished home backgrounds in the Western countries where the mother tongue is also the language of instruction in schools. Many incidences occur in schools where words - like the vocabulary tested for in this study and underlined below can be used. While comparing sizes of objects provided for manipulating, some may be shorter than others while one among many may be the tallest. Some objects may be placed on the shelves above others, some on the bottom shelf, some between others and some below others. Some objects may be kept on top of the cupboard, some inside the cupboard and others outside the cupboard. While rewarding a child for a good deed, the child may be given one sweet more than others, other children may be given as many as others, while the naughty ones may be given fewer than others. To clear the table in which they have been working on, they have to remove the objects. While making a train, they may have to join blocks. Children must know their right and left hands or sides which can often be referred to in relation to their positions among other children. While classifying objects in terms of - say, colour, shape, size, use etc., the teacher must, through everyday experiences, provide the vocabulary that will lead the children to further development of the language that will be used to learn mathematical concepts. Even for those children who use the language used in schools at home, teachers must not take for granted that descriptive words of mathematics and relational words are already part of the child's vocabulary and is understood by him.

There are many opportunities when mathematical learning can be encouraged in Nairobi pre-schools. The schools are provided with many blocks. In block play, the child can learn about size, shape, colour, weight and spatial relationships. He can learn to discriminate - to compare and contrast sizes and shapes. He may even begin to form the concepts of "as big as", "bigger than" etc. It is important that the teacher gives the right amount of help, and provides vocabulary, without doing the child's thinking for him. The teacher, then, should be well above the child's level of vocabulary.

5.24 Visual Memory

The visual memory items included sets of familiar objects and pictures. To recall them, the child needed to organize the material, on his own initiative, sc that he or she would be able to recall the object or picture missing. But the sets of objects and pictures used were randomly selected and did not necessarily belong to one easily recognizable category. So the only method left to the child to use was rote, perhaps in the order of arrangement, which was then made more difficult by closing in the gaps where the pictures or objects were placed. Many of these children could not think of a strategy that could aid them to recall better. The results of visual memory tasks are important in that they may be indicative of good or poor performance in school. Success in school, among other things, requires that children learn to commit large amounts of initially unrelated material to memory.

Differences in visual memory between children of different age groups revealed that visual memory, just like classification, number and vocabulary, was dependent on age. The older the child, the better the visual memory. The differences found between different types of schools, the LC performing poorly, the MC doing better while the HC were the best were difficult to explain, because although more children from the LC schools than MC and HC schools did not respond because they did not understand the rather lengthy explanations of the visual memory game, the results given were for those who responded.

The visual memory results showed that actual objects were remembered better than pictures. The difference was statistically significant at .05. The problem in recalling familiar pictures could easily be due to unfamiliarity of drawings by the children. Many of them do not see pencils or paper prior to joining school. It could also be due to the mode of representation of pictures in two dimensions.

If pictorial materials are a problem to pre-school Nairobi children as revealed by results in this study, then it may be in order here to suggest that some caution should be exercised in using visual aids and pictorial material in educational and test situations. A change from the common formal verbal rote learning in schools should be encouraged and more use of pictures should be made. Incidental exposure to pictures at pre-school level is unlikely to overcome the very real problems often found in Primary and even Secondary school pupils when using and interpreting illustrated textbooks. Perhaps there is a need for training in perception and in handling and organizing visual and spatial materials. This may reveal specific difficulties and about how Nairobi pre-school children translate two dimensional pictures into three dimensions.

5.25 General recommendations

The results of the findings just summarised in this study clearly indicate that there is a lot of mathematical knowledge that the standard one curriculum developers assume children possess that they do not necessarily possess. Many six year old children, most of whom were already in standard one classes were very poor in sorting, seriation, logical connectives, conservation and vocabulary. This poor comprehension of mathematical concepts some of which appear in the Kenya Primary Mathematics Book One calls for the need for an inventory of the children's mathematical knowledge at pre-school level and definitely at the beginning of standard one so that teachers can organise meaningful instructional programs for each child. Such a test would be of great advantage to children whose mathematical background experiences have been more limited than others.

These results emphasise the need for a planned mathematical program at pre-school level aimed at preparing children for standard one class. Such a readiness program would require a systematic presentation to replace the incidental approach that is now generally employed. The same program should be continued to standard one for continuity reflecting the readiness period carried out in the pre-school. The readiness program would be considerably shorter at the standard one level for most children, but could be extended for whatever period necessary for each child before the concepts developed in the usual standard one curriculum are represented.

The teacher should aim to provide a stimulating, satisfying environment which meets the individual needs of the children in all areas of development - mathematics being one of them. She must be aware of the potential areas of mathematical learning presented by different types of materials, activities and situations that may arise during the day. However, the teacher should not merely provide the materials and the opportunities for the child to use and then stand back and leave the child to get on with it. She must be ready and prepared to play her own part by reinforcing the learning situation in whatever way the occasion demands. One of the most powerful motivating factors available to the teacher is her own attention to the child, which she may give or withhold at her will. The pre-school teacher should be generous with praise and encouragement.

Many pre-schools in Nairobi require more outdoor play equipment but those which had swings, slides, see-saws, and climbing bars did not seem to use them to develop mathematical concepts. For example - weight and balancing can be referred to in the see-saws, rote counting can be learnt on the swings when children take turns to swing - say ten times each. The construction, shape and movement of a swing, the angle of a slide, the spatial relationships involved in using a space for some activity, all play their part.

There were no sand pits or opportunities for water activities or woodwork in the Nairobi pre-schools. These if provided would provide interesting experiences for pre-school children. The dry sand and water activities give the child experiences in capacity, weight and size, and with wet sand, he will be able to experiment with shape and weight. In filling various containers, the child can make comparisons - 'this is smaller than that one', 'the wet sand is heavier than the dry sand' etc. In woodwork, again, there are opportunities for comparisons e.g. one piece of wood is longer or shorter or thicker or heavier than another. To join two pieces of wood require a nail of a certain length etc. In all these experiences the vocabulary may be provided by the children on their own but the teacher should be ready to augment or supply the suitable words.

Songs and games that deal with time and constant references to clock-time can help the children develop the concept of time and learn the sequence of the nursery school routine.

Another recommendation for implementation that must be mentioned here is on the use of manipulative objects. The use of aids - objects for manipulation, audio-visual etc. is imperative at pre-school age. The Nairobi City Council supplies many geometric shapes, blocks, jigsaw puzzles, counters etc. to the pre-schools. But if the teachers do not know how to use these objects to develop and teach various concepts, or even to suggest ideas on what to do with them, these objects are useless, as indeed some of them were which were nicely packed in the store because the children might lose them and to keep them neatly after the children have played with them is time consuming. During free play, instead of the teachers actively participating in what the children are doing, offering suggestions, and positively reinforcing the children's activities through which the children would learn the language by interchange of ideas, most teachers sit down and relax. Teaching little children can be very taxing but that does not mean that teachers can assume the role of a class monitor - keeping law and order. Training of such teachers is necessary if the quality of education is to improve.

These are but a few examples of opportunities that may foster the development of mathematical concepts at the pre-school level. There are obviously many more opportunities available. While emphasizing these mathematical experiences, the teacher must be aware of the other aspects of the child's development - emotional, social and physical which must all be provided for. Experiences at pre-school level do not fall into isolated compartments. There will be times when one aspect will appear to be more important than another, and the observant teacher will recognize how she can best help the child at that particular moment. But wherea the teacher in the classroom is still the most important instrument of change and improvement in the education of our children, she requires help, guidance, interchange of ideas and co-operation from the education administrators, policy makers, parents and the society in general. The problem of communication in a city like Nairobi with children of different races, ethnic and tribal groups is real. The teachers need a clear guidance as to how to establish and develop communication with such children in the stated official medium of instruction. The policy makers, the curriculum developers and the education administrators must constantly get a feedback of what is actually going on in the classrooms at the different levels of the school system so that the policies laid out by them are practical and meaningful to the classroom teachers.

## 5.26 Conclusions on the hypotheses tested

The null hypotheses of no difference outlined in chapter one and whose results are reported in chapter four were rejected in 14 out of the 15 hypotheses tested. Differences between relationships were also found significant. No significant differences were found due to sex. Although in each of the four main tasks the girls' means were higher than the boys' means, the difference was not statistically significant while tested at .05 confidence level.

The differences found between different types of schools deserve mention here. The difference between means test showed that the means from the HC schools were significantly higher than those from the MC schools which were in turn better than the means from the LC schools. These differences were not only significant in the total scores but in each of the subtests. The 95% confidence intervals showed that the group of children from the MC schools were nearer those from the HC schools and that the children from the LC schools lagged way behind.

Such differences are also found at C.P.E. level where only about a quarter of the children are admitted to Secondary schools from LC schools, about half from the MC schools and about three quarters from the HC schools. Those children who attend LC and HC pre-schools also attend LC and HC Primary Schools, respectively. Whatever reasons may have caused the differences between different types of schools in this study, there must be other reasons that cause these differences right from pre-school up to C.P.E. level.

It could be the differential provisions in these different types of schools. It could also be due to the sort of home backgrounds that the children come from, as mentioned in chapter two on children from different socio-economic status. From the findings in this study, that there is a crucial need for change in the educational provisions for the children who attend the LC types of schools hardly bears argument. Since it is not possible to protect children from negative influences of poverty and other kinds of deprivations, any efforts to enrich the school curriculum for the children who attend the LC type of schools or any remedial action would help to bridge any gaps that may be existing between children from different types of homes here in Nairobi. The gaps may not be bridged by the time the children sit national selection examinations like C.P.E. as, indeed, table 1 on page 19 shows. In Kenya to-day, the job and salary an employee gets largely depends on how far he went in school and university. If he was eliminated at C.P.E. level, he cannot expect to be any more than a house servant or a street sweeper if he is lucky enough to find any paid employment. On the face value of these results, it seems like education contributes in creating different classes or levels, although not defined but easily observable, in the African society in Nairobi. This is inadmissable in a young developing country like Kenya which is trying to foster national unity.

The fact that the vocabulary subtests were found positively and highly related to the non-vocabulary subtests in hypothesis 14 shows that those children who had poor comprehension of the vocabulary items performed poorly in all the tests batteries. Since comprehension of the words tested in the vocabulary subtests was necessary to be able to solve other problmes, particularly in the classification items where knowledge of colours, shapes and pre-measurement vocabulary were used, it is not a wonder, then, that the children from the LC schools emerged poorest overall.

This poor performance due to poor comprehension of important pre-mathematics vocabulary calls for a re-examination of the language policy in Nairobi City Council schools. Whereas it is understandable that an international language has been chosen as the medium of instruction in the schools of Nairobi which is an international city, it is difficult to understand why the use of that language is not enforced. In practice, most of the LC schools use a combination of English, Kiswahili and mother tongues with a predominance of Kiswahili. It is important that whatever language has been chosen as the medium of instruction in Primary Schools should be properly mastered by children before they join standard one. Pre-schools, then, seem to be the right places for learning that language gradually and informally. Children pick new languages quite fast if practised. An effort in that direction is urgently required to avoid children feeling deficient and psychologically disturbed when they have to learn concepts and the language together.

The Nairobi children found it easier to count a fixed number of pictures than to select the required number of beans from a bigger heap. The fact that the difference between the two counting subtests were significant at .05 level further emphasises the sort of behaviour found in the classification items where children often forget what they are looking for when they have to deal with many objects.

The high correlation between the main tasks - classification, number, vocabulary and visual memory show how interrelated they are and how each one influences the learning of the other. The very high correlation, though, could be due to a third variable as mentioned on page 140, in this case, perhaps, age.

The writing and identifying numerals, naming and identifying colours and shapes were statistically highly related. The correlation between rote counting and counting of beans and pictures, although statistically significant, is not as high as in the naming, writing and identifying numerals, shapes and colours. To be able to count, a child must know the number names but the reverse is not necessarily true.

## 5.3 IMPLICATIONS FOR FURTHER RESEARCH

### 1. On method and language of testing

The present study was carried out in English, a second or a third language for all the children, but the official medium of instruction in all schools. The children's responses, even when they appeared suspect, were not probed to ascertain the children's understanding of the question. The tester did not provide any explanations for the tasks beyond what the standard procedure specified. The question is, had a more probing approach been adopted, preferably in the languages the children understood-mother tongues - would the test have yielded any further information and therefore have provided a more valid assessment? Would the differences between types of schools disappear as they did with Kabiru's (1973) study ?

Such an approach should be tried out as a preliminary step towards working out standardized procedures appropriate to Nairobi children and indeed to Kenyan children of all tribal and ethnic groups.

### 2. On a longitudinal study and experience under testing situations

A longitudinal study for another two or three years would help to show whether the trends of cognitive development observed among Nairobi children in 1977 are similar to those found in other years so that a generalised conclusion of what mathematical concepts Nairobi pre-school children know can be reached not only from one year's experience but from three or four years' experience. For most of the children tested, this was their first experience in a test. A longitudinal study would help in clarifying whether the children's poor performance can be explaine by lack of experience and acquintance with test situations than a stable deficit in cognitive facilities.

3. <u>On unfamiliarity with test materials</u>

Pre-school.education, in this study's contest, did not only mean what has been learnt in institutions like nursery schools but what the child has learnt since he was born. It is true that the geometric shapes used in this study would have been strange to a child who had just joined the nursery schools because most Kenyan children do not play with such toys at home. The study was done in January, February and March of 1977. Any child who had just joined the nursery school would have been at a disadvantage. It would be interesting to find out whether if the study was done at the end of the year, when presumably children would have been exposed to play materials, the results would have been better.

4. <u>On knowledge of Kenyan children</u>

As the pace of educational development in Kenya quickens, it becomes increasingly apparent that the foundation of this development is not very strong. Curriculum content and methodology, instructional materials, and examination instruments, as well as many other facets of the educational program, are still largely predicted on knowledge and research about children reared in Western culture. Researches encompassing the factors that motivate Kenyan Nairobi children from different geographical locations and various ethnic and tribal groups; their feelings, attitudes, values and aspirations; how they learn; what strengths and weaknesses they bring from their backgrounds to school; group behaviour; disadvantaged children who are culturally, materially and mentally deficient in facing the urban life of the twentieth century are urgently needed. Since cognitive development of the children is influenced and conditioned by physical, emotional, and social factors which touch the child, Kenyan people's efforts should be aimed at improving the physical and human development of the young child. The solution to all these problems will not be found by one man or one ministry of the government. This is where the "Harambee" effort well known to Kenyan people is urgently required if Kenya wants to reduce and wipe out the delinquency that is flourishing at such a fast rate in Nairobi.

5. <u>On acceleration of progress</u>

Although training procedures to accelerate development from one stage to another have not been invariably successful, as expressed by Wohlwill and Lowe (1962), Piaget and Almy (1967) mentioned in chapter two, results from those that have been successful, like, Harper and Steffe (1968) and Schmalohr (1964-66) seem to suggest that such training is particularly beneficial to the lower socio-economic group of children. Leiderman and Rosenthal-Hill (1968) found greater gains among kindergarten children of the lower socio-economic group than those from the middle socio-economic group after one years's structure mathematics program.

The children in Nairobi pre-schools are in the stage Piaget calls the pre-operational stage or transitional stage. This is the stage when achievement can be accelerated through training and guidance as Piaget (1970) indicated: "most of the results clearly agree with the fact that if a child is already transitional, that is, at stage two, the level at which he manifests vacillation in thinking, it then becomes much easier to introduce and make him aware of other possibilities, including operatory solutions."

The present study has revealed that not only are the Nairobi pre-school children in the transitional stage in age but also in classification and number as revealed by their inability to sort by colour, size and shape, understand inclusion relation and conservation of number. There is a need to find out how pre-school children in Nairobi who are in the transitional stage respond to such training. The kind of training and under what conditions is very important. Some of the private pre-schools try to train pre-school children because the parents want their children "to be taught" something. This has made private nurseries popular. But teachers must be aware that unless this is very carefully done, it may lead to worse problems than if it did not exist at all.

6. On adult participation in children's activities

A number of researches related to child-rearing and socialization practices show that members of the adult culture play a significant role in children's cognitive development. Macanley (1972), Uka (1966), Hake (1972), Smilansky (1968), Hess et al (1965) and others in their studies came up with the findings that in general traditional mothers actively discourage their children from asking questions, from exploring, and from otherwise learning how to be autonomous. This assumes that the mothers are with the children every day or all the time. But this is not so in urban areas. Here, most of the children who attend the low cost type of schools are on their own most of the time and are free to roam about quite a lot. Whether this is to their advantage in that restrictions the traditional mothers would impose on them do not exist is not clear. Child-rearing practices and how they affect cognitive development in a fast developing city like Nairobi are studies that are long overdue. Such studies would aid the curriculum developers to develop curricula that would suit the various different groups of children in the city where a sort of compensatory and remedial pre-school education would be more appropriate than the academic type of education.

7. On the quality of pre-school teachers

To avoid the rote memorization and often meaningless verbalization that is so popular in Nairobi pre-schools, teachers must learn to explain concepts with the language and the stage of the children in mind. The children's comprehension of such concepts must be assessed regularly through questioning in a one-to-one situation in order to understand the children they work with. Any improvement of pre-school education clearly depends on the quality of its teachers. Teacher preparation and teacher effectiveness is vital. Beeby (1966)[1] suggested that in connection

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1. Beeby, C.E. The Quality of Education in Developing Countries. (Cambridge, Mass: Harvard University Press, 1966).

with primary system which is also relevant for pre-primary system - the two main factors that determine the stage of development of any primary system are the level of general education of its teachers, and the length and type of their professional training. He warned that to "speak of the quality of education also depends on what the teachers in the school are capable of accomplishing." The Nairobi City Council is moving towards the right direction in training and educating their teachers through the K.I.E. pre-school unit. But the training is not fast enough. At the time of collecting the data for this study, only about one teacher in each school had benefitted from this training. What pre-school education needs in training their teachers is what primary school teacher education hopefully is in the process of doing - a drastic overhaul of teacher training - to make teacher training intellectually richer and stimulated by pedagogical research.

8. <u>On a similar study in rural areas</u>

Kenya's aim in development is to improve the education of her people both in urban and in rural areas. Differences at C.P.E. level between the performance of urban and rural children have already been observed. It would be interesting to find out whether differences at pre-school level exist between children being brought up in urban and rural environments by replicating this study in a rural area.

9. <u>On different types of Schools</u>

There is undoubtedly an urgent need to harmonize the three educational levels of Nairobi - the Low, Medium and High Cost. This calls for urgent action - oriented research and experimentation. Significant questions which should be further explored are:-

a) Are the quantitative and qualitative disparities observed in this study in comprehension of mathematical concepts among Kenyan children attending the three types of schools in Nairobi temporary or permanent?

b) What effects do such disparities have on subsequent school performance in mathematics?

c) How long does this disparity last or what time does this gap close under the status quo position?

d) What are the effects of differential educational provision at pre-school and primary school level on the future Kenyan society?

e) Is it possible to change the present curriculum to take into account the low cost sshool children's experience prior to joining school, his abilities, his value, language?

f) Have the past curriculum developers ignored the effect of environment on the development of school related abilities?

## 5.4 Conclusions

The level of comprehension of mathematical concepts shown in this study is based on a number of test batteries given to four to six year old children in Nairobi in January, February and March, 1977. This was the beginning of the year. Most of the five to six year olds had attended nursery schools for some time. Many of the four year olds were new in the schools.

The experience gained in this study is that there are many school related experiences that children may not get to learn in their home environments. The classification skills examined in this study are a good example. Compulsory nursery school education, for at least a year, that introduces children to such experiences can go a long way in assisting and orienting children, particularly, those with more limiting home backgrounds, to experiences that are more school oriented. Such experiences require a standardised, well planned curriculum guide which is followed by all nursery schools, irrespective of ownership. Such a curriculum guide should be on pre-mathematics readiness activities which are played as games. The standard one teacher in the Primary School should be given a mathematics curriculum guide that reflects the readiness period carried out in the nursery school. This would mean that the standard one teachers would have an idea as to what pre-mathematical experiences the children have been exposed to. They can then find out what these children know. This knowledge referred to in the introduction of this thesis as " entering behaviour" is useful for the planning and execution of instruction.

Requiring children to perform in ways for which they are inadequately prepared is violating whatever is known about learning. What must be realised is that no matter what feats of will, self-denial, and enthusiasm the Kenyan child may perform and no matter how much dedication, love, and imagination the Kenyan teacher may supply, the child cannot acquire new skills based on other skills which he has not acquired. Since learning builds on learning, when the foundation blocks are missing, future construction, if possible at all, is a very precarious affair.

# APPENDIX 1

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# APPENDIX 11

## GENERAL INSTRUCTIONS TO THE TESTERS FOR ADMINISTERING TESTS

### GENERAL DIRECTIONS

1. Setting for Administration of Tests

It is important to have a separate room, if at all possible, so that interruptions and distractions are minimized.

In introducing these tests to the child, make certain that they are always referred to as games and not as tests. The child will feel more comfortable if this is not presented as a testing situation and if the tester chats with the child to put him at ease before starting.

2. Equipment

You will need a table and two chairs. Preferably, the table and chairs should be low (from the pre-school classroom) so that they are a comfortable height for the child. Seat the child across the table from you.

The materials you will need are those supplied and include:

2 sets of geometric shapes - same colour

50 beans

4 boxes with tops

pads of paper

crayons

1 set of 8 cards marked on the back, "Counting Members of a Given Set"

10 matchboxes with beans inside and numerals on them

1 each object for Visual Memory: aeroplane, banana, block, book, box, button, car, spoon, watch, crayon, bird, key and pencil

12 blocks

2 sheets of construction paper

1 set of 6 cards marked on the back, "Equivalent Sets"

5 trucks

25 marbles

4 sets of geometric shapes for Ordering and Classifying (marked: Set, I III, V, VII)

5 sets of pictures for Visual Memory

2 sets of colour cards

3. Procedure

Read over the instructions for administering the tests several times, and become familiar with the materials before you start testing your children.

The instructions for you, as tester, are typed in lower case. What you actually say to the child is typed in capital letters.

Follow the written directions carefully:

Do not probe to get an answer beyond what is suggested in the directions. This is an evaluation and should not be used as a teaching situation.

Use reassurance without specifying that responses are right or wrong. This may be done in a variety of ways:

Repeating what the child has said in a reassuring voice.

Remarks such as "Um - Hum," "All right".

Comments between tests such as "You do these very well."

Conversation with the child between tests.

In certain of the tasks, specific comments are requested (e.g., Ordering). Be certain to enter comments where specifically noted and at any point where they are relevant to understanding the child's response. <u>If doubtful about the correctness of a response, do not check the response as correct or incorrect, but write down exactly what the child said in the "Comments" space.</u>

5. <u>Important Considerations</u>

In order for these test results to be meaningful:

(1) it is imperative that the tester adhere to the written directions as closely as possible. Rapport with the child is crucial; however, cueing the child beyond the written directions invalidates the results.

(2) it is imperative that recording of children's performances on the score sheets be as accurate as possible. Score sheets may be completed in pencil; overemphasis on neatness may be unnecessarily time-consuming. Entries should be legible and accurate; neatness is not a primary consideration.

(3) it is imperative that every subject be completely recorded.

<u>SCORING THE TESTS.</u>

0 Incorrect response. Some tests were to be stopped after the child made a total of three errors. Where testing was discontinued for this reason, all subsequent items for that child were scored as 0's.

1 Correct response.

9 No attempt by child, or child says he doesn't know, or verbal responses are given such as "no", "what does that mean", etc.

# APPENDIX III

## THE TEST BATTERIES

OOI GEOMETRIC SHAPES: MATCHING (4 items)

TEST MATERIALS :

Geometric shapes :

Child's Set:

I rectangle
I triangle
I square
I circle
I L-shape

Tester's Set: the first four shapes of the child's set: the L-shape is excluded.

TEST DIRECTIONS:

I HAVE SOME SHAPES HERE.

I AM GOING TO PUT THEM ON THE TABLE.

Place the set of shapes in front of you. Arrange from your left to right: square, circle, rectangle, triangle.

NOW I AM GOING TO PUT SOME ON THE TABLE FOR YOU, TOO.
Place the set of shapes, including the L-shaped region in front of the child, starting from your left to right: rectangle. triangle, L-shape, square, circle.
Touch your circle but do not name it.

LOOK AT THE SHAPE I AM TOUCHING.
PUT YOUR FINGER ON THE SHAPE IN YOUR SET THAT IS JUST LIKE THIS ONE.
If the child does not respond, or touches tester's shapes, say:
PUT YOUR FINGER ON ONE OF THESE SHAPES (pointing to the child's set THAT IS JUST LIKE THIS ONE (pointing to your circle).
Proceed, using above directions, with square, triangle, rectangle,
Continue with Naming and Identifying parts of this assessment whether or not the child has made any errors in Matching.

002 GEOMETRIC SHAPES: NAMING (4 items)

TEST MATERIALS:
The child's set of geometric shapes as described in OOI.

TEST DIRECTIONS:
Leave shapes set up as they were for matching.
CAN YOU TELL ME THE NAMES OF THE SHAPES?
WHAT IS THIS? (pointing to square in the child's set)
AND THIS? (pointing to triangle in the child's set)
THIS (pointing to rectangle in the child's set)
WHAT IS THIS? (pointing to circle in the child's set)

003 GEOMETRIC SHAPES: IDENTIFYING (4 items)

TEST MATERIALS:
The child's set of geometric shapes as described in OOI.

TEST DIRECTIONS:

Leave shapes set up as they were for Matching and Naming.
WOULD YOU GIVE ME THE TRIANGLE SHAPE?
WOULD YOU GIVE ME THE RECTANGLE SHAPE?
NOW, THE CIRCLE.
AND NOW THE SQUARE.
AND THE L-SHAPE.

004 COUNTING BEANS ( 7 items)

TEST MATERIALS:
50 Beans
4 small open boxes
1 small pad of scratch paper
1 crayon

TEST DIRECTIONS:
LET'S PUT SOME BEANS IN THESE BOXES.

Place a heap of beans in front of the child and give him a box
WILL YOU PUT TWO BEANS IN THE BOX ? I WILL MARK A "2"
ON THIS PAPER. (The tester counts 2 if the child does not respond).
Mark "2" on the paper, show child, and place it standing in box
with beans.

NOW WE WILL KNOW HOW MANY BEANS ARE IN IT.
Push the box to your right.
Place another box in front of the child and say:
WOULD YOU PUT THREE BEANS IN THIS BOX? (wait while the child
counts out beans) WOULD YOU LIKE TO MAKE A "3" ON THIS PAPER?

Continue in the order listed on the scoring sheets.
Stop after child has made three errors in counting.

005 WRITING NUMERALS ( 7 items)

TEST MATERIALS:
The test materials for this scale are listed with the test materials for scale 004.

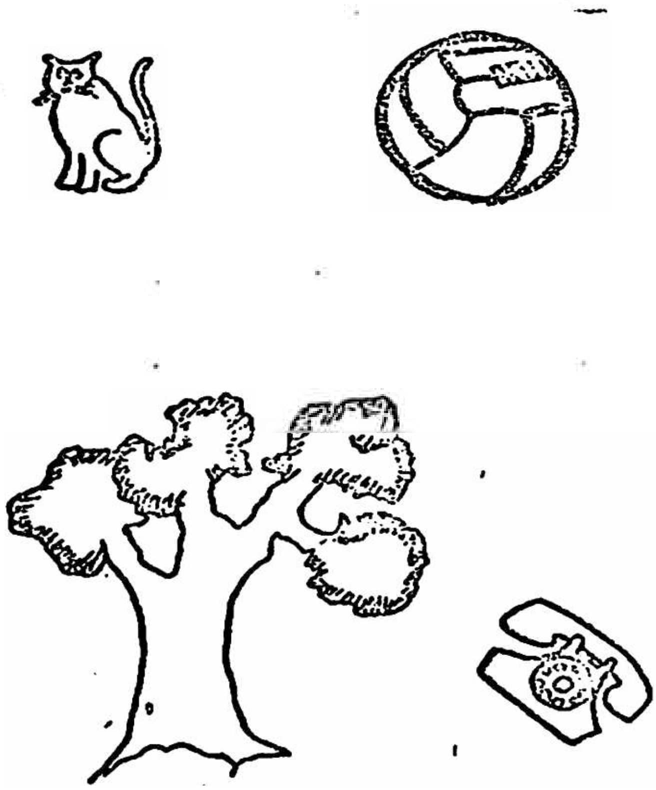
TEST DIRECTIONS:
The directions for this scale are part of the test directions for scale 004.

006 COUNTING MEMBERS OF A GIVEN SET PICTURE CARDS (8 items)

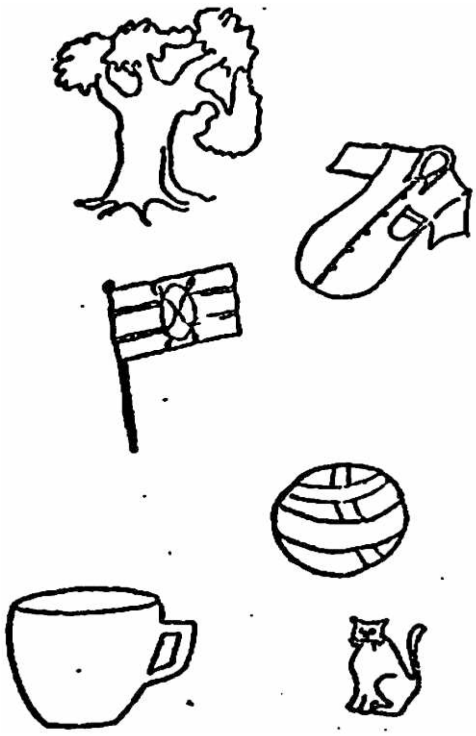
TEST MATERIALS:

8 cards with varying numbers of drawings of familiar objects on each card. (The cards are numbered I to 8 to indicate the order in which they are to be presented to the child), the cards are reproduced below.

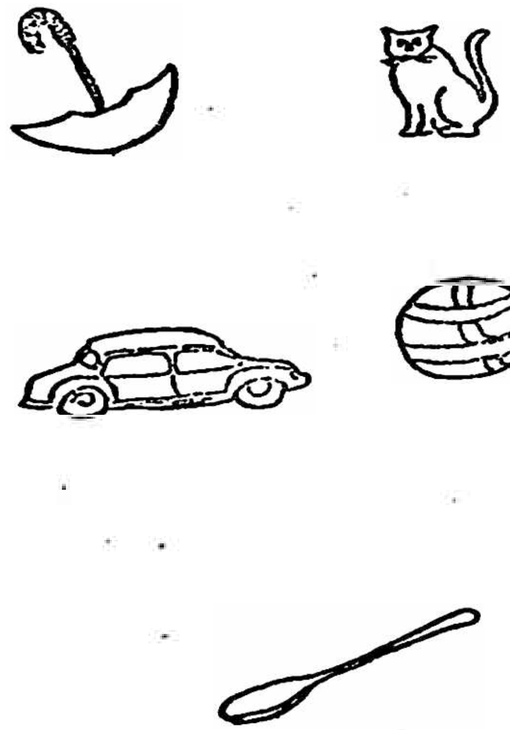
## COUNTING MEMBERS OF A GIVEN SET: PICTURE CARDS



Card 1

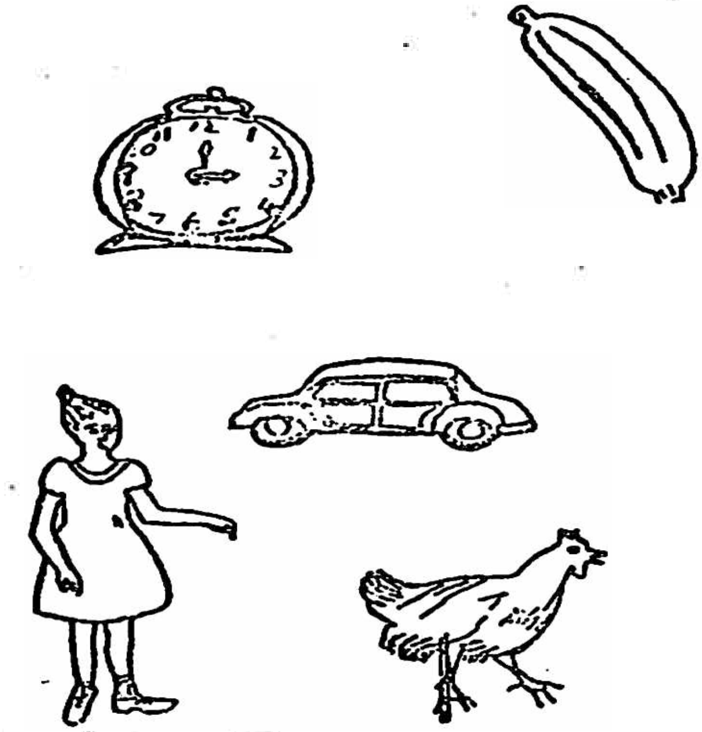


Card 2

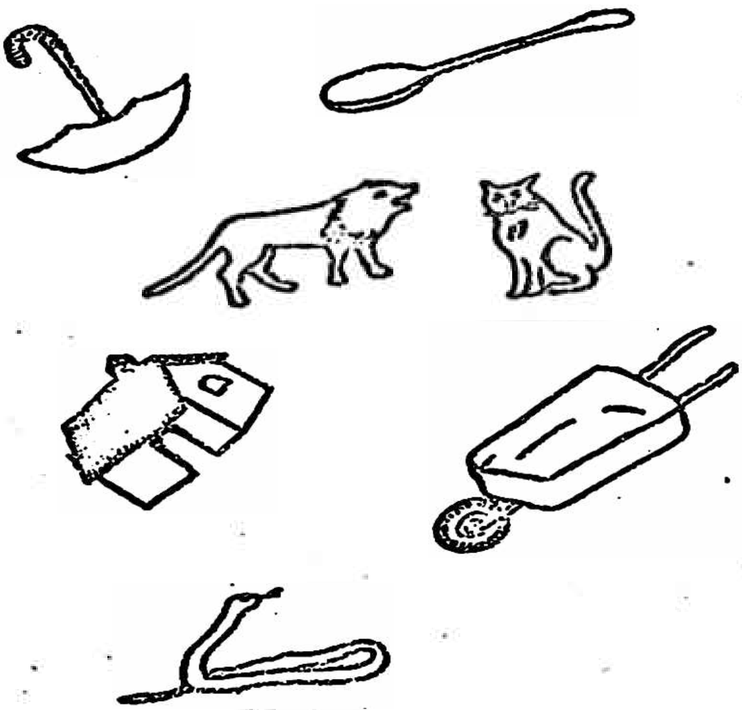


Card 3

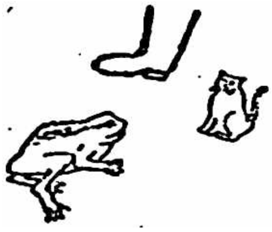
Card 4



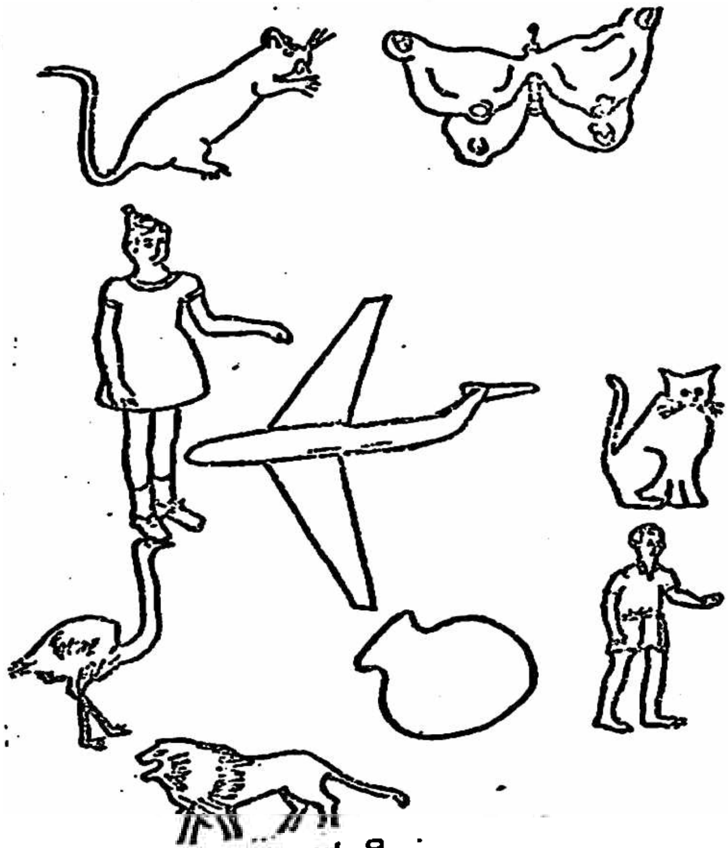
Card 5



Card 6



Card 7



Card 8

TEST DIRECTIONS:

Place Card I in front of the child and say:

HOW MANY MEMBERS ARE THERE IN THIS SET?

If no response, say:

HOW MANY DRAWINGS ARE ON THIS CARD?

Continue in the order, using the same directions as for Card I. Stop after the child has made three errors in counting.

007 IDENTIFICATION OF NUMERALS (8 items).

TEST MATERIALS:

10 matchboxes with varying numbers of countring beans sealed inside. Each matchbox has a numeral (0 through 9) written on the front which corresponds to the numbers of beans.

TEST DIRECTIONS:

I HAVE SOME BEANS IN THEM. THIS (point to the numeral on the envelope) TELLS US HOW MANY BEANS ARE INSIDE.
GIVE ME THE ENVELOPE THAT HAS 3 BEANS INSIDE.

Continue, asking for the envelope that has I bean, and then the envelope that has 4 beans.

If the child has failed on these three tasks (3, I, 4), stop this task.

If the child has been successful on these three trials, then randomly place the remaining match boxes on the table. Do not replace on the table the matchbox that the child has already handed you. Say:

GIVE ME THE ONE WITH 5 BEANS INSIDE:

Continue in the order marked in the scoring sheet through the remaining numerals.

008 VISUAL MEMORY OBJECTS (5 items)

13 familiar objects - car, bird, marble, spoon, aeroplane, crayon, Key, book, banana, watch rubber, button, pencil

TEST DIRECTIONS:

NOW, WE WILL TRY A DIFFERENT GAME. I AM GOING TO PUT SOME THINGS ON THE TABLE. WATCH CAREFULLY.
Place the objects in a line, from your left to right, on the table as listed on the scoring sheet.

LOOK AT THEM VERY CAREFULLY.
Make sure the child attends to the objects. Ascertain the child knows names of all the objects. Ask her/him to name each one in any language.

I AM GOING TO TAKE ONE OF THESE AWAY (point to each object separately) WHILE YOU HAVE YOUR EYES CLOSED.

008 VISUAL MEMORY: OBJECTS (continued)

NOW CLOSE YOUR EYES TIGHTLY AND KEEP THEM CLOSED UNTIL I TELL YOU TO OPEN THEM.

Remove the underlined object from the table and place it in the box under the table. Close objects up so that spacing is even.

OPEN YOUR EYES. WHAT DID I TAKE AWAY?

If the child is correct, mark under First Recall on score sheet and proceed with the next group. If no reply, or incorrect, then say:

WHAT ELSE WAS THERE BEFORE YOU CLOSED YOUR EYES THAT ISN'T THERE NOW?

Pause. If correct, mark under Second Recall on score sheet and proceed with the next group. If no reply, then say:

DO YOU REMEMBER WHAT I TOOK AWAY?

If the child is correct this time, mark under Third Recall and proceed with the next group. If the child cannot recall, then proceed as follows:

I'LL PUT SOME OTHER THINGS ON THE TABLE.

Move objects already on the table to the side, and put the new set on the table in a line as listed. The object that had been removed is underlined on the score sheet.

WHICH ONE OF THESE WAS ON THE TABLE BEFORE YOU CLOSED YOUR EYES?

If the child cannot recognize the object included in the new set, tell and show him which object it was. Tell the child:

LET'S TRY ONE OTHER GAME LIKE THIS.

Continue through all five groups with above directions.

OIO VOCABULARY (20 items)

TEST MATERIALS:

12 wooden blocks
2 sheets of white construction paper

TEST DIRECTIONS:

Keep blocks in box on the floor to tester's left. If blocks are needed on the table, keep them piled to your right.

Build all sets which you must construct to your right. When not in use, remove blocks from the table. Continue through all 20 items of the Vocabulary assessment whether or not there are three errors.

| Vocabulary | Materials | Directions |
|---|---|---|
| Behind | 1 block | Hand child 1 block.<br>CAN YOU PUT THIS BLOCK BEHIND YOU?<br>If child does not respond, say:<br>CAN YOU PUT THIS BLOCK BEHIND YOUR BACK SO THAT I CAN'T SEE IT? |
| Above | 1 block | NOW HOLD THE BLOCK ABOVE YOU.<br>If child does not respond, say: |

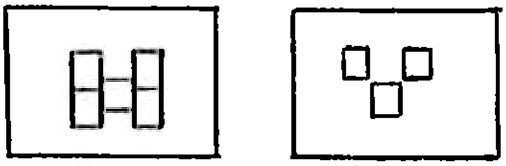
OIC VOCABULARY (continued)

| Vocabulary | Materials | Directions |
| --- | --- | --- |
| | | CAN YOU HOLD THAT BLOCK ABOVE YOUR HEAD? |
| Bottom | 12 blocks | Hand child 4 blocks. |
| | Sheet of construction paper | WILL YOU BUILD A TOWER ON THE PAPER WITH THESE BLOCKS? |
| | | If the child does not start, say: |
| | | STACK THEM UP LIKE THIS. (And start stacking blocks. Stack 2 and tell child:) |
| | | YOU GO AHEAD AND PUT THE BLOCKS ON THE TOWER. |
| | | If the child has difficulty, don't push him; help him build the tower. |
| | | When the tower is built, say: |
| | | CAN YOU TOUCH THE BOTTOM BLOCK IN THE TOWER? |
| | | Leave tower standing, and say: NOW I AM GOING TO BUILD 2 MORE TOWERS. |
| | | Build 2 more 4-block towers in a row on the paper next to the child's tower with a 3-inch separation between each 2. |
| Between | | WHICH IS THE TOWER BETWEEN THE OTHERS? |
| Each | | CAN YOU TOUCH EACH TOWER? |

010 VOCABULARY (continued)

| Vocabulary | Materials | Directions |
|---|---|---|
| Tallest | 11 blocks | Change the three towers so the tower to your left contains 2 blocks, the middle tower 5 blocks and the right tower has 4 blocks.<br><br>NOW, WHICH IS THE TALLEST TOWER? |
| Remove | | ALL RIGHT, NOW I WANT YOU TO REMOVE THE BLOCKS FROM THE PAPER. |
| Set | Sheet of construction paper | Put all blocks in a heap at the side of the table to your right. Have your pen or pencil and papers on the table. Place the sheet of construction paper in front of the child.<br><br>NOW, I WANT YOU TO MAKE A SET HERE ON THE PAPER.<br><br>Point to construction paper. Any collection of objects - blocks, pencils, etc., placed on the paper is acceptable. If the child does not respond, say:<br><br>PUT A SET OF THESE OBJECTS ( pointing to objects) ON THIS PAPER (pointing to sheet of paper). |
| More than | 2 sheets of construction paper<br><br>12 blocks | Place 2 pieces of construction paper, with 3 inches between the 2 sheets, in front of the child.<br><br>HERE ARE 2 SHEETS OF PAPER. I AM GOING TO PUT SOME BLOCKS ON THIS SHEET OF PAPER.<br><br>Place 3 blocks on sheet to your right.<br><br>YOU PUT MORE BLOCKS ON YOUR PAPER (pointing to empty sheet) THAN I |

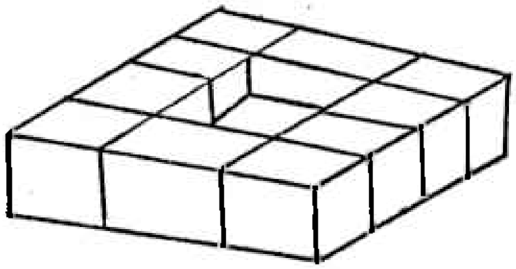
010 VOCABULARY (Continued)

| Vocabulary | Materials | Directions |
|---|---|---|
| | | PUT ON THIS (pointing to your sheet).<br>If the child cannot do this task, place 5 blocks on the empty paper and say:<br>NOW, WHICH PAPER HAS MORE BLOCKS ON IT THAN ON THE OTHER PAPER?<br><br>If child does not respond, say: WHICH OF THESE PAPERS (pointing to the 2 sheets) HAS MORE BLOCKS ON IT? |
| as many as | 2 sheets of con-struction paper<br>12 blocks | Leave the 2 pieces of paper in front of the child. Have blocks heaped at the side of the table. Place 4 blocks on the paper to your right.<br>I AM PUTTING SOME BLOCKS ON THIS PAPER. YOU PUT AS MANY BLOCKS ON THIS PAPER (point-ing to empty sheet) AS I HAVE PUT ON THIS PAPER (pointing to the sheet with blocks on it). |
| Fewer than | 2 sheets of con-struction paper<br>12 blocks | Leave the 2 sheets of paper in front of the child. Have all the blocks heaped at the side of the table. Place 5 blocks on the paper to your right. |

OIO VOCABULARY (continued)

| Vocabulary | Materials | Directions |
|---|---|---|
| | | I HAVE A SET OF BLOCKS ON THIS PAPER (pointing to the paper with blocks). YOU PUT A SET WITH FEWER BLOCKS THAN THIS (again pointing to paper with blocks) HERE (pointing to empty sheet).<br>If the child does not respond, say:<br>PUT FEWER BLOCKS ON THIS PAPER THAN I HAVE PUT ON THIS PAPER.<br>If the child still cannot do the task, score as "not attempted" and place 3 blocks on the empty sheet. |
| Join | | NOW, JOIN THESE TWO SETS OF BLOCKS.<br>If the child does not respond, say:<br>CAN YOU JOIN THIS SET OF BLOCKS (pointing to blocks on paper to your left) TO THIS SET OF BLOCKS (pointing to blocks on paper to your right)? |
| Below | 1 block | Hand the child 1 block.<br>CAN YOU HOLD THAT BLOCK BELOW YOUR CHIN?<br>If the child does not respond, say:<br>CAN YOU POINT TO YOUR CHIN?<br>If the child cannot correctly point to his chin, hold your hand, palm |

OIO VOCABULARY (continued)

| Vocabulary | Materials | Directions |
|---|---|---|
| | | down, over the table at the height of the child's chin, and say:<br>CAN YOU HOLD THE BLOCK BELOW MY HAND? |
| Left | 1 block | Place 1 block on the table in front of the child.<br>CAN YOU HOLD THE BLOCK IN YOUR LEFT HAND? |
| Outside | 12 blocks | Make a rectangular-shaped construction, using 10 blocks, in front of the child.<br><br>I AM BUILDING A WALL. CAN YOU PUT THIS BLOCK OUTSIDE THE WALL? (Hand the child 1 block). |
| Inside | | NOW, PUT THAT BLOCK INSIDE THE WALL. |
| On | | PUT THE BLOCK ON THE WALL. |

OIO VOCABULARY (continued)

| Vocabulary | Materials | Directions |
|---|---|---|
| Right | 1 block | Place one block on the table in front of the child.<br><br>CAN YOU HOLD THE BLOCK IN YOUR RIGHT HAND? |
| Shorter than | 12 blocks | Have the child build a tower with 4 blocks. You build two more towers to the right of the child's tower, using 5 blocks for the middle tower, and 3 blocks for the right-hand tower.<br><br>WHICH TOWER IS SHORTER THAN THE OTHER? |
| Top | | Remove the three-block and the four-block towers, leaving only the five-block tower standing.<br><br>TOUCH THE TOP BLOCK IN THE TOWER. |

012 <u>EQUIVALENT SETS: DOTS</u> (6 items)

TEST MATERIALS:

20 beans
I sheet of white construction paper
6 cards with varying numbers of dots of varying sizes on each card. The cards are numbered I through 6 to indicate the order in which they are to be presented to the child.

TEST DIRECTIONS:

Heap the beans to the child's left. Place the sheet of construction paper in front of him.

I AM GOING TO SHOW YOU SOME CARDS WITH DOTS ON THEM.

Show the child Card I. Place it above his sheet of paper and say:

ON THIS SHEET (point to his construction paper) MAKE A SET, WITH THE BEANS, WHICH IS EQUIVALENT TO THIS SET (pointing to the card).

If the child does not respond, say:

MAKE A SET WITH YOUR BEANS ON THIS SHEET (point to construction paper) THAT HAS THE SAME NUMBER OF (BEANS OR MEMBERS) AS MY SET HAS (point to your number card).

Pause after the child finishes, and remove the beans from his paper to the side of the table each time. Continue with the cards in the <u>order</u> and <u>position</u> as marked on the back of each card, using the same directions as for card off the table.

Have on the table only the card for which the child is constructing an equivalent set. Keep all other cards off the table.

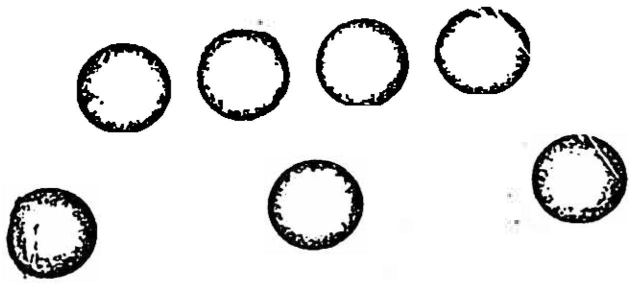
Stop after the child has made three errors in constructing sets.

In scoring this test, make certain you check <u>two</u> columns for each card: either correct or incorrect. If the number of beans is the same as the number of dots on the card, the scoring is "correct" regardless of whether the pattern has been copied or not.

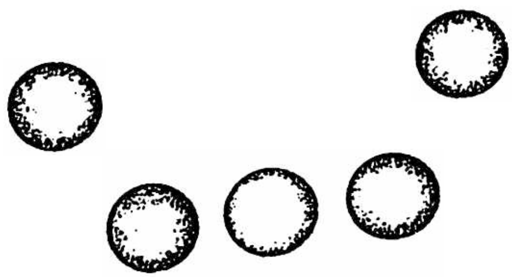
Indicate on the scoring sheet whether the child copied the pattern, counted the dots and then the beans or both copied the pattern and counted.

The cards are reproduced below -

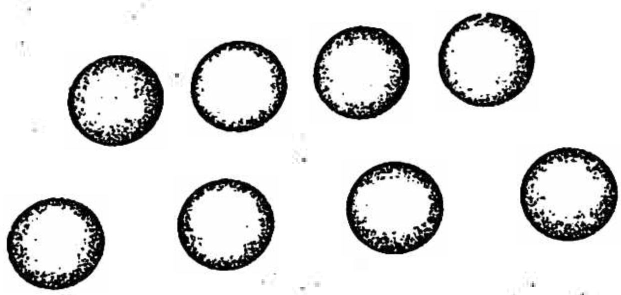
CONSERVATION: DOTS



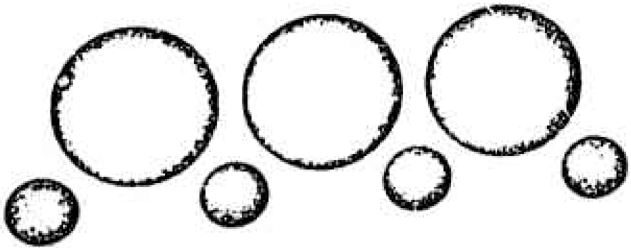
Card 1



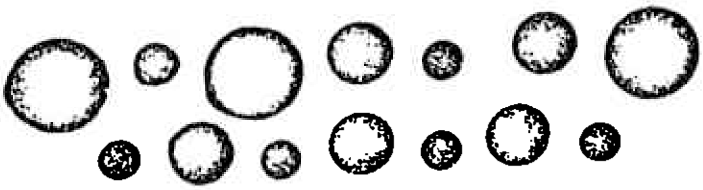
Card 2



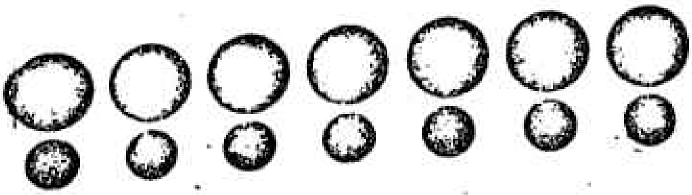
Card 3



Card 4



Card 5



Card 6

013 ORDINAL NUMBER 98 items) TEST MATERIALS: 5 toy trucks, 25 marbles

TEST DIRECTIONS:

HERE ARE SOME TRUCKS AND SOME MARBLES. I AM GOING TO LINE UP THE TRUCKS LIKE THIS.

Line up the five trucks with cabs of trucks at an angle facing toward the pupil's right:

Hand the child a marble, Say:

WOULD YOU PUT THIS MARBLE IN THE FIRST TRUCK?
THIRD TRUCK?
FIFTH TRUCK?
FOURTH ?
FIRST ?
LAST ?
SECOND ?
FOURTH ?

Mark as correct from whichever end the child chooses as first. Use his reference to judge correctness of his following responses.

Continue through this assessment whether or not there are three errors.

GEOMETRIC SHAPES - CLASSIFYING

TEST MATERIALS:

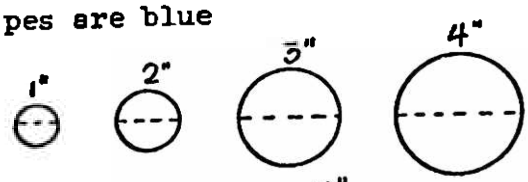
4 sets of geometric shapes cut from light-weight cardboard of various colours and packaged in four envelopes marked "Ordering and Classifying - Set I" (or Set III, Set V, Set VII).

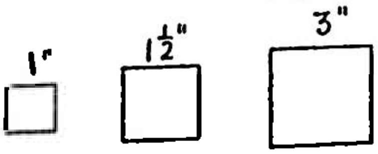
CLASSIFYING

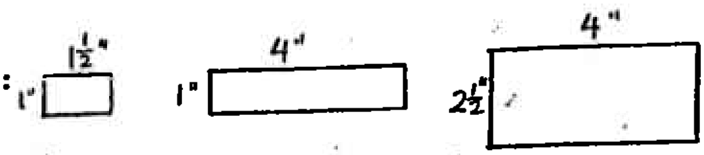
TEST MATERIALS:

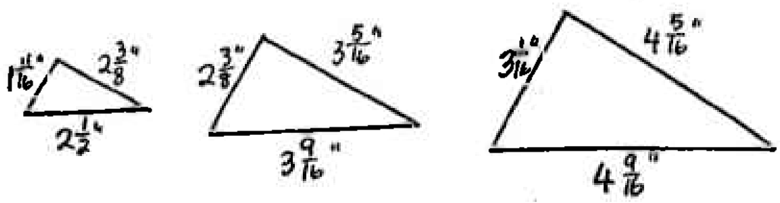
4 Sets of geometric shapes of various colours - Set I, Set III, Set V and Set VII.

Set I - all shapes are blue

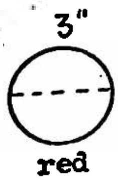
4 circles: 

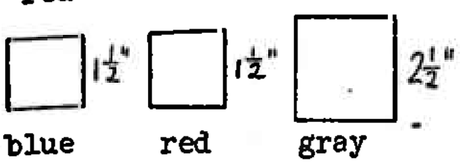

3 squares: 


3 rectangles: 


3 triangles: 

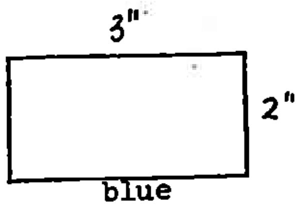

Set III - multi-colored

1 circle: 

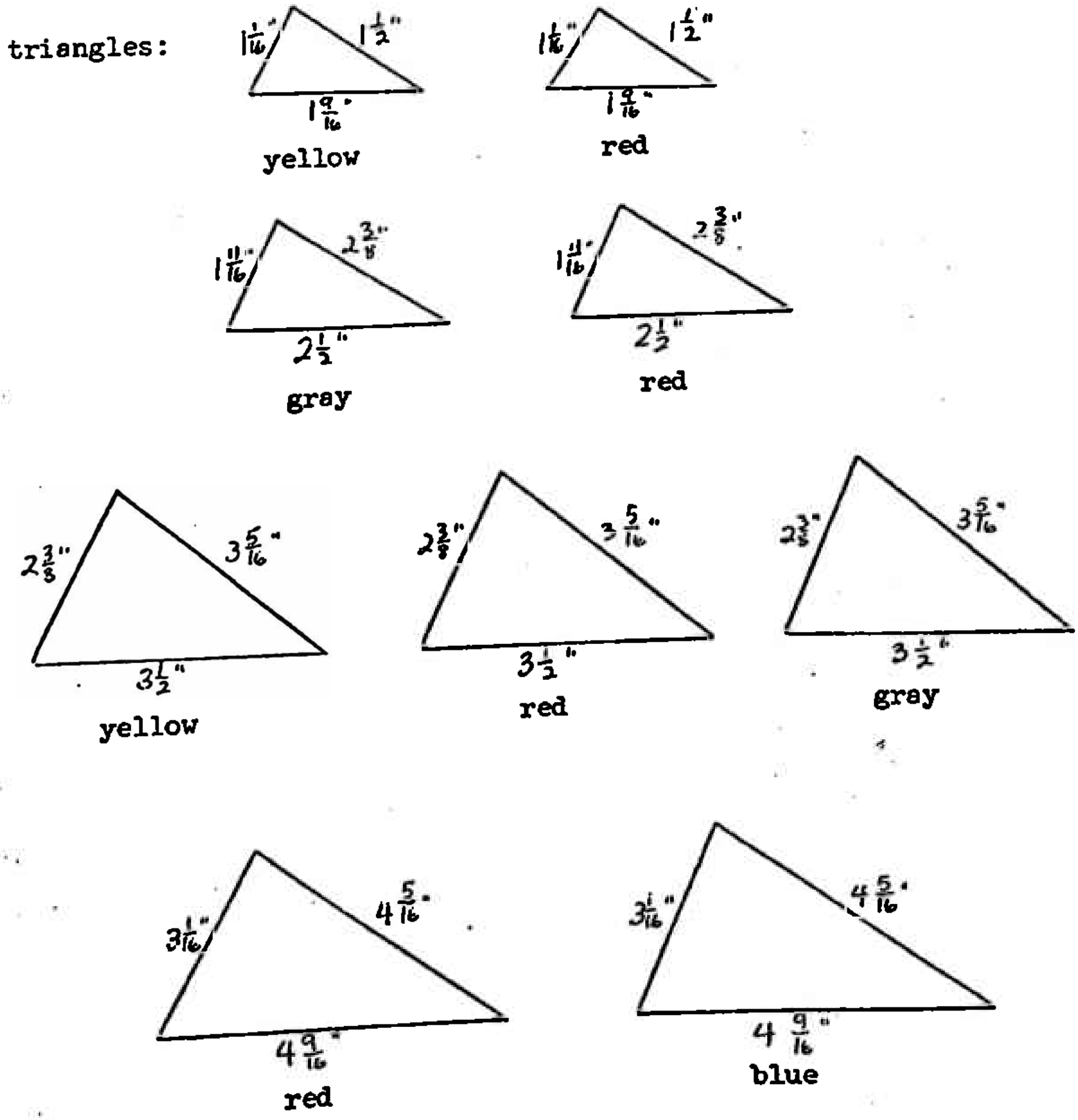

3 squares: 

015 CLASSIFYING (continued)

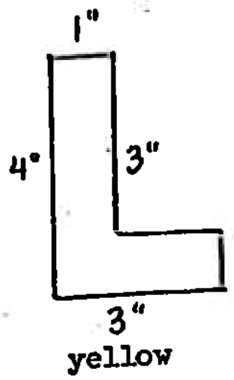
1 rectangle:




9 triangles:



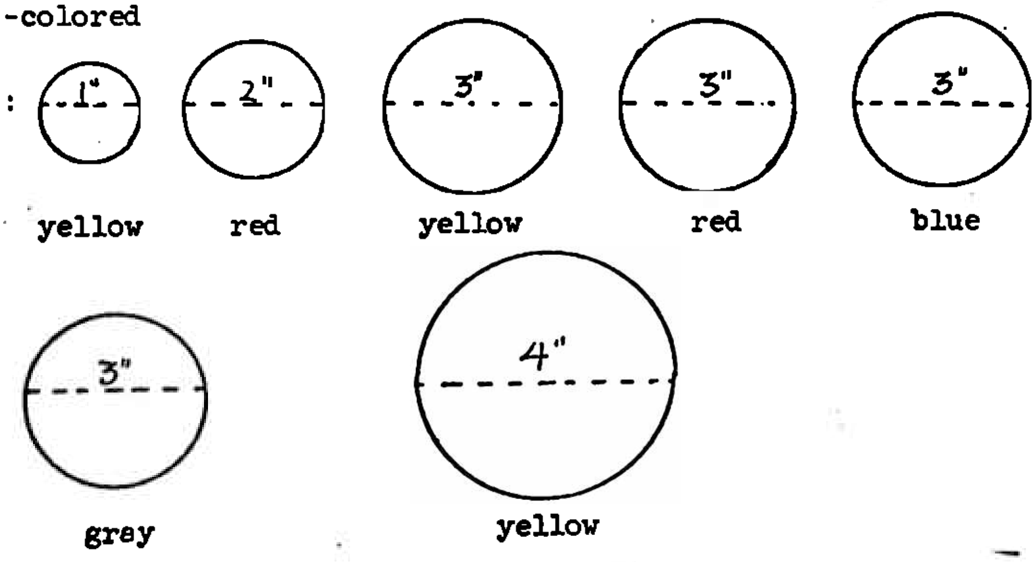

1 L-shape:



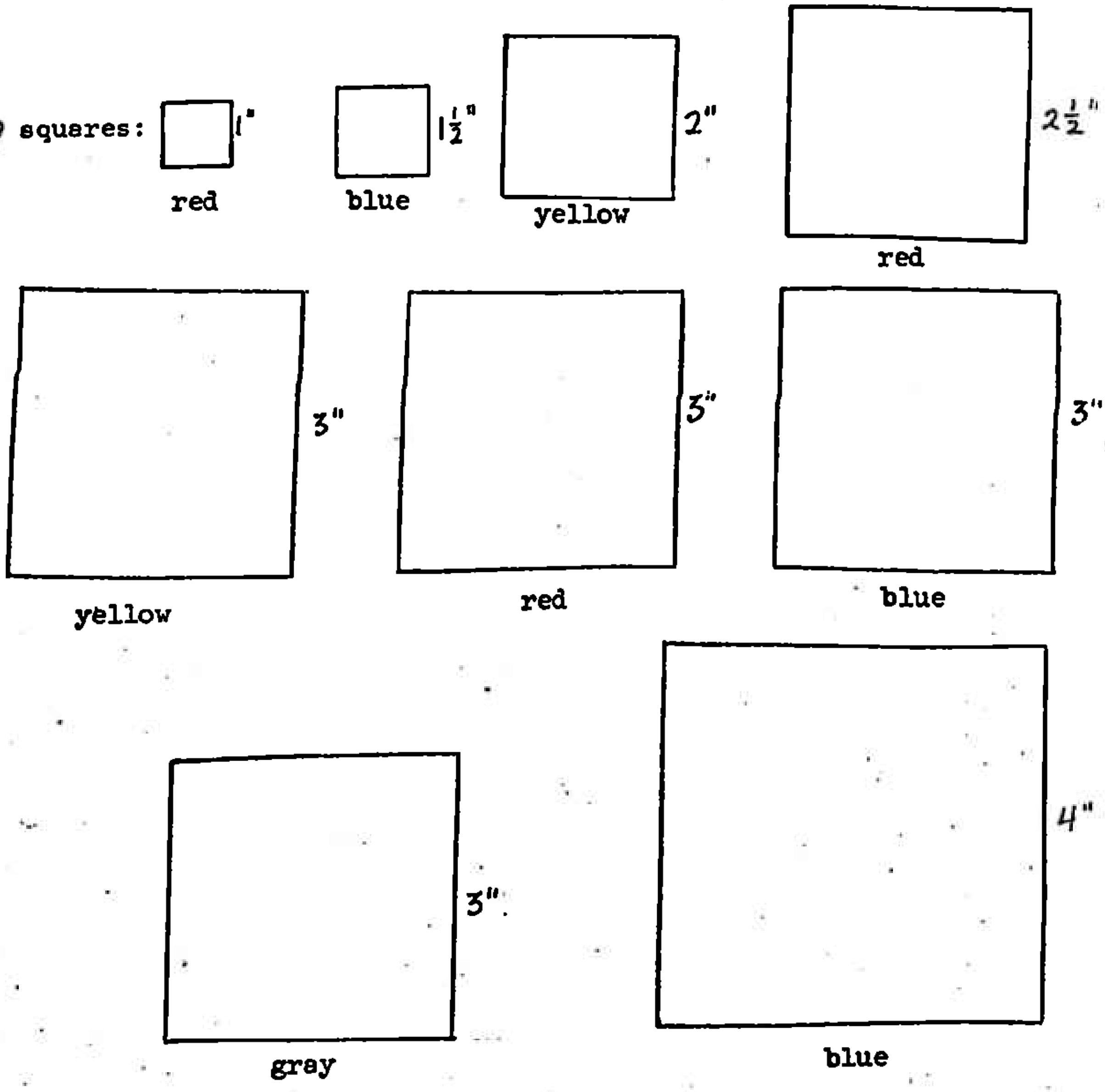
015 CLASSIFYING (continued)

Set V - multi-colored

7 circles:

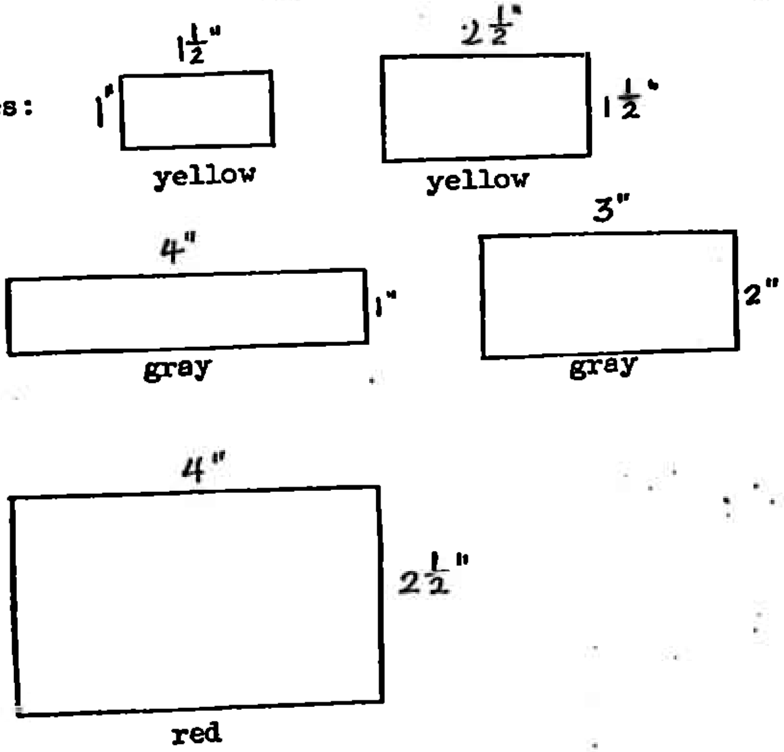



9 squares:

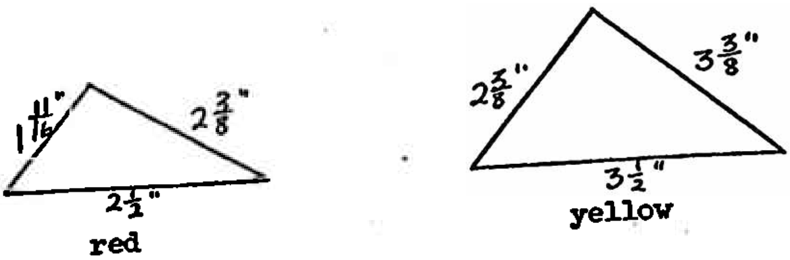


015 CLASSIFYING (continued)

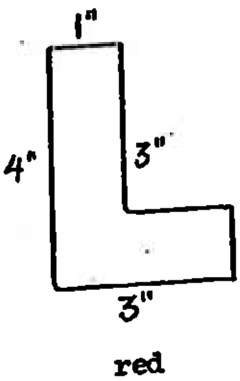
5 rectangles:




2 triangles:



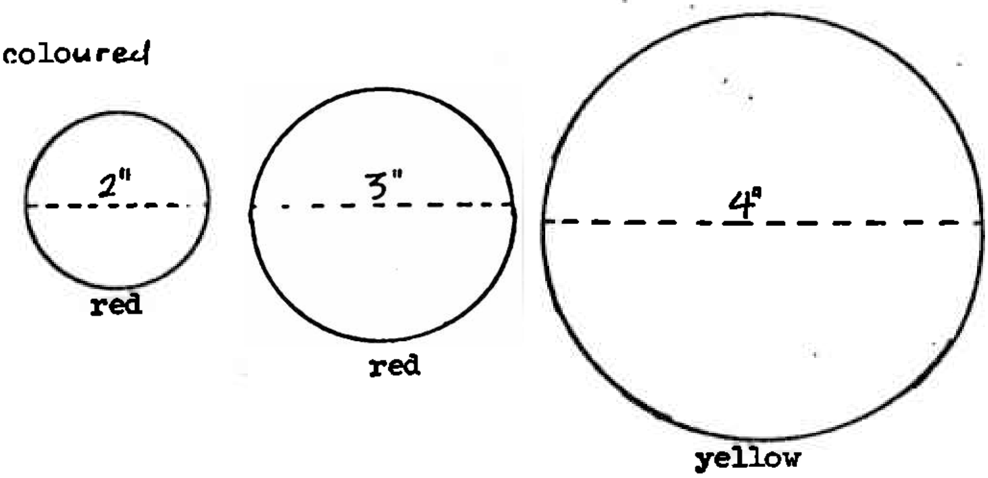

1 L-shape:



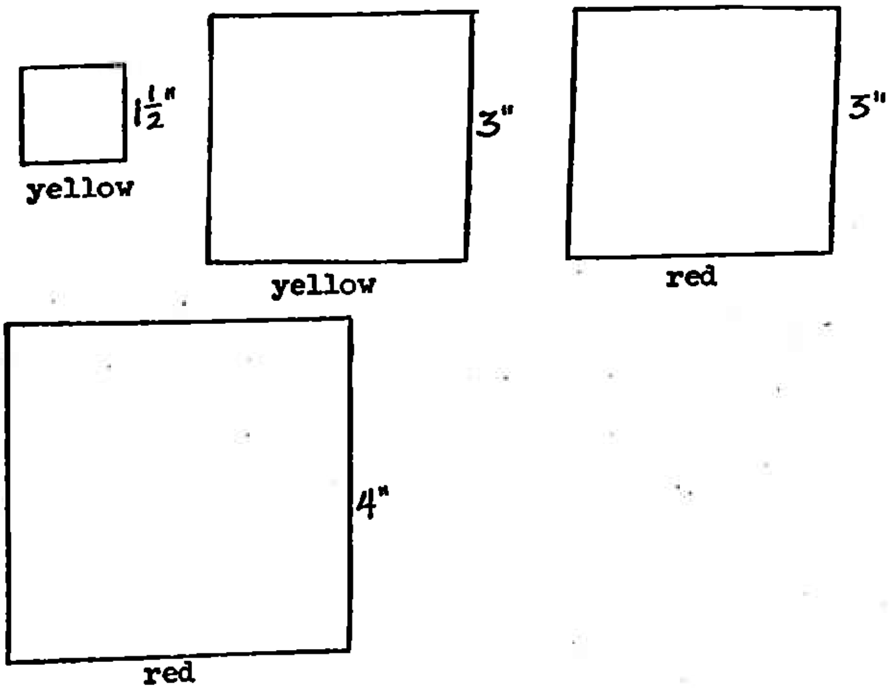
015 CLASSIFYING (continued)

Set VII - multi-coloured

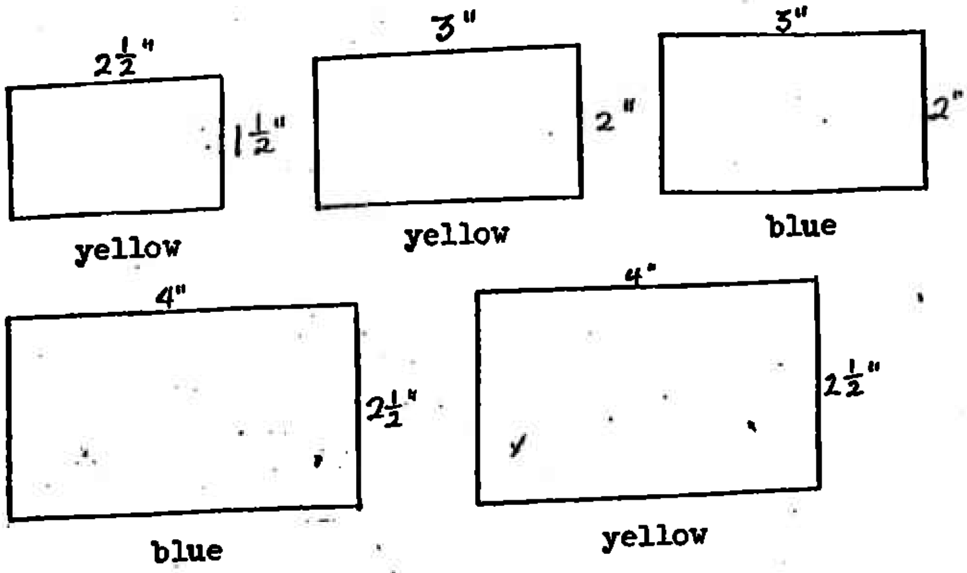
3 circles:




4 squares:

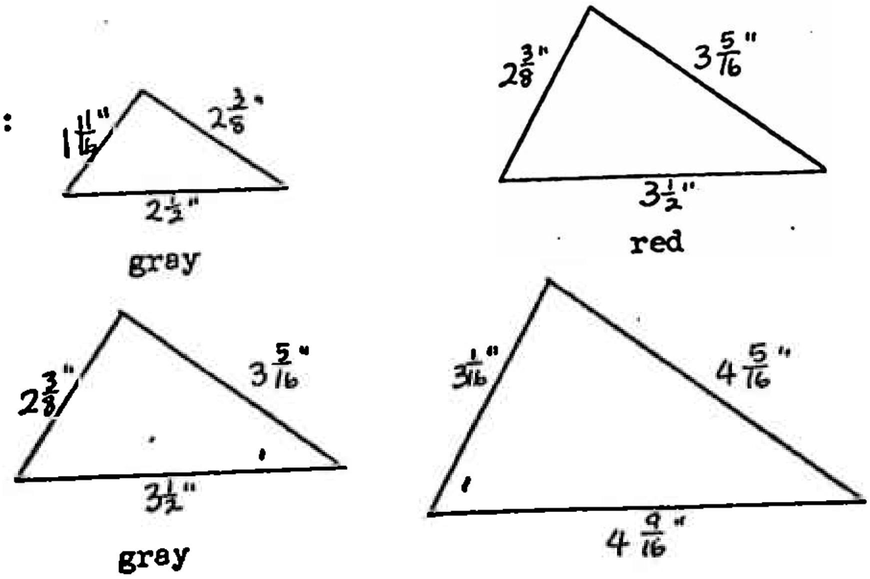



5 rectangles:



015 CLASSIFYING (continued)

4 triangles:




TEST QUESTIONS

Although a small part of the following test directions do not pertain to the Classifying scale, the complete test is printed here to give the pertinent sections perspective. The directions which do not apply to Classifying are marked with brackets.

Set I. Circles

Spread out the geometric shapes of Set I randomly in front of the child so that all are visible.

HERE ARE SOME SHAPES OR REGIONS. FIND ALL THE CIRCLE SHAPES. PUT THEM HERE (pointing to the table at the child's right).

014 ORDERING: GEOMETRIC SHAPES (Continued)

Count the number the child finds and record under the number Sorted. If the child does not respond, say:

SHOW ME A CIRCULAR SHAPED REGION. (Pause) NOW PUT ALL THE SHAPES THAT ARE CIRCLES OVER HERE (pointing to child's right)

If the child cannot identify a circle, record as 0 under Sorted.

If the child has included any shapes other than the circular regions, note number and shape in Comments on the score sheet.

Remove all the shapes except the four blue, circular regions from the table, and say:

CAN YOU PUT THESE (pointing to circles) IN A LINE SO THAT THEY GO FROM THE LARGEST TO THE SMALLEST?

Record in correct box under How Ordered.

GIVE ME THE SMALLEST CIRCLE.

Continue through all four sets of Ordering and Classifying independent of the number of errors the child makes.

Set III. Triangles and Red

Spread out the geometric shapes of Set III randomly in front of the child so that all are visible.

HERE ARE SOME OTHER SHAPES. SHOW ME THE SHAPES THAT ARE BOTH TRIANGLES AND RED.

If the child does not respond, say:

SHOW ME A TRIANGULAR REGION. (Pause) NOW PUT ALL THE SHAPES THAT ARE TRIANGLES AND RED OVER HERE (pointing to the table at the child's right).

Count the number of red triangular shapes the child finds and record under Sorted. If the child cannot identify a triangle, record as 0.

Q14 ORDERING: GEOMETRIC SHAPES (Continue)

Be certain to write down in Comments if other shapes were included in the sorting. Note the shape and colour of non-triangular shapes included in the set. Note if other colored triangular shapes were included.

Add any red triangular shapes that he has overlooked. Remove all shapes except the red triangular shapes from the table, and say:

CAN YOU PUT THESE IN A LINE SO THAT THEY GO FROM THE SMALLEST TO THE LARGEST?

Record in correct box under How Ordered.

Set V. Same Size

Spread out the geometric shapes randomly in front of the child so that all are visible.

A. FIND THE SHAPES THAT ARE THE SAME SIZE. PUT THEM OVER HERE (pointing to the child's right).

If no response, say:

B. CAN YOU FIND SETS OF SHAPES WHICH HAVE MEMBERS ALL THE SAME SIZE?

If the child sorts both the squares and circles, score appropriately under Sorted.

If the task is done correctly, there should be scores of 4 for Square and Circle; 0 for Rectangle and Triangle.

If the child sorts only the squares or circles, then say:

IS THERE ANOTHER SET OF SHAPES WHICH HAS MEMBERS ALL THE SAME SIZE?

Score under Sorted After Prompting.

Be sure to check in appropriate space if no prompting is necessary after the initial directions (A. and B.).

014 ORDERING: GEOMETRIC SHAPES (Continued)

Set VII.

Spread out the shapes of Set VII randomly in front of the child so that all are visible.

A. HERE ARE SOME OTHER SHAPES OR REGIONS.
THERE ARE FOUR DIFFERENT SHAPES IN THE SET. (Point to one of each shape.) GIVE ME THE SMALLEST ONE OF EACH DIFFERENT SHAPE.

If the child does not respond, say:

MAKE A SEPARATE PILE FOR EACH SHAPE. (Point again to one of each shape.) THEN GIVE ME THE SMALLEST OF EACH SHAPE.

Be certain to note in Comments if it is necessary to tell the child to do this.

If an error was made, note in the Comments which smallest shape was omitted or if any larger one were included.

Record under A. number sorted and error, if made.

Return all the shapes to the random position within the set of shapes before beginning B.

B. CAN YOU GIVE ME THE SMALLEST RED CIRCLE?

If the child does not respond, say:

MAKE A SEPARATE PILE FOR ALL THE RED CIRCLES. THEN GIVE ME THE SMALLEST RED CIRCLE.
Be certain to note in Comments if it is necessary to tell the child to do this. After completing this part of Set VII, return the red circles to random positions within the set of shapes. Make certain that all shapes are visible.

C. GIVE ME THE LARGEST YELLOW RECTANGLE.

If the child does not respond, say:

C14 ORDERING: GEOMETRIC SHAPES (Continued)

MAKE A SEPARATE PILE FOR ALL THE YELLOW RECTANGLES.
THEN GIVE ME THE LARGEST YELLOW RECTANGLE.

Note in Comments if it is necessary to tell the child to do this. After completing this part of Set VII, return the yellow rectangles to random places within the set of shapes. Make sure all shapes are visible.

D. NOW, ARE THERE MORE TRIANGLES OR RED SQUARES?

If the child does not respond, say:

CAN YOU FIGURE OUT A WAY TO TELL IF THERE ARE MORE TRIANGLES OR RED SQUARES? (pause)
YOU MAY MOVE THE SHAPES AROUND OR PILE THEM UP IF YOU WANT TO.

Return removed shapes to random places within the set of shapes, making sure that all shapes are visible, before starting E.

E. NOW, ARE THERE MORE CIRCLES OR BLUE RECTANGLES?

If the child does not respond, say:

CAN YOU FIGURE OUT A WAY TO TELL IF THERE ARE MORE CIRCLES OR BLUE RECTANGLES? (pause)
YOU MAY MOVE THE SHAPES AROUND OR PILE THEM UP IF YOU WANT TO.

016 ROTE COUNTING (I item)

TEST MATERIALS:

none

TEST DIRECTIONS:

WILL YOU COUNT FOR ME?

Pause, if no response, say:

I'LL START AND THEN YOU GO ON, 1, 2.

Pause. If still no response, say:

ONE. WHAT COMES NEXT?

Stop the child when he reaches '100'.

Write down numbers exactly as the child says them. Enter numerals on score sheets across the rows (as in reading lines of print in a book). If he stops and starts from one, or from another number more than twice, stop the task (e.g., child counts through 19, then starts again and counts through 25, don't let him start again, but be sure the I through 19 and the I through 25 are written in on the scoring sheet).

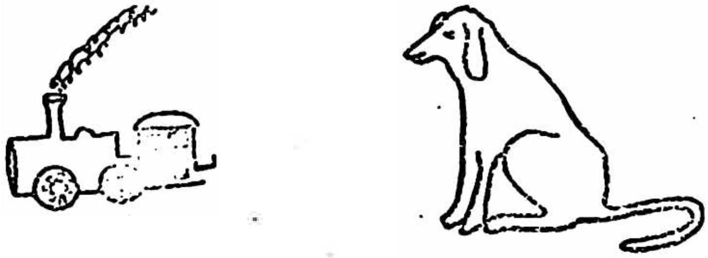
017 VISUAL MEMORY: PICTURES (4 items)

TEST MATERIALS:

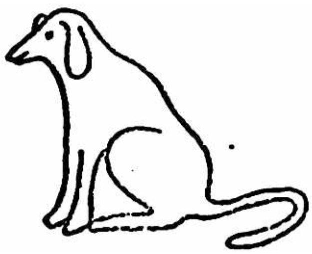
5 sets of drawings bound in five booklets with three pages of drawings in each as reproduced below –

## VISUAL MEMORY: PICTURES

### Practice Set



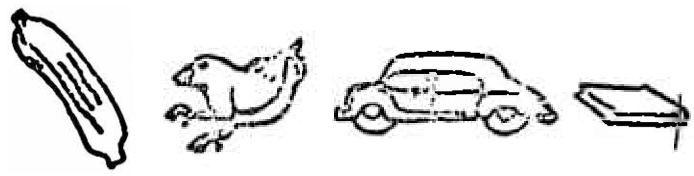
(page 1 - original pictures)



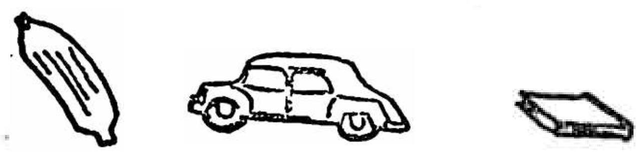
(page 2 - picture removed)

(page 3 - new set)

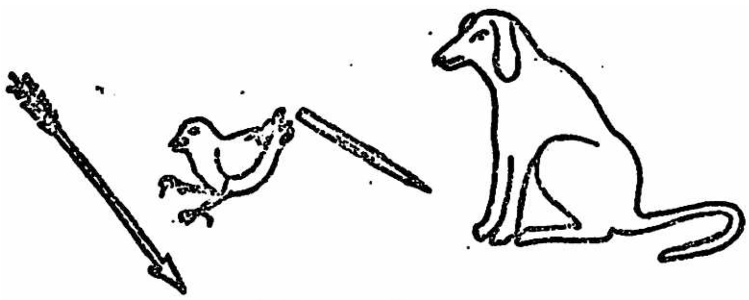
Set I



(page 1 - original pictures)

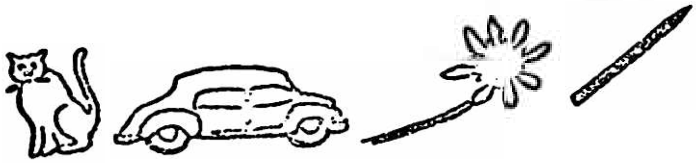


(page - picture removed)



(page 3 - new set)

Set II

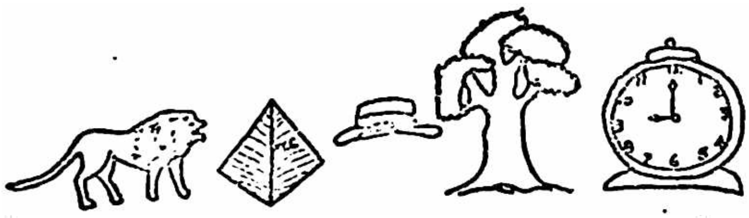


(page 1 - original pictures)

(page 2 - picture removed)

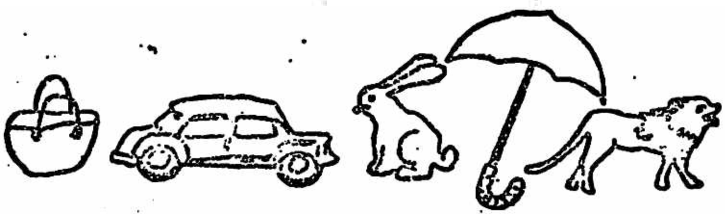
(page 3 - new set)

Set III



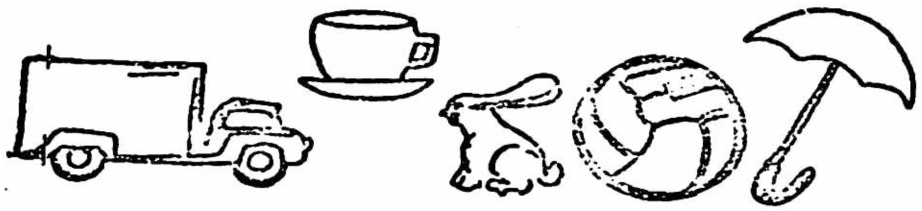
(page 1 - original pictures)

(page 2 - picture removed)

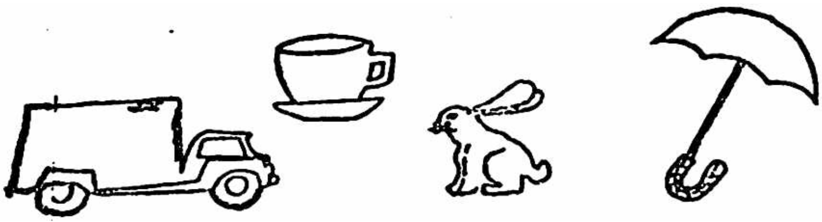


(page 3 - new set)

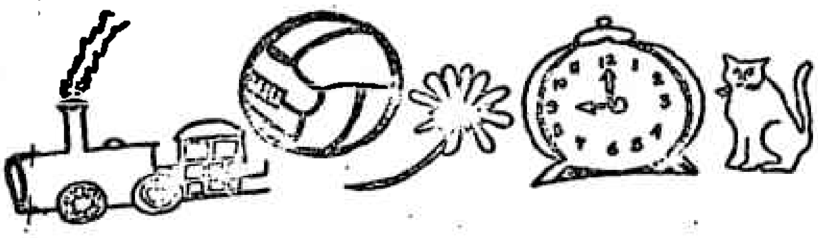
Set IV



(page 1 - original pictures)



(page 2 - picture removed)



(page 3 - new set)

VISUAL MEMORY: PICTURES (Continued)

TEST DIRECTIONS:

HERE ARE PICTURES OF SOME THINGS YOU KNOW.

Place Practice Set in front of the child.

LOOK AT EACH OF THESE PICTURES VERY CAREFULLY.

Make sure the child attend to the pictures.

ON THE NEXT PAGE THE PICTURES ARE THE SAME, BUT ONE OF THESE (pointing to the pictures) WILL BE MISSING. YOU HAVE TO REMEMBER THE PICTURES ON THIS PAGE SO THAT YOU KNOW WHAT IS MISSING ON THE NEXT PAGE.

Make sure the child looks at both pictures. If the child does not look at each picture, say:

LOOK AT EACH ONE.

Since the paper is thin and the pictures can be seen through from the page underneath that being shown to the child, a clean sheet of paper has been placed between the one being shown and those underneath it. (Fold the page with the drawings and the plain paper back under the next two pages).

ALL RIGHT, WHAT PICTURE IS MISSING FROM THIS PAGE THAT WAS ON THE PAGE YOU JUST LOOKED AT?

If the child is correct, mark under First Recall on score sheet, and proceed with Set I. If the child does not reply, or is incorrect, say:

WHAT ELSE WAS ON THE LAST PAGE THAT INS'T ON THIS PAGE?

Pause. If correct, mark under Second Recall on score sheet, and proceed with Set I. If no reply, then say:

DO YOU KNOW WHAT IS MISSING?

If the child is correct this time, mark under Third Recall, and proceed with Set I. If the child still cannot recall, then proceed as follows;

I'LL SHOW YOU SOME NEW PICTURES.

Turn to the third page of the Practice Set, showing the mouse and the engine. Say:

017 VISUAL MEMORY: PICTURES (Continued)

WHICH ONE OF THESE WAS ON THE FIRST PAGE BUT NOT IN THE PICTURES I JUST SHOWED YOU?

If the child cannot recognize the removed picture in the new set, tell and show him the train engine. Tell the child:

LET'S TRY ANOTHER GAME LIKE THIS.

Proceed with the same directions through Set IV.

In scoring this test, if the child makes a mistake in vocabulary, such as calling the bird a duck or the engine a train, this is acceptable. However, be sure to note this in the Comments.

Continue through all four items in this assessment, plus the Practice Set.

Note that for each of the five booklets, the third page (e.g., mouse and engine in the Practice Set) is not used if the child is successful within the first three recalls.

019 COLOUR: MATCHING (6 items)

TEST MATERIALS:

2 sets of cards with a two-inch circular area of colour on each card.

Child's set of colours: Yellow, blue, brown, red, orange, green, black.

Tester's set of colours: the first six colours of the child' set; black is excluded.

TEST DIRECTIONS:

I HAVE SOME COLOUR CARDS. I AM GOING TO PUT THEM ON THE TABLE.

Arrange tester's colour cards on the table, from left to right: yellow, blue, brown,green, orange, red. Note that the tester's set does not include black.

NOW I AM GOING TO PUT SOME ON THE TABLE FOR YOU TOO.

Arrange pupil's cards on the table in front of the child with, from tester's left to right: orange, blue, red, black, brown, yellow, green. Pause for any spontaneous comments from pupil and record them in "Other Observations".

Touch your green card, but do not name the colour.
LOOK AT THE COLOUR CARD I AM TOUCHING. NOW LOOK AT ALL OF YOUR COLOUR CARDS. DO YOU HAVE ONE JUST LIKE IT?
If the child does not spontaneously point to his card, then say:

PUT YOUR FINGER ON THE COLOUR CARD OF YOURS THAT IS JUST LIKE THIS ONE.

If the pupil does not understand directions, or touches tester's card rather than his own, say:
PUT YOUR FINGER ON ONE OF THESE COLOUR CARDS (pointing to his set) THAT IS JUST LIKE THIS ONE (the one I am touching).

Proceed in the order listed on the scoring sheets.

When Matching is completed, remove tester's set of colour cards from the table, and start colour Naming.

Continue all three parts of the Colour Inventory whether or not the child makes three errors.

020 <u>COLOUR:</u> <u>NAMING</u> (7 items)

TEST MATERIALS:

The child's set of colour cards as described in 019.

TEST DIRECTIONS:

Point in order to the colour cards, starting with <u>orange</u>, and say:

CAN YOU TELL ME THE NAME OF THE COLOURS?

WHAT COLOUR IS THIS?

AND THIS ONE?

When Naming is completed, leave cards set up as they are, and start <u>Identification</u> of colours.

021 <u>COLOUR:</u> <u>IDENTIFYING</u> (6 items)

TEST MATERIALS:

The child's set of colour cards as described in 019.

TEST DIRECTIONS:

WOULD YOU GIVE ME THE RED CARD?

Proceed, using the order listed on the scoring sheet.

CONSERVATION: PICTURES (6 items)

TEST MATERIALS:

6 cards with two rows of Kenya Flags or shields on each card. The cards are numbered I to 6 to indicate the order in which they are to be presented to the child.

TEST DIRECTIONS:

Place Card 1 in front of the child. The top of the card, as noted on the back, should be on the tester's side.

Say to the Child:

ON THIS CARD THERE ARE TWO ROWS OF FLAGS. HERE (running your finger along the row nearer you) IS THE TOP ROW, AND HERE (running your finger along the row nearer the child) IS THE BOTTOM ROW. ARE THERE MORE FLAGS IN THE TOP ROW, OR ARE THERE MORE FLAGS IN THE BOTTOM ROW, OR IS THERE THE SAME NUMBER OF FLAGS IN EACH ROW?

If the child does not respond, say:

WHICH ROW HAS MORE FLAGS, THE ONE ON TOP OR THE ONE ON THE BOTTOM? OR ARE THEY THE SAME? (pause) On this and the succeeding cards in this task, allow the child to point to his choice if he wishes to.

Replace Card 1 with Card 2, again making sure it is oriented correctly.

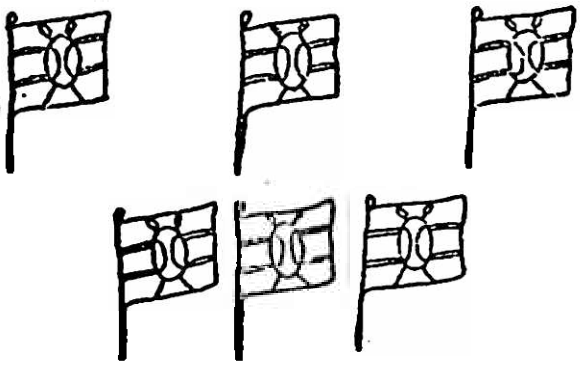
This time say:

WHICH ROW ON THIS CARD HAS MORE FLAGS? (pause) DOES THE TOP ROW HAVE MORE FLAGS, OR DOES THE BOTTOM ROW HAVE MORE FLAGS, OR DO THEY BOTH HAVE THE SAME NUMBER?

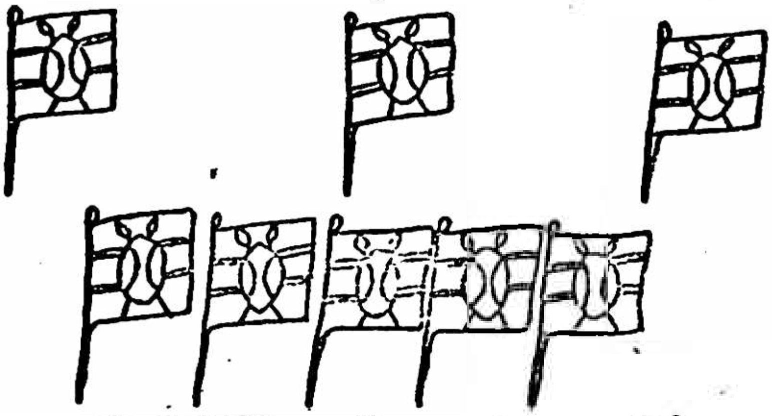
This time, if the child does not respond, go on to Card 3 and continue through Card 6 asking the same question each time, except that on Card 4 through 6 the word FLAGS should be replaced by the word SHIELDS.

The cards are reproduced below -

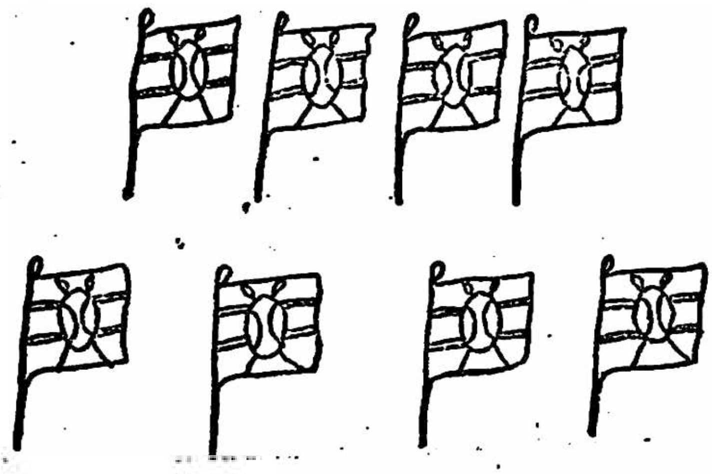
CONSERVATION : PICTURES

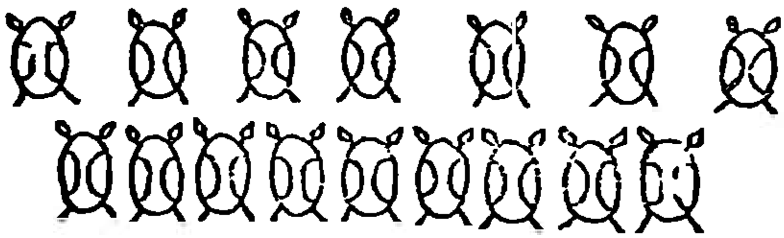


Card 1

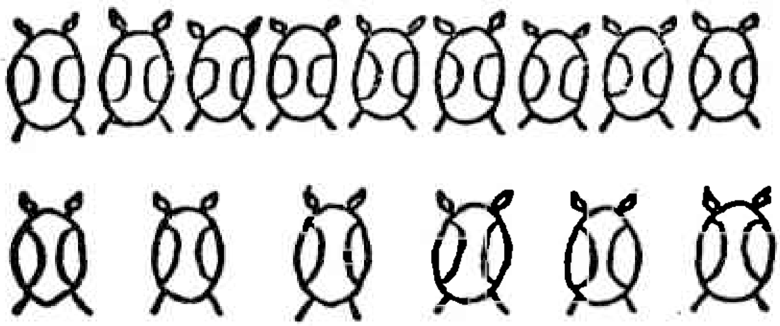


Card 2

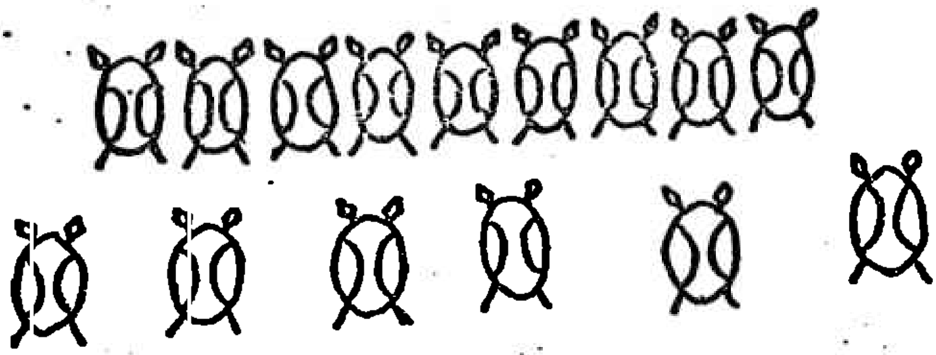




Card 4



Card 5



Card 6

In scoring these items, put a check mark in the left-hand column if the child assert that there are more in the top row than in the bottom row, a check mark in the second column if the child assert that there are more in the bottom row, a check mark in the third column if the child asserts that there are the same number in each row, and a check mark in the last column if the child does not respond.

CONSERVATION: DOTS

TEST MATERIALS:

6 cards with two rows of dots on each card. (The cards are numberd 1 to 6 to indicate the order in which they are to be presented to the child.)

TEST DIRECTIONS:

Place Card 1 in front of the child. The top of the card, as noted on the back, should be on the tester's side.

Say to the child:

ON THIS CARD THERE ARE TWO ROWS OF DOTS. HERE (running your finger along the row nearer you) IS THE TOP ROW, AND HERE (running your finger along the row near the child) IS THE BOTTOM ROW. ARE THERE MORE DOTS IN THE TOP ROW, OR ARE THERE MORE DOTS IN THE BOTTOM ROW, OR IS THERE THE SAME NUMBER OF DOTS IN EACH ROW?

If the child does not respond, say:

WHICH ROW HAS MORE DOTS, THE ONE ON TOP OR THE ONE ON THE BOTTOM OR ARE THEY THE SAME? (pause)

On this and the succeeding cards in this task allow the child to point to his choice if he wishes to.

Replace Card 1 with Card 2, again making sure it is oriented correctly.

This time say:

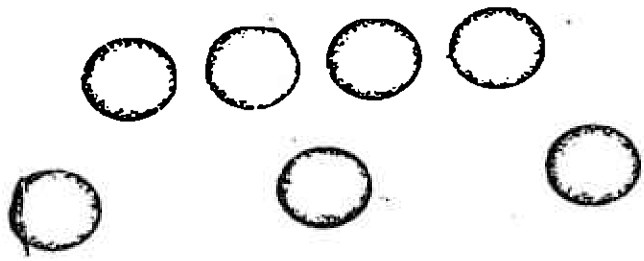
WHICH ROW ON <u>THIS</u> CARD HAS MORE DOTS? (pause) DOES THE TOP ROW HAVE MORE DOTS, OR DOES THE BOTTOM ROW HAVE MORE DOTS, OR DO THEY BOTH HAVE THE SAME NUMBER?

This time, if the child does not respond, go on to Card 3 and continue through Card 6 asking the same question each time.

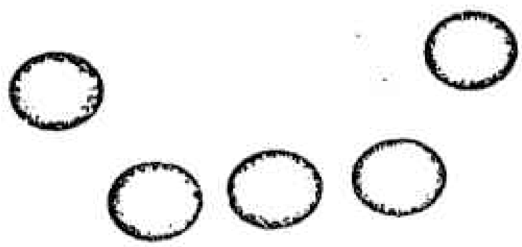
In scoring these items, put a check mark in the left-hand column if the child asserts that there are more dots in the top row than in the bottom row, a check mark in the second column if the child asserts there are more dots in the bottom row than in the top row, a check mark in the third column if the child asserts there are the same number of dots in each row, and a check mark in the last column if the child does not respond.

The cards are reproduced below -

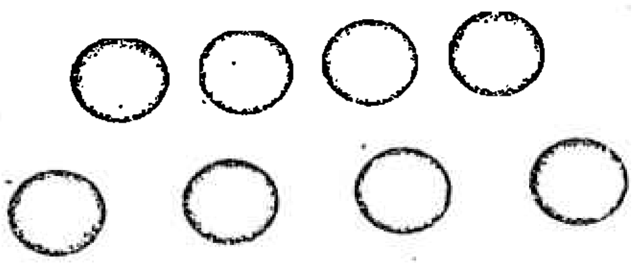
CONSERVATION: DOTS



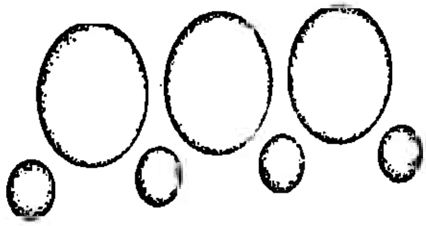
Card 1



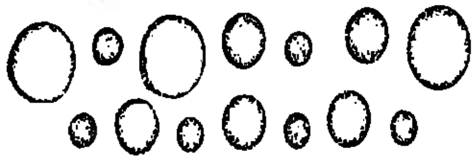
Card 2



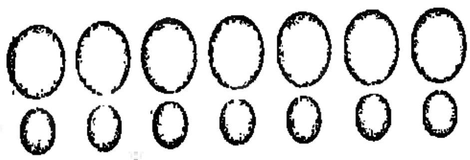
Card 3



Card 4



Card 5



Card 6

# Scoring Grid

Id. No. ________ Sex ______ Age ______ yrs. ______ Months

Type of School 75/200/250

Does your father own a car? Yes / No

How do you go to school walk / taken

Where do you live? ____________

Is your father/guardian employed? Yes /

Is your mother employed? Yes / No

Pupils Name ____________________ Tester's Name ________

School ____________________

## GEOMETRIC SHAPES

01 Matching

| | | | Correct Response (✓) | Incorrect Response (✓) | No Response (✓) |
|---|---|---|---|---|---|
| 11 | 1 | Circle | | | |
| 2 | 2 | Square | | | |
| 3 | 3 | Triangle | | | |
| 4 | 4 | Rectangle | | | |

02 Naming

| | | | | | |
|---|---|---|---|---|---|
| 5 | 1 | Square | | | |
| 6 | 2 | Triangle | | | |
| 7 | 3 | Rectangle | | | |
| 8 | 4 | Circle | | | |

03 Identifying

| | | | | | |
|---|---|---|---|---|---|
| 9 | 1 | Triangle | | | |
| 10 | 2 | Rectangle | | | |
| 11 | 3 | Circle | | | |
| 12 | 4 | Square | | | |

Comments:

## 04 COUNTING BEANS

| Number Asked | | Correct (✓) | Incorrect (✓) |
|---|---|---|---|
| 13 | 3 | | |
| 14 | 5 | | |
| 15 | 4 | | |
| 16 | 6 | | |
| 17 | 8 | | |
| 18 | 7 | | |
| 19 | 9 | | |

## 05 WRITING NUMERALS

| | Numeral | Formed Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 20 | 3 | | | |
| 21 | 5 | | | |
| 22 | 4 | | | |
| 23 | 6 | | | |
| 24 | 8 | | | |
| 25 | 7 | | | |
| 26 | 9 | | | |

Comments:

## 06 COUNTING MEMBERS OF A (

| | Card No. | Counted Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 27 | 1 | | | |
| 28 | 2 | | | |
| 29 | 3 | | | |
| 30 | 4 | | | |
| 31 | 5 | | | |
| 32 | 6 | | | |
| 33 | 7 | | | |
| 34 | 8 | | | |

## 07 IDENTIFICATION OF NU

| | Numeral | Identified Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 35 | 3 | | | |
| 36 | 1 | | | |
| 37 | 4 | | | |
| 38 | 5 | | | |
| 39 | 0 | | | |
| 40 | 8 | | | |

# Scoring Grid

Id. No. ______ Sex ______ Age ______ yrs. ______ Months Date ______ 19__

Type of School 75/200/250

Does your father own a car? Yes / No

How do you go to school walk / taken by car / other

Where do you live? ______

Is your father/guardian employed? Yes / No

Is your mother employed? Yes / No

Pupils Name ______________ Tester's Name ______________

School ______________

## GEOMETRIC SHAPES

01 Matching

| | | | Correct Response (✓) | Incorrect Response (✓) | No Response (✓) |
|---|---|---|---|---|---|
| 11 | 1 | Circle | | | |
| 2 | 2 | Square | | | |
| 3 | 3 | Triangle | | | |
| 4 | 4 | Rectangle | | | |

02 Naming

| | | | | | |
|---|---|---|---|---|---|
| 5 | 1 | Square | | | |
| 6 | 2 | Triangle | | | |
| 7 | 3 | Rectangle | | | |
| 8 | 4 | Circle | | | |

03 Identifying

| | | | | | |
|---|---|---|---|---|---|
| 9 | 1 | Triangle | | | |
| 10 | 2 | Rectangle | | | |
| 11 | 3 | Circle | | | |
| 12 | 4 | Square | | | |

Comments:

## 04 COUNTING BEANS

| | Number Asked | Correct (✓) | Incorrect (✓) |
|---|---|---|---|
| 13 | 3 | | |
| 14 | 5 | | |
| 15 | 4 | | |
| 16 | 6 | | |
| 17 | 8 | | |
| 18 | 7 | | |
| 19 | 9 | | |

## 05 WRITING NUMERALS

| | Numeral | Formed Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 20 | 3 | | | |
| 21 | 5 | | | |
| 22 | 4 | | | |
| 23 | 6 | | | |
| 24 | 8 | | | |
| 25 | 7 | | | |
| 26 | 9 | | | |

Comments:

## 06 COUNTING MEMBERS OF A GIVEN SET

| | Card No | Counted Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 27 | 1 | | | |
| 28 | 2 | | | |
| 29 | 3 | | | |
| 30 | 4 | | | |
| 31 | 5 | | | |
| 32 | 6 | | | |
| 33 | 7 | | | |
| 34 | 8 | | | |

Comments:

## 07 IDENTIFICATION OF NUMERALS

| | Numeral | Identified Correctly (✓) | Attempted but Incorrect (✓) | No Attempt (✓) |
|---|---|---|---|---|
| 35 | 3 | | | |
| 36 | 1 | | | |
| 37 | 4 | | | |
| 38 | 5 | | | |
| 39 | 0 | | | |
| 40 | 8 | | | |
| 41 | 7 | | | |
| 42 | [illegible] | | | |

Comments:

14 Geometric Shapes - Classifying

Set I Circles

77 Sorted
(Circle total number of Circles sorted)

0 1 2 3 4

Did child include other shapes in addition to the circles sorted?

Yes ______ No ______

If yes, what? ____________

89 How Ordered?
(Check the 1 appropriate box)

| | |
|---|---|
| Largest to smallest | |
| Smallest to largest | |
| Randomly ordered | |

90 Handed smallest circle

Yes ___ No ____

Comments:

Set III Triangles and Red

91 Sorted
(Circle total number of triangles and red sorted)

0 1 2 3 4

Did child include other shapes in addition to the red triangles sorted?

Yes ____ No ____

If yes, what? ____________

92 How Ordered?
(Check the 1 appropriate box)

| | |
|---|---|
| Smallest to largest | |
| Largest to smallest | |
| Randomly ordered | |



Set V Same Size

Sorted shapes of same size without

93 Prompting: (Circle 1 numeral for each shape)

| | | | | | |
|---|---|---|---|---|---|
| Square | 0 | 1 | 2 | 3 | 4 |
| Rectangle | 0 | 1 | 2 | 3 | 4 |
| Triangle | 0 | 1 | 2 | 3 | 4 |
| Circle | 0 | 1 | 2 | 3 | 4 |

Sorted after prompting:

| | | | | | |
|---|---|---|---|---|---|
| Square | 0 | 1 | 2 | 3 | 4 |
| Circle | 0 | 1 | 2 | 3 | 4 |

If no prompting necessary after initial directions, check here ______

Comments:

Set VII

A. Smallest members

94 (Circle total no. sorted) 0 1 2 3 4

Did child include other shapes in addition to the smallest members sorted?

Yes ____ No ____

If yes, what? ____________

B. Handed smallest red circle Yes __ No __

95 If No, error was shape ___ size ___

Colour ____

C. Handed largest yellow rectangle

96 Yes ____ No ___

If No, error was shape ____ Size ___

Colour ____

D. More triangles or red squares

97 Correct (more triangles) __

16

ROTE COUNTING

| | |
|---|---|
| | 99 |
| | 100 |
| | 101 |
| | 102 |
| | 103 |
| | 104 |
| | 105 |
| | 106 |
| | 107 |
| | 108 |

Comments for Rote Counting:

E. More circles or blue rectangles

98 Correct (more circles) ____

Incorrect (more blue rectangles) ____

Comments for Set VII:

14 Geometric Shapes - Classifying

Set I Circles

77 Sorted
(Circle total number of Circles sorted)
0 1 2 3 4

Did child include other shapes in addition to the circles sorted?

Yes ______ No ______

If yes, what? ____________

89 How Ordered?
(Check the 1 appropriate box)

Largest to smallest ☐
Smallest to largest ☐
Randomly ordered ☐

90 Handed smallest circle
Yes ____ No ____

Comments:

Set III Triangles and Red

91 Sorted
(Circle total number of triangles and red sorted)
0 1 2 3 4

Did child include other shapes in addition to the red triangles sorted?

Yes ______ No ______

If yes, what? ____________

92 How Ordered?
(Check the 1 appropriate box)

Smallest to largest ☐
Largest to smallest ☐
Randomly ordered ☐

Set V Same Size

Sorted shapes of same size without

93 Prompting: (Circle 1 numeral for each shape)

| | | | | | |
|---|---|---|---|---|---|
| Square | 0 | 1 | 2 | 3 | 4 |
| Rectangle | 0 | 1 | 2 | 3 | 4 |
| Triangle | 0 | 1 | 2 | 3 | 4 |
| Circle | 0 | 1 | 2 | 3 | 4 |

Sorted after prompting:

| | | | | | |
|---|---|---|---|---|---|
| Square | 0 | 1 | 2 | 3 | 4 |
| Circle | 0 | 1 | 2 | 3 | 4 |

If no prompting necessary after initial directions, check here ______

Comments:

Set VII

A. Smallest members

94 (Circle total no. sorted) 0 1 2 3 4
Did child include other shapes in addition to the smallest members sorted?

Yes ______ No ______

If yes, what? ____________

B. Handed smallest red circle Yes ____ No ____

95 If No, error was shape ____ size ____
Colour ______

C. Handed largest yellow rectangle

96 Yes ______ No ______
If No, error was shape ______ Size ____
Colour ______

D. More triangles or red squares

97 Correct (more triangles) ____

16

ROTE COUNTING

9
10
10
10
10
10
10
10
10
10

Comments for Rote Counting:

E. More circles or blue rectangle

98 Correct (more circles) ______

Incorrect (more blue rectangle ______

Comments for Set VII:

17 VISUAL MEMORY - PICTURES

| | | Original Set | Removed Pictures | Recalls 1st | 2nd | 3rd | New Set | Correct | Incorrect | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pr | Engine Fish | Engine | | | | Mouse Engine | | | |
| 111 | 1 | Cat car, flower, pencil | car | | | | car book KCC butterfly | | | |
| 112 | 2 | Book Car Bird banana | bird | | | | arrow pencil fish bird | | | |
| 113 | 3 | Lion KCC hat tree clock | lion | | | | basket rabbit umbrella lion | | | |
| 114 | 4 | Truck Cup Rabbit Ball Umbrella | ball | | | | Engine ball flower clock ca | | | |

COLOR INVENTORY

19 Matching

| | | | Correct Response | Incorrect Response | No Response |
|---|---|---|---|---|---|
| 115 | 1 | Green | | | |
| 116 | 2 | Blue | | | |
| 117 | 3 | Orange | | | |
| 118 | 4 | Brown | | | |
| 119 | 5 | Red | | | |
| 120 | 6 | Yellow | | | |

Comments:

20 Naming

| | | | | | |
|---|---|---|---|---|---|
| 121 | 1 | Orange | | | |
| 122 | 2 | Blue | | | |
| 123 | 3 | Red | | | |
| 124 | 4 | Black | | | |
| 125 | 5 | Brown | | | |
| 126 | 6 | Yellow | | | |
| 127 | 7 | Green | | | |

21 Identifying

| | | | | | |
|---|---|---|---|---|---|
| 128 | 1 | Red | | | |
| 129 | 2 | Brown | | | |
| 130 | 3 | Green | | | |
| 131 | 4 | Orange | | | |
| 132 | 5 | Yellow | | | |
| 133 | 5 | Blue | | | |

22 Conservation - Pictures

| Item No. | Card No. | Child asserts more flags in TOP row | Child asserts more flags in BOTTOM row | Child asserts same number flags in each row | No attempt |
|---|---|---|---|---|---|
| 134 | 1 | | | | |
| 135 | 2 | | | | |
| 136 | 3 | | | | |
| 137 | 4 | | | | |
| 138 | 6 | | | | |
| 139 | 6 | | | | |

23 Conservation - Dots

| Item No. | Card No. | Child asserts more dots in TOP row | Child asserts more dots in BOTTOM row | Child asserts same number dots in each row | No Attempt |
|---|---|---|---|---|---|
| 140 | 1 | | | | |
| 414 | 2 | | | | |
| 142 | 3 | | | | |
| 143 | 4 | | | | |
| 144 | 5 | | | | |
| 145 | 6 | | | | |