CONSERVATION OF NUMBER, LENGTH, MASS AND SERIATION AMONG KIKUYU PRE-PRIMARY SCHOOL CHILDREN AGED 4-6 YEARS

by Wangari Edith

This thesis is submitted in part fulfilment for the degree of Master of Arts in the department of Educational Psychology in the University of Nairobi

April 1982

Declaration

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

Wangari

Wangari Edith

This thesis has been submitted for examination with my approval as University Supervisor.

Dr. Daniel Kiminyo

Contents

T A B L E S

A C K N O W L E D G M N T

Firstly, I wish to thank the University of Nairobi for giving me the scholarship that enabled me to carry out this research. Secondly, I wish to thank Dr. Daniel Kiminyo for his continuous advice and suggestions when I was carrying out this research. Indeed he was very patient. I would also like to thank Professor A. Irudayanathan of Mathematics Department at Kenyatta University College for analysing the raw data. I would also like to thank my sister, Joyce Wanjira, for not getting tired of typing and retyping this thesis even when it meant giving up her weekends to get a few lines done. Her moral support has been invaluable.

Last, but not least, I would like to thank Mr. B. Karaimu for his assistance during the writing of this work.

A B S T R A C T

This thesis is based on a research carried out among Kikuyu pre-primary school children 4-6 years old living in Nairobi and the surrounding areas. The research was based on Piaget's theory of cognitive development and the main aim of this study was to find out if this theory holds for a non-western society especially at the pre-primary school level.

The procedure in this study was interview method using some of Piaget's tasks to test for conservation of number, length, mass and seriation. The effects of age, sex and the type of school attended on conservation were investigated into by classifying the subjects into three age groups, male versus female, and the high versus low cost schools.

There were 90 boys and 90 girls whose age was closely matched. Each subject was categorized as attending eitner low or high cost school.

This research was carried out during the period mid-September to mid-October in 1979. The information was collected through interview method and the data obtained was analysed using t-tests and F-ratio for differences between and among means respectively.

Generally the results supported Piaget's theory of cognitive development whereby older children

performed better than younger children at some of the tasks such as number and seriation tasks. Using Piaget's percentage comparison (75%) criterion, none of the conservation concepts in this study was developed.

There were no significant differences in performance between boys and girls on number, mass and seriation tasks. It was suggested that lack of significant difference in performance on the basis of sex is due to the upbringing of the children. At the time of this study, there has been considerable change in attitude and values among Kikuyu parents and therefore children of either sex are encouraged to perform well both at home and at school.

With respect to the type of school attended, significant difference in performance was found for seriation task only. This was attributed to the differences in home experiences whereby children attending high cost schools had better opportunity of playing with structured toys such as those for constructing staircases while such playthings were not available to the children attending low cost schools.

In conclusion, the results of this study agree with Piagets theory of cognitive development.

CHAPTER I

INTRODUCTION

An understanding of cognitive development is a prerequisite to curriculum development in any education system. The system of education here in Kenya has been branded as "alien" since it has been a continuation or perpetuation of the education system that the British (former Kenyan colonizers) left behind after independence. As a result therefore, curriculum developers here in Kenya have been making efforts to meet with the challenge of localizing the curricula. Consequently, a lot of research is necessary to reveal the processes of cognitive development at all levels, particularly the rates and ages at which scientific concepts are mastered. Such findings will result in more effective methods of teaching and better media of communication will be developed. Cross-cultural studies on cognitive development have been on the increase whereby the work of Jean Piaget has been replicated and validated as literature review in Chapter Two will show.

Cognitive development Theory of Jean Piaget:

In his theory, Piaget (1954) holds that cognitive development takes place in stages. He calls the first stage as the Sensory-Motor (0-2 years) During this period, Piaget holds that the child attains rudimentary knowledge of objects, people and events, differentiating the self from the object,

localizing the self in physical space and establishing the beginning awareness of cause and effect and of time and space. The Child also learns that objects have permanence (Sigel (1977)). Sensory Motor intelligence is intelligence in action and in no way reflective (Piaget, 1950, p. 121).

The preoperational phase, according to Piaget covers 2 - 4 years. The child here is approaching ability to function symbolically. With the beginning of symbolic thought, language plays a significant role. Flavell makes the distinction between Sensory Motor stage and the preoperational phase as follows:

> The Sensory Motor intelligence is capable only of linking one by one, the successive actions of perceptual stages with which it gets involved. Piaget likens it to a slow motion film which represents one static frame after another but can give no simultaneous and all-encompassing purview of all the frames. Representational thought, on the other hand, through symbolic capacity has the potential for simultaneously grasping in a single interval epitome, a whole sweep of separate events. It is much faster and more mobile device which can recall the past, represent the present, and anticipate the future in one temporarily brief organized act (1963, pp. 151-152).

The child is egocentric during this stage and cannot take other person's view point. The child still judges by face value and not reflectively. At this stage the child categorizes objects on the basis of single characteristic and is unable to classify the multifaceted aspects of stimuli simulteneously. The child is conceptualizing on

single salient, features of the environment. The child's conceptualization is perceptual-dominant since organization, classification, and primitive concepts are determined to a large measure by the potency of the apparent physical attributes.

Intuitive Phase (4-7 years)

Here the child has increased symbolic functioning (Flavel 1963), Piaget and Inhelder 1969). Although still egocentric, the child is now able to think in terms of classes, to see relationships and to deal with number concepts, the child can classify material on the basis of objective similarity. When presented with a group of squares or triangles, the child can classify these on the basis of triangularity or colour, but still only on the basis of one of these characteristics. The child is now said to be intuitive because she does not necessarily verbalize or indicate awareness of classification. The child is also beginning to utilize numbers and to order things in terms of quantity.

The period of Concrete Operations (7-11 years)

During this period, the child is able to think in terms of classes, relations and number and to be able to do this he must understand reversibility and conservation. .ccording to Piagets theory, a child at this stage of conceptual development should be able to perform log cal operations. These operations

include the ability to return to the original point in thought (reversibility), organize items into hierarchies of classes (classification), or arrange items along continuation of increasing value (seriation). In effect, the mental operations are integrated into a cognitive system (Piaget 1950). During this period, the complete picture evolves to provide a mental structure increasingly capable of developing concepts for representational thought. Basic to logical thought is the principle of conservation, the ability to perceive quantity as invariable even after transformation.

The Period of Formal Operations (11-15 years).

This is the last stage of cognitive development. At this stage the child reasons logically and his mind is capable of engaging in abstract thinking. Children here can operate in what is called hypothetical-deductive procedure of logical thought. During this stage, the child is able to form logical combinations called combinational thinking by Piaget. An illustration of this type of thinking is given by Hunt (1961) in an experiment in which he gave children animals to classify either as Vertebrates (V), or Invertebrates (I) and as Aquatic (A) and Terrestial (T). The child is then asked to describe the population on a newly discovered planet. A child using concrete operation level of thinking gives only four possible combinations while adolescent at the formal operations level gives sixteen possible combinations.

Piaget assumes that concepts develop and that the discovery of conservation earmarks the final stage of development. According to Piaget, development follows a sequential order "such that each of its previous stages are necessary to the construction of the next" (Piaget 1976 p.11). For him, development means movement from stage to stage resulting in changes both in what one can understand and how one understands it. Cognitive development for Piaget is through two processes, assimilation and accommodation (Sigel 1977 p.15). Assimilation means taking in of information, just as the body assimilates food through the digestive system. Accommodation is the process by which the human body takes in or assimilates that class of information which cognitive system is capable of dealing with, at that time. The knowledge that is learned from this process is organised into what Piaget calls a scheme (pl. schemata), a coherent organised set of "information" about objects events or whatever may be the content in question.

Piaget holds that the course of cognitive development is influenced by maturation, experience of the physical environment, the action of the social environment and equilibration or self-regulation by the organism. In cross-cultural research, it has been found that children in other societies, such as those quoted by Piaget from Iran, lag behind European

and American children by one to two years in mental development while still exhibiting the same sequence of stages. This difference can be attributed to different cultural environments while the salient pattern of cognitive development is perpetuated by maturation. The same research has been replicated to demonstrate that "stages" in mental development exist in urban and rural children and that rural children usually fall behind their city peers. This will be illustrated by the next chapter on literature review. Piaget therefore concludes that the experiential features of the environment exert tremendous impact upon the developing organism. The impact appears to be demonstrated most dramatically at ages 4 and 5 (Piaget 1937 p. 152). Piaget has stated that the child's active manipulation of objects is a necessary part of teaching for intellectual development. He has been challenged and empirical evidence from review of literature shows that Piaget's insistence on physical activity and his dismissal of observation are excessive. Some researchers point out that many experiments have had apparent success in teaching concrete operational thinking without involving physical manipulation by the child in the training. Other researchers support Piaget's findings by agreeing to the fact that experiences acquired within an environment influence cognitive development. Caldwell (1968) holds that environmental

stimulation is thought to have its most potent effects during periods of maximum growth. Differences in attainments are believed to reflect differing treatments in the early years (Kagan 1970).

The stages enumerated are accelerated or retarded for the average chronological ages according to the cultural and educational environment. But the fact that the stages occur in the same sequence in any environment is enough to show that the social environment cannot account for everything. This constant order of succession cannot be ascribed to the environment (Piaget 1970b p.721). There is, according to Piaget, requirement for maturation experience and the social environment to be in balance. This is what he calls equilibration.

For Piaget, the environment plays a facilitating role by providing the necessary stimulation. Flavell (1963) holds that Piaget's theory employs an adaptation model where the individual himself plays a very active role which is expressed in his action or actions on the environment.

Piaget (1957) theorizes that the transition from nonconservation to conservation occurs through the "equilibration process" an internal process heavily dependent upon activity and experience.

Although he has been accused of over emphasis of experience, and manipulation, as literature review

will show, Piaget goes on further to say that those investigators who challenge him have merely misunderstood his theory; he says the following:

> "...It appears that many educators believing themselves to be applying my psychological principles, limit themselves to showing the objects to the children without having the children manipulate them or still worse simply present audio-visual representation of objects in the erroneous belief that the mere fact of perceiving the objects and their transformations will be equivalent to direct actions of the learner in the experience. The latter is a grave error since action is only instructive when it involves the concrete and spontaneous participation of the child himself with all the tentative groupings and apparent waste of time that such involvement implies. It is absolutely necessary that learners have at their disposal concrete material experience (and not merely pictures) and that they form their own hypotheses and verify them (or not verify them) themselves through their own active manipulation. The observed activities of the others including those of the teacher are not formative of new organizations in the child's."
> (Piaget 1947 p.ix)

Further, Piagets theory of cognitive development proposes that operations or actions become more structured with increasing age with each new structurings. Flavell (1963) supports Piaget in this respect by saying that from the point of view of the Piagetian system, "the older child seems to have at his command a coherent and integrated cognitive system with which he organises and manipulates the world about him. It is this system that makes the elementary school age child different from his preschool age counterpart, for now he gives the

decided impression of possessing a solid cognitive bedrock, something flexible and plastic and yet consistent and enduring, with which he can structure the present in terms of the past without undue strain and dialocation i.e. without the ever present tendency to tumble into the perplexity and contradiction which mark the preschool (p.165).

Piaget's theory has been criticised for lacking in sophisticated statistical analyses as well as using too few samples which are not representative of a society. Furthermore Piaget didn't show how he controlled for some variables such as age and how scoring was done to distinguish the conservers from non-conservers. But despite all these criticisms, Piaget's theory and the clinical method of testing (interviewing) has been given credit for the pioneering of this work on conceptual development and his theory has been replicated in other societies to find out if his findings on Swiss children hold cross-culturally. His findings have been validated although some differences in findings have cropped up here and there as literature review will show.

These cross cultural researches have been replicated at the primary and post primary school levels. In Africa, not much has been done on pre-primary school level as far as conceptual development is concerned. Some research at the pre-primary level has been done in other societies and it is these researches that

this present study would like to replicate on the Kikuyu children.

In cross-cultural psychology, Piaget's work has been replicated using either English (for a second language) or the mother tongue. Proficiency in the subjects language eliminates the kind of differences observed in research findings where a subject is interviewed in another language apart from his mother tongue.

With regard to cognitive development, Piaget (1926) feels that language does not play a major organizing role in determining intellectual development until children achieve formal mature thought, during adolescence. Studies support him by asserting that due to the minor role played by language in cognitive growth during the pre-school and primary years, verbal output should not be emphasized in schools until well after the normal age for initial literacy training. Piagets contention about language in relation to cognitive development is confirmed by Dodwell's (1960) study that children's ability to count does not necessarily signify comprehension of numbers. These findings forewarn us that verbal output should not be regarded as concept attainment. At the same time at the elementary school level, teachers should avoid too much verbalisation and instead embark on more demo stration.

The Rationale of the Study

The need for preprimary school education as a prerequisite to primary school education is on the increase in urban areas. It is therefore important that curriculum developers understand the processes of cognitive development at this level. Such understanding will enable teachers to build a firm foundation on which later conceptual development of the children will build. This is possible if the concepts are taught at a time when a child is mature enough to conceptualize what is expected. Cross-cultural research on Piagetian theory has been concentrated on primary and post primary levels as literature review will show. Contradictory results have been found by different researchers probably due to differing research methodologies as well as varied cultural environments rather than due to different innate dispositions.

Research in cognitive development among preprimary school children has been done in other societies such as by Lovell and Ogilvie (1960), Uzigris (1964), Dodwell (1960), Elkind (1964), Wohlwill (1960), Ngini (1979) but more information is required in this area. Consequently the present study will attempt to investigate what Piaget did with his Swiss children (subjects) at preprimary school level. The results of this study will increase our knowledge on cognitive development at preprimary school level which is

important for curriculum planning and development in this area.

A SUMMARY

Theoretical Framework

Piaget's theory of cognitive development proposes that operations are structured through "stages". Each new structure builds upon and incorporates previous structures. Piaget (1941) investigated the ages at which children discovered the conservation of mass, weight and volume and he observed that discoveries of conservation followed a regular order that was related to age. This implies that there will be significant differences between 4, 5, and 6 years old children in the conservation of number, length, mass and seriation tasks in favour of the older children.

Piaget's theory didn't mention the effects sex differences might have on the performance of the various tasks. However other researchers (Goldschmidt, 1967: Otaala, 1970; Kiminyo, 1973; Mureria, 1974) have reported differences in performance in favour of the boys. They have suggested that the cultural environment in their respective societies are responsible for the superior performance of the boys. The boys' plays usually involve manipulation of objects which gives them an opportunity to view them under different situations However contradictory results of Fogelman (1970), Lester and Klein (1973) whereby Fogelman reports that

girls perform better than the boys while Lester and Klein reports no significance. There is need for further investigations in the part played by sex on conservation of number, length, mass and seriation at this level.

In his theory, Piaget implies that a rich environment would accelerate conceptual development as opposed to a poor environment. This has been supported by other researchers (Greenfield (1966), Otaala (1970), Price Williams (1961)). In all these studies manipulation of the environment by the the subject is regarded as a great influence on conceptual development. Based on this theory, therefore, it is anticipated that subjects who attend Higher cost school perform better in the tasks. Here the subjects are taught by highly qualified teachers through manipulative methods as opposed to children in low cost schools

CHAPTER II

LITERATURE REVIEW

Piaget's theory of cognitive development has led to a lot of cross cultural research, to find out if his findings with Swiss children hold universally. Some of these cross-cultural studies are cited in Dasen (1977) and Okatcha Ed. (1977). Contradictory findings have been attributed to the experimenters' lack of proficiency in the language of testing, or the lack of understanding of the subjects' cultural background. Such situations create a cultural barrier whereby the investigator misinterprets the results because of lack of proper understanding of the cultural values. In some societies for example, the boys are encouraged to excel in various "masculine" tasks while the girls who participate in such tasks may be looked upon as deviants. Lack of standardized methods of testing and analysis of data is also taken as a major contributing factor to the contradictions in findings. All these factors consequently lead to differences in interpretations.

Cross-cultural replication studies of Piaget's theory of cognitive development have mainly dealt with subjects in primary and post-primary schools (Goodnow 1962; Goodnow and Bethon 1966; Greenfield 1966; Otaala 1970; Mureria 1974; Price 1967 and 1968; Kelly 1971 and 1974; and Nyiti in Okatcha Ed. 1977).

Some of their findings show that children in non-European cultures perform differently from those in European cultures. The non-European children "lag" behind their Swiss counterparts according to these studies. At the preprimary school level, few studies on Piaget's theory of cognitive development have been done for example those in Sigel & Hooper 1968 (Elkind, Wohwill and Dodwell) and Ngini (1979).

Price (1967, 1968) tested school children ranging from grade 3 to 9 years old from central and western provinces and the Highland areas of Papua New Guinea. Price (1968) tested European students from three primary 'A' schools and a multi-racial school in Port Moresby.[1] The European children were from grades 2 to 9. The subjects were tested for conservation of length and quantity.

Kelly (1971) and Philip and Kelly (1974) did a research similar to Price's with subjects from Papua New Guinea. In all these experiments, length tends to be the first physical property to be conserved as compared to volume and area. In general, the performance of

---

[1]The former territory of Papua New Guinea had two types of school. 'A' schools operated on an Australian curriculum and catered mainly for expatriate children. 'T' schools operated on a special "territory" curriculum designed for indigenous children.

these children on the conservation tasks is below that of European children of the same age.

In the present study, the conservation of number, length, mass and seriation will be investigated among preprimary Kikuyu school children. Therefore the literature review that follows will be related to these concepts under investigation in this study.

Conservation of Number:

In his work on the child's conception of Number, Piaget (1952) did a research with preprimary school children using eggs and eggcups. When the eggs are placed in the eggcups the child says that the eggs and the eggcups are the same number but when removed from the cups and are more spread out, the child contradicts himself by saying that the eggs are more in number. Piaget argues that the replies of the child in this experiment indicate that he is either attending to the arrangement of the eggs or the arrangement of the eggcups but not to both and their relationships to each other. "When the eggcups are spread out they appear to have increased in number, when the eggs are spread out, they too dominate his thinking and therefore appear to have increased in number. Piaget refers to this fixation upon one aspect of changing relationship to the exclusion of other aspects as centration." (Richmond 1970 p. 27). According to Piaget, this inability to manipulate mental representations in a

rapid and flexible way and to be able to handle tranformations is "static representation".

In his experiments on discrimination seriation, Piaget used individual methods of testing. In one of his studies Piaget used two sets of graded sticks. The sticks in the second set were smaller than those in the first set. With these, Piaget (1952) devised three types of tests. The first test was a control measure involving simple discrimination problems. For example the child was asked to select "the largest" and the "smallest" of the sets of sticks when the sticks were in disarray upon the table. In a second test, the child was asked to build a "stairway" out of one set of sticks. After the stairway was constructed, the second set of sticks was produced. The child was told that this set of sticks had been forgotten and was required to insert the latter set of sticks within the stairway. In his investigations, Piaget found that the discrimination problems were passed at the age of 4 but that the more complex of the seriation problems were not passed until the ages of 6 or 7. Piaget therefore came up with three stages in children's ability to seriate and numerate size differences.

At the first stage (usually at age 4) children generally are unable to seriate sticks above a small number (three or four). At the second stage, (usually age 5) children are able to seriate after a considerable

trial and error but are unable to insert the second set of sticks within the completed stairway. At the third stage (6-7 years) children are able to form a stairway and to insert correctly new sticks within it. Piaget observed parallel stages in development of numeration.

Piaget's studies with Swiss children have aroused a lot of research in cross-cultural psychology. Some of these studies have been direct replications of Piaget's studies while some others have been done with some modifications. Such modifications include the use of mother tongue as a medium of testing, (Otaala 1970; Kiminyo 1973; Mureria 1974). However, replication studies of Piaget's work on conservation of number and seriation are limited. Some of the available experiments have been summarized in Sigel and Hooper (1968).

In Elkind's (Sigel & Hooper 1968) study subjects 4 to 6 years old were tested individually. The median age for each group was (a) 4 years 6 months (b) 5 years 7 months (c) 6 years 9 months. Each child was tested for discrimination, seriation and numeration of the materials. Elkind's findings are in agreement with Piaget's observation that significant differences exist between 4-, 5-, and 6 year old children in their ability to discriminate, seriate and numerate size differences. In the same study, Elkind's findings agree with Piaget's results with respect to

the relative difficulty of the three types of test whereby the scores are as follows: discrimination (mean = 11.6), seriation (mean = 8.7) and numeration (7.4).

In another study, Dodwell (1960, 1961) did an experiment on the relationship between the understanding of logic of classes and of cardinal number in children. His subjects were children aged from 5.2 - 6.8. Testing was done individually on class inclusion. The specific hypothesis investigated concerns the relations between the responses on class inclusion and the responses made on the number of concept. Dodwell predicted that some understanding of class composition is a necessary condition for dealing with numbers. Dodwell concludes that the pattern of intellectual development is neither as regular nor as simple as Piaget has suggested. Wohlwill (1959) also feels that the child's failure to form groups classify items implies that he cannot answer correctly questions related to number. This is in agreement with what Vygotsky, (1962) says about the child's ability to classify. He says that the young child starts off by putting together a number of objects in unorganized manner or heap so as to solve a problem an adult would solve by forming a new concept. The group is created at random and each object is added in mere guess or trial, it is replaced by another object when the guess is proven

wrong. This unorganized way of ordering objects agrees with Piaget's stage at the prelogical level which coincides with prenumerical period. In his own words Piaget says:

> "Our hypothesis is that the construction of number goes hand in hand with the development of logic and that prenumerical period corresponds to the prelogical level...logical and arithmetical operations therefore constitute a single system." Piaget 1952 p.vii).

Piaget (1952) argues that conceptualizing ability derives from internalization of the child's own action and stages in the development of particular conceptions reveal the sequence of internalisations.

These stages in conceptual development are evident in several of the investigations whereby older children perform better than younger children (Elkind in Sigel and Hooper, 1968 pp. 59-75; Piaget, 1952; Mureria, 1974; Kiminyo, 1973; Ngini, 1979). Ngini investigated children's comprehension of some mathematical concepts, classification, number and vocabulary and visual memory. In her study, the subjects were of age 4, 5 and 6 years old taken from high cost, medium and low cost schools. Her findings were that Nairobi children displayed poor knowledge of names of colours and shapes which was necessary in classification skills. She also found that ordinal numbers, writing numerals and conservation of number were some of the most difficult of the number concepts.

Conservation of Length:

In his theory of general intelligence, Piaget (1950) argues that the first spatial operations the child comes to understand involve primitive notions of proximity enclosure and boundary, which are entirely non-metric in character. Piaget makes a distinction between perceived and conceived space. He says that a young child may be able to distinguish perceptually between say, a square and a circle, without conceptualising the difference. In another study, Piaget et al (1948) designed a research on the children's understanding of additive operation involved in length measurement. The stimuli were two "roads" of match sticks. He found that the youngest children (aged 4-6 years) did not consider the lines the same length after rearrangement had taken place. They considered either the straight line to be longer because it extended beyond the other one or else they thought the "zig-zag" line longer because of the turns. Around ages 7 and 8 years, the line was known to be the same length irrespective of the rearrangement of its parts. In other words, conservation of length is acquired at this age. Similar findings occurred in some two other experiments (Piaget, 1946; Piaget et al, 1948). Here the subjects were aged 4-8 years and the experimenter moved a bead a certain distance along a wire and the subject was required to move another bead the same

distance along a second wire. Subjects aged 4-6 years moved their beads a position P^1 directly opposite the position P of the experimenter's bead, failing to account for the differing points of departure of the two beads. Piaget concludes that it is not until after age 7 years were the subjects able to measure adequately. He interpreted his findings to indicate that his youngest subjects identified length with 'final' position occupied. The errors made at this age reflect that the logical operations basic to measurement are not yet available. Piaget's other studies on the inception of measurement invited children to build with blocks, a tower equal in height to a tower already built by the Experimenter (E) (Piaget, 1953; and Piaget et al, 1948). However, the table on which the E's tower stood was higher than the table on which the subject's was to be build. The E's tower was also away from the table where the S was to build his. Sticks shorter, longer and equal to the height of the experimenter's model were available to the subjects. Piaget's results showed that the youngest children built up the second tower to the same visual level as the first, without worrying about the difference in height of the tables. They compared the towers by stepping back and sighting them. At a slightly more advanced stage, the child laid a long rod across the tops of the two towers to make sure that they are level. Later, the Ss

noticed that the base of his tower was not at the same level as the Experimenter's. In his own words, Piaget says that:

> "...the first measuring standard that occurs to the child is his own body. He puts one hand on top of his tower, and the other at its base, and then trying to keep his hands the same distance apart, he moves over to the other tower to compare it. ...the last discovery involves two new operations of logic, the first is the process of logic which permits the child to conceive that the whole is composed of a number of parts added together ...the second one enables him to apply one part upon others and thus to build a system of units. (Piaget 1953a pp.77-78).

Piaget's study of the conservation of length among Swiss children has triggered research in other societies by Lovell Healy and Rowland (in Sigel and Hooper 1968), Lovell et al (1962), Fraisse and Fautrey (1952a), Philip and Kelly (1974), and Vernon (1965).

Lovell Healy and Rowland replicated some of the experiments in Piaget (1960) on the conservation of length. The subjects in their study were 5-9 years old. Their study confirmed the main stages in the growth of certain geometrical concepts proposed by Piaget, Inhelder and Szemlinaka as follows:

Stage 1 : The length of a line is estimated by its end points.

Stage 2A: Judgement is modified by movement of fingers. The child reverts to original judgement on static inspection again.

Stage 2B: The child is aware of the intervals that lie between the end points.

Stage 3: The child recognizes that the sticks are and must be the same length.

In a similar study, Lovell et.al,(1962) extended the above experiment to include Educationally Sub-Normal (ESN) special school children. It was found that the 14 year olds in the ESN group were less able that the 13-year old group. While the ESN group tended to go through the same earlier stages as ordinary primary school children, the overall performance of the 14 to 15 year olds is about the same as that of an average 7 to 8 year old primary school child. It was concluded that few of the least able school educable children reach Piaget's stage of concrete operational thinking.

Fraisse and Vautrey's (1952a) study employed the paths traced by moving objects. Their objects were aged 4 years 6 months and 5 years 6 months. They found that the subjects who were told to indicate the starting position of the objects responded correctly more often than subjects whose response was not prefaced by this instruction. Fraisses and Vantrey found no evidence for finalism in young children's perception of length. The authors suggest that the errors typical of Piaget's youngest subjects reflect their failure to recall the

starting positions of the objects. Further, Piaget's methods of testing have been criticised because his questions have been labelled as too complex for the young child to understand. For example the use of words such as long or length is abstract for lines that might not necessarily be straight. Therefore vocabularly development may be a factor in many of Piaget's experiments.

Price (1967); Philip and Kelly (1974); Dowell (1973); Vernon (1965) and Mureria (1974) agree that conservations of length is achieved first among other tasks. Vernon compared (50) eleven year old West Indian boys with 100 boys of comparable age from South East England. West Indian boys did not perform as well as the English boys on the conservation of length. He attributed this difference in performance to lack of adequate experience including lack of constructive play and failure to develop verbal concepts. In Mureria's study mentioned earlier, conservation of length, among other tasks was investigated. Her findings were that the number of subjects conserving length rose significantly from lower to upper grades. Conservation of length by girls occurred at grade seven (mean age 13½) while boys showed evidence of conservation of length at grade five (mean age 12½). These results agree with what Okonji (1970) obtained with Banyankole children of Uganda.

Conservation of Mass

Piaget and Inhelder (1941) and Piaget (1952) have shown clearly that until the age of about six or seven, children believe that quantities change under transformation. Piaget and Inhelder stated that substance conservation is reached, on the average, around the age, 7-8 years. Piaget's theory is that concepts of quantity develop in three stages with the final stage earmarked by the discovery of conservation. Children at the first stage have only a general impression of quantity but are capable of judging crude weight, volume and mass differences. In the sausage experiment, they gave non-conservation responses because to their general impression, the sausage is different from the ball. In their explanations on the relative amounts of quantity in the sausage or in the ball, children judge quantity by single dimension, which they are unable to co-ordinate, one with the other. At the second stage, the children have a differentiated impression of quantity and are unable to judge quantity by more than one dimension, such as long-narrow, short- wide which Piaget calls "logical-multiplication." At the third stage children have an abstract quantity concept and judge quantity in unit terms. Their explanations indicate that the perceived transformation can be cancelled. In other words, the children

understand reversibility and therefore become conservers.

In studies mentioned earlier, Elkind (1961), Lovell and Ogilvie (1960), Philip and Kelly (1974), Flavell (1963), Wallach (1963), Kiminyo (1973) Mureria (1974), and Nyiti (Okatcha Ed. 1977), conservation of quantity was investigated among other tasks. It is not until about the age of 7 or 8 that children start to see invariance of quantity under transformation.

Elkind tested 175 children from 5 years 8 months to 11 years 9 months old on conservation of quantity. The subject was asked to predict then judge and explain his response. The results in this experiment agreed with Piaget's findings that there is a marked difference between the 5-6 year old and the 7-12 year old groups in favour of the older group.

The three stages in the development of the conservation of substance given by Piaget were confirmed by another study by Lovell and Ogilvie (1960). In their study, all the children in a junior school were tested along the lines illustrated by Piaget in an effort to establish the invariance of substances and the arguments used by the children to justify their answers.

Although conservation increases with school grade, time lag is reported among subjects of non-Western origin (Otaala, 1970; Nyiti in Okatcha Ed., 1977

pp. 39-58; Mureria 1974). Otaala tested children from Teso tribe on the conservation of mass. School children ranging from primary one to primary six were tested. Conservation increased with school grade but it was not yet complete at primary six i.e. children aged about 12 years. Otaala observes that his subject's progress is much slower than Piaget's theory would suggest. In his experiment with Meru children, Nyiti reports that the age 8-9 years at which the Meru subjects conserved mass was comparable to the Swiss children. But on the conservation of weight and volume, Meru children lagged behind Swiss children. Nyiti attributes this time lag to different experimental procedures particularly the interview method he used which was too rigorous as compared to other researchers. Nyiti further observed that lack of recorded age may lead to "time lag" whereby children may be seen as too old for non-conservers yet the age given to the experimenter may have been guessed according to seasons such as festivities, famines or floods. Kiminyo's study on the conservation of mass weight and volume among Kamba primary school children reveals significant differences in performance between the ages 7-8 and 9-12 age groups. Also perceptual explanations decreased with age. Mureria's study also revealed a time lag in conservation. In her study, the subjects were 120 primary school

children randomly taken from grades 1, 3 and 5 and 7. Thirty subjects come from each grade. She attributed the "lag" to lack of manipulative activities at home for the Kikuyu children. The rural Kikuyu child as opposed to the white or urban child has no access to toys or games that would foster conservation.

Schooling Effects

For Piaget, the environment plays a facilitating role by providing the necessary stimulation. There is a great emphasis on "inner organisation and mutual co-ordination of subjects schemata" (Smedslund, 1961a p.85). As described by Flavell (1963) Piaget's theory employs an adaptation model where the individual himself plays very active role which is expressed in his actions on the environment. As the child comes in contact with reality he assimilates the information and by making the necessary adjustments is able to accommodate this new knowledge. In Piaget's words, "... the organization of space objects and other fundaments of human experience are not given at the outset but are constructed in the course of complex and interesting evolutions... (in Flavell 1963 p. 263). It is implied therefore that a non-restrictive environment will enhance conceptual development while a restricting environment will hinder conceptual development.

As an answer to the question whether or not conservation can be induced in the child, Piaget (1952)

holds that for conservation to appear, the child must be able to perform the following operation - multiple classification, multiple relationality, atomism, reversibility and seriation. Atomism is the theory which holds that things can be broken into the various parts that constitute the whole. This implies that if the schooling procedures embody these prerequisites conservation can be induced. However investigators dealing with acceleration of conservation have reported negative results, (Wohlwill, 1960; Wohlwill and Lowe, 1962; and Beilin and Franklin, 1962). Contradictory results have been given by other researchers regarding the effects of schooling on conservation. For example Greenfield (1966) Lloyd (1971), Prince (1968) have reported direct relationship between schooling and conservation while, on the contrary, Goodnow (1962); Goodnow and Bethon (1966); Kelly (1971); Sylvia (in Dasen 1972) and Mermelstein and Shulman (1967), and Kiminyo (1973) have reported lack of relationship between schooling and conservation of concepts. In support of experiental factors regarding Greenfield suggests that "without school intellectual development defined as any qualitative change ceases shortly after age nine" Greenfield (1966 p.234). To her, it would appear that technologies and skills absorbed from the school experiences may indeed strongly affect the question of whether some children in Senegal and perhaps

elsewhere even achieve the conservation of continuous quantity.

Kelly (1971) compared children in terms of schooling which amounted to 0, 1, 4 or 6 years. The total group of 432 was divided into two samples of 216 schooled, 216 unschooled. They were tested for conservation of length and quantity. Kelly reported no significant difference between the performance of the schooled and the unschooled children. However Philip and Kelly (1974) repeated Kelly's research and reported contradictory results. They found that those children who had been to school performed at a level superior to those in the village. They also argued that schooling makes a considerable difference to age of achievement and this difference is accentuated if schooling is in the child's vernacular or alternatively in the language of the culture in which he is living (p.238). Their results have been disputed, however, for lack of statistical proof. Philip and Kelly's findings were supported by Rawlinson (1974).

Rawlinson's study compared children from Southern Highlands in Papua New Guinea in grades 3, 4, 5 and 6 with a sample of Tasmanian children at the same school level. She reported a significant effect over grades for Papua New Guinea children but not for Tasmanian children. She concluded that conservation in Tasmania appears to be the result of supportive environment with minimal influence from formal schooling.

In New Guinea, it appears that conservation is mainly a result of formal schooling but it is handicapped greatly by non-supportive cultural environment (p.39). She reported significant correlation between conservation and schooling but not necessarily a causal relationship.

In a similar study, Kelly and Philip (1975) tested the relative effects of schooling and language on conservation. He used two criteria in his testing method, whereby some subjects gave answers with or without explanation. They found that the proportion of subjects meeting the more rigorous criteria declined according to both schooling and language from school children tested in English (82%), school children tested in Melpa (72%) and village children tested in Melpa (50%). This difference was reported as significant. They found that the difference between those able to state a reason and those unable to do so was greatest among the village sample which probably reflects a combination of language difficulty and educational deficiency. They also argued that schooling would help performance to the extent that it provides a wider conceptual framework. Further, the mother-tongue that was used for testing, Melpa, poses great difficulties in explaining reversibility activity.

Owock's (1973) study with Nigeria's subjects supports Kelly and Philip's findings on the effects

of schooling on conservation. His subjects came from three different cultural linguistic groups, Ejiks, Hausas and Yoruba, in widely separated areas of Nigeria. The following four contrasts were made by the investigator; schooling versus non-schooling, urban versus rural and the four age groups of 6-7 years, 8-9 years, 10-13 years, and over 18 years. His findings were that conservation attainment was related to age. There was no significant difference in performance between urban and rural children. There was significant difference on conservation of quantity between the schooled and the unschooled in favour of the former group.

Goodnow and Bethon dealt with U.S. school children selected to allow a close matching for either M.A. or C.A. and cover a wide range of IQ. This data was combined with data of schooled and unschooled children in Hong Kong. The results showed that lack of schooling does not upset the conservation of weight, volume or surface but does upset the tas of combinatorial thinking.

Contrary to above findings Kiminyo (1973) found no significant differences in performance between schooling and non-schooling. Mermelstein's study produced results similar to those by Kiminyo.

Training on conservation tasks has shown that conservation can be inculcated at an earlier age

than Piagetian findings have shown (Pinard et. al, 1969, Lister, 1968; Fischbein, 1970; and Wallach et. al, 1967). Pinard et al argue that training on the conservation of some tasks have positive effects on conceptual development. Three groups of 16 subjects (rural schooled and rural unschooled Rwandese and urban schooled French-Canadian children) were selected. These groups had been classified as preoperational on a pretest including eight tests of conservation. Among other tasks was training on conservation of liquid quantities by a method based on the anticipation of levels and compensation of dimensions. It was found that the performance of all the three groups when compared with comparable control groups was significantly higher on two successive post-tests (two months interval).

Cultural Environment

Price-Williams (1961), Vernon (1969), Otaala (1972) and Poole (1968) have emphasised the importance of the environment in the development of conservation concepts. These environmental influences and experiences include the societal values particularly the biases the culture may have concerning the upbringing of boys and girls. In some societies, for example, certain plays are regarded as purely for boys while girls are discouraged from participating in such plays. As a result the motivation of the girls during tests on conservation tasks may be much

lower than that of boys and consequently their poorer (lower scores) performance.

In Price-Williams study, five groups of nine illiterate West African children of the Tiv tribe were tested on conservation of continuous and discontinuous quantities. The five groups ranged from 5-8 years old. Results indicated that the progression of the idea of conservation followed that found by Piaget among European and other western children by previous investigators. Also conservation came at approximately the same time as it occurred among Western children. Price-William's study indicates that Tiv culture promotes active manipulative approach to the physical world. About the subjects, Williams says:

> "these children did spontaneously perform the operation themselves... Furthermore they would reverse the sequence of operation for example pouring back the earth from the second container to the first."
>
> (Price Williams 1961, p. 302)

Vernon's study (1969) among Baganda tribe in Uganda supports Price-Williams findings. Vernon concludes that the lack of manipulative activity hinders conservation. In another investigation applied to four cultural groups, Jamaicans, Ugandans, Eskimos and Canadian Indians, Vernon found that Ugandan boys in common with other African groups are lowest on a test of recognition of perspective of the third dimension in drawing. He argues that the young

African child is particularly deprived of experience that underlies the visualkinesthetic schemata, the manipulation of objects and toys (p. 490). Otaala (1970) supports the idea of active role of manipulation of objects. He says that environmental and experiential factors may have influenced the performance of the children.

Urban subjects have been declared to be superior performers in some of the conservation tasks (Kiminyo, 1973; Sylvia in Dasen Ed., 1972; and Poole, 1968) when compared with a sample of rural children of comparable age and education. However the criteria for defining urban and rural environment have been criticized particularly where the urban setting is small. In Kiminyo's study, the rural subjects performed just as well as the urban children in the conservation of mass and weight but lagged behind the urban children in the conservation of volume. In Northern Nigeria, Poole made comparisons in concept attainment by drawing eight samples from eight schools, three of which were located in a city, three in isolated rural areas and two from large mainland market villages intermediate between these extremes. All the subjects were 10-11 year old children of Hausa tribe. The results confirmed the superiority of urban children over rural children in concept attainment. Some of the tasks used included measures of time and space, prediction of

spatial relationships and conservation of liquids and solids.

Sylvia's investigations among Thai children revealed that urban children compared favourably with Swiss children while the rural sample showed same time lag or slower rate of cognitive development. Her subjects were (50) children from capital city of Bangkok and children from rural district of Bang Pa In. The tasks were class inclusion using animals (Inhelder and Piaget 1964), class inclusion using flowers (Piaget 1952), conservation of length (two sticks) and conservation of length (several sticks), (Piaget et al 1960), conservation of liquid (Piaget 1952). In both groups the three stages of conceptual development of Piaget's theory were evident.

Sex differences:

Goldschmidt (1967), Otaala (1970), Mureria (1974) and Kiminyo (1973) have also been interested in the presence or absence of differences that may occur between the performance of boys and girls in conservation tasks. Their findings show that boys perform better than girls in conservation tasks. In Goldschmidt's study, the subjects were 6 and 7 years old. His results showed that older boys performed better than girls of the same age in tasks including length. Goldschmidt argues that the superior performance of the boys as compared to the girls'

is attributable to the play activities of the boys which give them opportunity to perceive objects under different transformations. Ottala's study was with Iteso primary school children and the results showed a significant difference in performance between boys and girls.

Contradictory findings on sex differences are reported by Fogelman (1970) and Klein (1973). Fogelman's study involved active and passive methods of testing of six and seven year old English subjects. In the active situation the subjects manipulated the materials while in the passive situations the subject only observed the experimenter manipulate the materials. On the whole the girls performed better than the boys and the former excelled in the passive conditions of testing while the latter excelled in the active conditions of testing. He explains the boys superior performance under active conditions by saying that they are encouraged at home to manipulate and think about objects in their play.

SUMMARY

Replication studies on Piagets theory of cognitive development do not give a conclusive report concerning the intellectual development of children of all cultures. Investigators such as Elkind (1961), Lovell and Ogilvie (1960), Kiminyo (1973), Mureria

(1974), Lovell et al (Sagel and Hooper 1968) Goodnow (1962), Goodnow and Bethon (1966), Greenfield (1966) have all reported supportive evidence of Piaget's theory regarding the age related stages in conservation where older children perform better than younger children. On the contrary, Dodwell (1960, 1961) suggests that the pattern of intellectual development is neither as regular nor as simple as Piaget puts it.

With regard to the specific age at which a child conserves, investigators have reported a time lag among non-western subjects (Mureria, 1974; Nyiti in Okatcha Ed., 1977; Kiminyo, 1973, Otaala, 1970; Sylvia in Dasen Ed. 1972). Discrepancies in findings have been attributed to the lack of recorded ages of the subjects, the different cultural settings, social values and biases as well as the attitudes the children may have on the testing procedures. The motivation state of the subject is also very important in the testing procedure. The language used for testing is also very important in determining conservers and non-conservers. For example Ngini's research (1979) could probably have yielded different results if she had tested the subjects in vernacular (mother tongue) instead of using English.

Sex differences have been a contributing factor. In general boys have been seen as better performers than the girls due to the former being encouraged to play certain games that give them an enquiring mind,

while the girls help with household chores.

As literature review shows, only few studies have been carried out among pre-primary school children in non-western societies. Ngini's study, for example, dealt with pre-primary school children while Otaala, Kiminyo, Mureria and Nyiti all dealt with primary and post-primary school children.

Therefore, more investigation of the development of conservation concepts among pre-primary school children is necessary to enable educationists to develop an appropriate curriculum for their education. In this study, the author lives in Nairobi and is conversant with the kind of lifestyles that these people lead. The researcher is proficient in the language of testing which is her mothertongue. This study will attempt to get information on the conservation of number, length, mass and seriation among pre-primary Kikuyu school children 4, 5 and 6 year old attending school in various parts of Nairobi.

HYPOTHESES

(1) It is expected that there will be significant differences in the performance on the conservation of number, length, mass and seriation tasks between the 4, 5, and 6 years old children.

(2) It is expected that boys will perform better than girls in the conservation of number, length, mass and seriation tasks.

(3) It is expected that children attending Higher cost schools will perform better than those attending low cost schools in the conservation of number, length, mass and seriation tasks.

CHAPTER III

PROCEDURE

Description of the Sample

In this study, the subjects were 90 boys and 90 girls all of age group 4-6 years old. These children were attending day nursery schools in various parts of Nairobi. Table 1 shows the mean age of the children.

Table 1

Group	BOYS	GIRLS
3	4 years 2 months	4 years 2 months
2	4 years 10 months	4 years 11 months
1	5 years 9 months	5 years 11 months

The types of schools attended were categorized either as high cost schools (HCS) or low cost schools (LCS) based on the following criteria:-

(1) The amount of money paid per month. If the parent paid over six hundred shillings per term, per child, this school was then regarded as high cost.

In the HCS the teachers had qualifications of up to Ordinary Level of education and above. In one HCS two teachers had diplomas in primary school education. They reflected great ability in their

work. They had created a lot of teaching materials which were displayed on some shelves in the rooms.

In the LCS, the teachers had qualifications of up to Certificate of Primary Education. Efforts to get more information on the specific qualifications was fruitless. They however seemed to lack confidence during my presence in their schools.

(2) The time spent at school. A full-day nursery school costs a little more than a half-day nursery because of the lunch offered as well as the extra attention the children get in the afternoon sessions.

(3) The location of the school was also a distinguishing factor. For example the low cost schools were found in the outskirts of Nairobi while the high cost schools were much closer to the city centre.

The LCS were characterized by lack of resources for teaching such as visual aids and at the time of this study, rote memorization was evident. The

classroom was characterized by overcrowding. There were no desks except long benches on which the children squeezed. The blackboard was shared by the two groups in the same room. Consequently there was a lot of distraction in the room. This room had 85 children, the older ones with their teacher on one side and the younger ones on the other. The children in these schools lacked confidence. They took a longer time than the children in HCS to give a response during the interview. In one of the LCS the fees were sh. 50 per term and sh. 150 per term in the other one.

On the other hand the HCS had a lot of teaching aids, a lot of charts on the walls and toys to manipulate. There were fewer children per class, about twenty children in each and it was therefore easier for the teacher to interact with each child. It was also easier to have access to the toys and the other playthings. In these schools children looked more confident with themselves. They gave responses more readily even when they were wrong. These children seemed more free with their teachers as opposed to the children in the LCS.

The school fees were Ksh. 600 per term in one school and Ksh. 1,500 per term in the other one.

Description of the Population

Subjects from LCS were drawn from a population that is predominantly occupied with subsistence farming. These peasant farmers grow crops for home consumption and cannot therefore raise a lot of money to send their children to higher cost schools in the city. Those who did other things apart from cultivating included vegetable vendors in the city. These are mainly the women hawkers seen in the streets of Nairobi City. The fathers included those working on low paid jobs here in Nairobi. In one school the children were actually housed in the premises of the Veterinary Laboratories and a good number of the children came from the housing estate. The other children came from the neighbouring Kabete area which is very similar to the K.I.A. area. The inhabitants around the schools have similar occupations. The children here came to school on foot unescorted by older people.

Subjects from HCS came from medium and high income parents. They lived much closer to the city centre. These children are escorted to their respective schools either by car or by bus.

Apparatus

Task One - Number Conservation

Eight sweets of the same size but different colours. Positions for placing the sweets were

marked by small dots on a sheet of white paper 10" x 10". These sweets were placed two inches from each other in two rows with four sweets each. These apparatus were to be used to find out if the child conserves number.

Task Two - Length Conservation

There were six sticks two of which were the same length. Their lengths were 10 cm., 10.5 cm., 11 cm., 11.5 cm., and 12 cm.

Task Three - Mass Conservation

Some ball-shaped pieces of plasticine, all of different colours and two of them were equal. These were used to test for conservation of mass.

Task Four - Seriation

Five sticks lengths were used for this task. Their lengths were 10 cm., 10.5 cm., 11 cm., 11.5 cm., 12 cm.

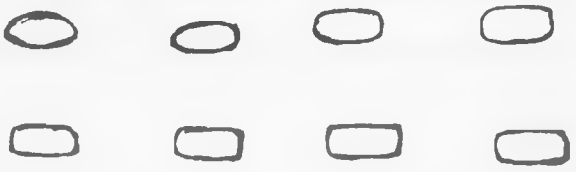
Procedure

Conservation of Number

The eight sweets were placed on the sheet of white paper at the positions marked earlier. The sweets in the two rows were placed such that they were in a one-to-one correspondence. The child was asked if the number of sweets in one row was the same as the sweets in the other row. When a positive response was given, the experimenter put

one row of the sweets closer together and asked the subjects if there were still the same number of sweets in both rows. The subject's response was then followed by the question why.

The criterion for conservation was that the child responds that the two rows have still the same number of sweets and that in his response, the subject gives evidence of reversibility, that is, they can be put back the way they were or identity whereby the subject responds that none have been added or taken away or compensation where the subject responds that as one row gets longer, it also gets more spread out. In most of what the author classified as conservation response, the children gave the response ... "they are four" ...



One-to-one correspondence

After transformation

Conservation of length

From the sticks, the subject was asked to pick the two that were equal in length. If the subject had difficulty in this multiple discrimination, the experimenter prompted by pointing to two sticks (unequal in length) and asked about their length. Eventually he took the two equal sticks and asked the subject about their length. This ensured that before the experiment started, the subject understood what the experimenter was looking for. The experimenter then placed the two sticks upright and side by side on the table to enable the subject to confirm their equality before placing them in the inverted Oppel-T-illusion. The subject was then asked if the sticks were still the same length. The conserver was the subject who said that the sticks were still the same length and gave identity or reversibility as a reason.

Conservation of Mass

From the six pieces of ball-shaped plasticine, the subject was asked to pick two which were the same size. If the child was unable to discriminate, he was prompted by the experimenter by being shown balls not equal and asked about their size. Eventually the two equal balls were shown to the subject. Having established equality of the two balls, the experimenter rolled one of them to a sausage shape and then asked

the subject if the two shapes were still the same size and why. The conserver was the person who gave an identity, or reversibility or compensation explanation.

Seriation

The subject was presented with five sticks of differing length. The experimenter constructed a model which was called a staircase. The child was asked to demonstrate to the experimenter how one would climb from the lowest "stair" to the highest one. Having done that the subject was warned that he would be given the five sticks to construct a similar model of a stair case. The subject was given the five sticks and then given some time to finish the construction.

Scoring

Non-Conservers

The subjects who insisted that transformation or deformation of items created inequality in number, length and mass tasks. Here the subject scored a single mark (1) for being misled by perceptual cues. A subject who could not construct a stair case was also given a score of 1 mark.

Transition Stage

A subject who said that the items were still equal after the transformation but could not give a

justification answer scored two (2) marks.

Conservers

A subject who said that the items were still equal after transformation and gave a justification answer scored three (3) marks. A subject who had constructed the staircase correctly scored 3 marks.

CHAPTER IV

RESULTS AND ANALYSIS OF DATA

The data were collected in the field and analysed using Analysis of Variance as well as t-tests to find out if there were any differences in the performance on the number, length, mass and seriation tasks between HCS and LCS. These tests were carried out with respect to the hypotheses regarding the effects of age, sex and the type of school attended on the subjects' performance.

Age:

It was earlier hypothesised that older subjects would perform better than younger subjects at all the tasks.

Table 2: Number conservation showing conservers (C) non-conservers (NC) and transition (T) stage for LCS boys.

Table 2

Group	C	T	NC	Total
1	7	5	3	15
2	0	2	13	15
3	0	2	13	15
T	7	9	29	45

It was however evident that the six year old boys performed better at the number task than younger boys. The observed t = 4.48 as compared to .05 df 28 = 2.048 was significant. The five year old subjects got similar scores as those got by the four year old subjects.

Table 3: Number conservation showing conservers (C), non-conservers (NC) and Transition (T) stage for LCS girls.

Table 3

Group	C	T	NC	Total
1	6	3	6	15
2	0	7	8	15
3	0	1	14	15
T	6	11	28	45

Table 4 showing analysis of Variance for number conservation for LCS girls.

Table 4

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Means	5.6444	2	2.8222	6.0484* $F_{0.05}^{(2,42)}=3.2$
Within Samples or Error	19.600	42	0.4666	
Total	25.244	44	*Significant F was obser	

From the observed F = 6.0484 ratio, (above) it is concluded that older girls perform better than younger girls at the task on number conservation.

Table 5: Number conservation showing the conservers (C), non-conservers (NC) and transition (T) stage for HCS boys.

Table 5

Group	C	T	NC	Total
1	9	3	3	15
2	0	5	10	15
3	0	3	12	15
Total	9	11	25	45

Table 6 showing analysis of variance for number conservation for boys attending HCS.

Table 6

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Means	4.1333	2	2.0666	4.1208* $F_{0.05}^{(2,42)}=3.23$
Within Sample or Error	21.0666	42	0.5015	

* Significant F was observed.

From the observed F=4.1208, it is concluded that older boys attending HCS perform better at the number task than younger children attending the same type of school.

Table 7: Conservation of number showing conservers (C), Non-conservers (NC) and transition (T) stage for HCS girls.

Table 7

Group	C	T	NC	Total
1	8	3	4	15
2	0	2	13	15
3	0	0	15	15
Total	8	5	32	45

Table 8 showing analysis of variance for Number Conservation for girls attending HCS.

Table 8

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Means	5.200	2	2.6	F=6.5* $F_{0.05}^{(2,42)}=3.23$
Within Sample or Error	16.800	42	0.4000	

*Significant F was observed.

From the observed F=6.5, it is concluded that older girls attending HCS perform better at the number task than younger girls.

Performance at the number task improves with age for all the groups. Using the 75% criterion however, it can be said that conservation does not

Table 9: Conservation of length showing conservers (C) non-conservers (NC) and Transition (T) stage for boys in LCS.

Table 9

Group	C	T	NC	Total
1	0	12	3	15
2	0	4	11	15
3	0	1	14	15
Total	0	17	28	45

Table 10 showing analysis of variance for conservation of length for boys attending LCS.

Table 10

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Means	4.3111	2	2.1555	14.4471* $F_{0.05}(2,42)=3.23$
Within Sample or Error	6.2666	42	0.1492	
	10.5777	44		

*Significant F was observed.

From the observed F=14.4471, it is concluded that older boys attending LCS perform better than younger boys at the length task.

Table 11: Conservation of length showing conservers (C) non-conservers (NC) and transition (T) stage for girls in LCS.

Table 11

Group	C	T	NC	Total
1	0	5	10	15
2	0	2	13	15
3	0	1	14	15
Total	0	8	37	45

Table 12 showing analysis of variance for length conservation for girls attending LCS.

Table 12

Source of Variation	Sum of Squares	df	Mean Square	F Ratio
Between Means	0.5777	2	0.2888	F=2.0224* $F_{0.05}^{(2,42)}=3.23$
Within sample or Error	6	42	0.1428	
Total	6.57777	44		

*Not significant.

From the observed F=2.0224, it is concluded that there is no significant difference in performance between older and younger girls at the conservation of length for girls attending LCS.

Table 13 for conservation of length showing conservers (C), non-conservers (NC) and transition (T) stage for boys attending HCS.

Table 13

Group	C	T	NC	Total
1	0	5	10	15
2	0	4	11	15
3	0	3	12	15

Table 14 showing analysis of variance for length conservation for boys attending HCS.

Table 14

Source of Variation	Sum of Squares	df	ean Square	F Ratio
Between Groups	0.1333	2	0.0666	0.3228 $F_{0.05}^{(2,42)}=3.23$
Within Sample	8.6666	42	0.2063	
Total		44		

Observed F=0.3228 is not significant.

There is no significant difference in performance at the length conservation between older and younger boys attending HCS.

Table 15: Conservation of length showing conservers (C) non-conservers (NC) and girls in transition (T) stage attending HCS.

Table 15

Group	C	T	NC	Total
1	0	5	10	15
2	0	3	12	15
3	0	1	14	15
Total	0	9	36	45

Table 16 showing analysis of variance for length conservation for girls attending HCS.

Table 16

Source of Variation	Sum of Squares	df	Mean Square	F Ratio
Between Means	0.5333	2	0.2666	1.6799* $F_{0.05}(2,42)=3.23$
Within Samples	6.6666	42	0.1587	
Total		43		

*Observed F=1.6799 is not significant.

Therefore there is no significant difference in performance at length conservation between older and younger girls attending the HCS.

Using the 75% criterion, it is seen that length conservation is not acquired by age six.

Table 17 for conservation of mass showing conservers (C) non-conservers (NC), and boys in transition (T) stage attending LCS.

Table 17

Group	C	T	NC	Total
1	0	2	13	15
2	0	1	14	15
3	0	0	15	15

Table 18 showing analysis of variance for conservation of mass for boys attending LCS.

Table 18

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Groups	0.1333	2	0.0666	1.05* $F_{0.05}(2,42)=3.23$
Within Samples	2.6666	42	0.0634	
Total	2.800	44		

*Observed F=1.05 is not significant.

Therefore there is no significant difference in the performance between older and younger boys attending LCS at conservation of mass. There is poor performance at this task.

Table 19 for Conservation of Mass showing conservers (C), non-conservers (NC) and girls in the transition (T) stage attending LCS.

Table 19

Group	C	T	NC	Total
1	0	2	13	15
2	0	0	15	15
3	0	0	15	15
Total	0	2	43	45

The t-test was performed on the above data and the observed t was t = 1.4680 which was not significant as compared to $t_{0.05}$ df = 2.048.

Therefore, for Mass Conservation, there is no significant difference in performance between the older and the younger girls. There is in general very poor performance at this task.

Table 20 for mass showing conservers (C), non-conservers (NC), and transition (T) stage boys in HCS

Table 20

Group	C	T	NC	Total
1	0	2	13	15
2	0	0	15	15
3	0	0	15	15
Total	0	2	43	45

The t-test was carried out on the data above and observed $t = 0.7345$ as compared to $t_{0.05}$ df 28 = 2.048 was not significant.

Therefore there is no difference in the performance of older and younger boys attending HCS at conservation of mass.

Table 21 for mass conservation showing conservers (C), non-conservers (NC) and girls in the transition (T) stage in HCS.

Table 21

Group	C	T	NC	Total
1	0	3	12	15
2	0	3	12	15
3	0	0	15	15
Total	0	6	39	45

t-test was carried out for the data on conservation of mass for the girls attending HCS. Observed $t = 1.8708$ as compared to $t_{0.05}$ df 28 = 2.048 was not significant.

Therefore there is no difference in the performance of older and younger girls at the conservation of mass.

Using the 75% criterion, conservation of mass is not acquired by age six.

Table 22: The seriation task showing boys able (A) and unable (U) to construct a staircase for LCS.

Table 22

Group	A	U	Total
1	4	11	15
2	1	14	15
3	1	14	15
Total	6	39	45

The t-test was performed on this data and observed t = 2.9498 as compared to $t_{0.05}$ df 28 = 2.048 was not significant.

Older boys performed better than younger boys at the seriation task.

Table 23: Seriation task showing girls Able (A) and girls unable (U) to construct the staircase.for LCS.

Table 23

Group	A	U	Total
1	3	12	15
2	2	13	15
3	0	15	15

Table 24: Analysis of variance for seriation task for girls attending LCS.

Table 24

Source of Variation	Sum of Squares	df	Mean Square	F Ratio
Between Means	0.3111	2	1.1555	1.5802 $F_{0.05}^{(2,42)}=3.23$
Within Sample	4.1333	42	0.0984	
Total		44		

Observed F = 1.5802 is not significant.

Therefore there is no significant difference in the performance at seriation task between younger and older girls attending LCS.

Table 25 for seriation task showing boys able (A) and unable (U) to construct the "staircase" attending HCS.

Table 25

Group	A	U	Total
1	9	6	15
2	3	12	15
3	1	14	15
Total	13	32	45

Table 26 showing analysis of variance for seriation task for boys attending HCS.

Table 26

Source of Variation	Sum of Squares	df	Mean Square	F Ratio
Between Means	2.3111	2	1.5555	9.4273* $F_{0.05}^{(2,42)}=3.23$
Within Sample	6.9333	42	0.1650	
Total	9.2444	44		

*Observed F = 9.4273

Therefore there is significant difference between the performance of older and younger boys attending HCS at Seriation task.

Table 27 for seriation task showing girls able (A) and girls unable (U) to construct the staircase attending HCS.

Table 27

Group	A	U	Total
1	7	8	15
2	3	12	15
3	1	14	15
Total	11	34	45

Table 28 showing analysis of variance for seriation task for girls attending HCS.

Table 28

Source of Variance	Sum of Squares	df	Mean Square	F Ratio
Between Means	1.24444	2	0.6222	3.6972* $F_{0.05}(2,42)=3.23$
Within Sample	7.0666	42	0.1682	
Total	8.3111	44		

*Observed F = 3.6972 was significant.

Therefore older girls perform better at Seriation task than younger girls attending HCS.

Using the 75% criterion, seriation is not acquired by age six.

Sex

Comparisons were made between the performance of the boys and of the girls in number, length, mass conservation and seriation tasks.

Table 29 showing conservers (C), non-conservers (NC), and subjects in transition (T) stage in number conservation.

Table 29

Sex	C	T	NC	Total
Boys	16	20	54	90
Girls	14	16	60	90
Total	30	36	114	180

Observed t = 0.7798 as compared to $t_{0.05}$ df 178 = 1.96 was not significant.

Therefore there is no significant difference between the performance of boys and girls at number task.

Table 30 showing conservers (C), non-conservers (NC) and subjects in Transition (T) stage in length conservation.

Table 30

Sex	C	T	NC	Total
Boys	0	29	61	90
Girls	0	17	73	90
Total	0	46	134	180

Observed t = 2.0650 as compared to $t_{0.05}$ df 178 = 1.96 was significant. Boys did better than girls at length task.

Table 31 showing conservers (C), non-conservers (NC) and subjects in transition (T) stage in mass conservation.

Table 31

Sex	C	T	NC	Total
Boys	0	5	85	90
Girls	0	8	82	90
Total	0	13	167	180

Observed t = 0.8604 as compared to $t_{0.05}$ df 178 = 1.96 was not significant.

Therefore there was no difference in the performance between boys and girls at mass conservation.

Table 32 showing Avle (A) and Unable (U) subjects at seriation task.

Table 32

Sex	A	U	Total
Boys	19	71	90
Girls	16	74	90
Total	35	145	180

Observed t = 1.1266 as compared to $t_{0.05}$ df 178 = 1.96 was not significant. Therefore there were no differences in the performance between boys and girls.

Type of School

Comparisons were made of the performances on the basis of the types of school attended highcost vs lowcost.

Table 33 shows the number of conservers (C) non conservers (NC) and subjects in the transition (T) stage in number conservation with respect to the type of school attended.

Table 33

Type of School	C	T	NC	Total
High Cost (HCS)	17	16	57	90
Low Cost (LCS)	13	20	57	90
Total	30	36	114	180

Observed t = 0.3887 as compared to $t_{0.05}$ df = 128 = 1.96 was not significant. The point biserial correlation coefficient between HCS and LCS was not significant.

Therefore there was no difference in the performance between the subjects attending HCS and those attending LCS in number conservation.

Table 34 showing conservers (C), non-conservers (NC) and subjects in the transition (T) stage in length conservation on the basis of school attended.

Table 34

Type of School	C	T	NC	Total
High Cost (HCS)	0	25	65	90
Low Cost (LCS)	0	21	69	90
Total	0	46	134	180

Observed t = 0.6799 as compared to $t_{0.05}$ df 178 = 1.96 was not significant. The point biserial correlation coefficient between the type of school attended and length conservation was not significant.

Therefore there was no difference in the performance between subjects attending HCS and those attending LCS in length conservation.

Table 35 showing the number of conservers (C) non-conservers (NC) and subjects in transition (T) stage in mass conservation with respect to type of school attended.

Table 35

Type of School	C	T	NC	Total
HCS	0	8	82	90
LCS	0	5	85	90
Total	0	13	167	180

Observed t = 0.8604 as compared to $t_{0.05}$ df 178 = 2.048 was not significant. The point biserial correlation coefficient between the type of school attended and mass conservation was not significant.

Therefore there was no difference in performance between subjects attending HCS and LCS in mass conservation.

Table 36 showing the number of subjects able (A) and unable (U) to construct the staircase in seriation task with respect to type of school attended.

Table 36

Type of School	A	U	Total
HCS	24	66	90
LCS	11	79	90
Total	35	145	180

Observed t = 2.4762 as compared to $t_{0.05}$ df 178 = 2.048 was significant. The point biserial correlation coefficient between the type of school attended and seriation task was significant.

Therefore the subject attending High Cost Schools perform better than subjects attending Low Cost Schools in seriation.

CHAPTER V

DISCUSSION AND SOME EDUCATIONAL IMPLICATIONS

Age Effects on Conservation

In this study, the subjects were grouped with respect to age and sex and the following were the means of their age:

Group 1: boys 4 years 2 months, girls 4 years 2 mo

Group 2: boys 4 years 10 months, girls 4 years 11 m

The difference in age between group 1 and 2 as observed from the means above is barely a few months and this may be one of the reasons why there are no significant differences in performance at some of the tasks.

As was predicted earlier, the analysis of variance and t-test results show that age is an important factor in performance in conservation tasks. The results of this study agree with the findings of Piaget (1952), Elkind (in Sigel and Hooper, 1968), Dodwell (1960, 1961), Kiminyo (1973), and Mureria (1974) that older children perform significantly better than younger children at conservation task. In number conservation in particular, the subjects in the oldest group performed at a level superior to the other subjects. For boys attending low cost schools the observed t was significant at 0.05 level. The observed F=6.0484 ratio for number conservation for girls attending HCS the observed F ratio were F=4.1208

and F=6.5 respectively and these were significant at 0.05 level.

The older subjects were able to give more conservation justification responses than the younger subjects. They were able to do so probably because they had learned to associate number to an item. The most frequent conservation justification response was "ni inya" (they are four). With the younger subjects, there were problems in trying to associate a number to an item. Several subjects attempted to count when asked whether sweets in row two are the same as sweets in row one. In this process of counting, they skipped or double counted sweets which reflected previous rote memorization in a counting exercise. In agreement with Piaget (1952) findings, the non-conserving subjects saw the more spread out row as containing more sweets than the row with sweets close together. Logic has not yet developed at this early age of intellectual development ..." the child's thinking is dominated by fixation upon one aspect of changing relationship to the exclusion of other aspects ... (Richmond 1970 p. 27). Using Piaget's 75% criterion, number conservation was not mastered by age six.

In cases where the F ratio or t-tests were not significant, the general trend was that the older group had more subjects in the transition stage than younger subjects. The task on length conservation

was in general poorly performed. The horizontal stick during the T-inverted illusion, was seen as shorter than the vertical one. There was only one case of significant difference in performance between older and younger boys attending LCS. Probably the older boys had greater experience of observing objects from different perspectives during play. The findings of this study agree with Mureria's (1974) and Okonji's (1970) results in which there was significant increase in conservation of length with respect to age. Using Piaget's 75% criterion, length was not conserved by age six.

For mass conservation, there was poor performance generally. There was no significant difference between the performance of the older group and the younger groups. Mass conservation seemed to be more difficult than number, length, and seriation tasks, which agrees with the findings of Price (1967, 1968), Philip and Kelly (1974), Dodwell (1973) and Vernon (1965). All these investigators found mass conservation to be the most difficult concept to be mastered among the named tasks. In agreement with Piaget's (1952) findings, subjects failed to attend to more than one aspect of an object simulteneously. He argued that children below age seven have not developed "logical multiplication". The subjects therefore either attended to length or thickness at a time without the ability to reason that as an

object gets longer it also gets thinner or as the ball remains relatively shorter, it remains thick. The results on mass conservation reflect that logical thinking has not developed by age six and therefore perceptual cues dominate the child's thinking as Philip and Kelly (1974), Flavell (1963), Ogilvie (1960) Kiminyo, (1973), and Mureria 1974) found. Therefore, the hypothesis that older subjects would perform better than younger subjects was not supported for mass conservation.

In seriation task, there was significant difference in the performance of older subjects as compared to younger subjects in both types of schools. The results of this study agree with Piaget's (1952) and Elkind's (in Sigel and Hooper 1968) results that older subjects discriminate and seriate size differences better than younger subjects. In cases where the F ratio and t-tests did not reach significant level, the trend was that the number of subjects able to seriate in the older group were more than those in the younger group. Subjects attending HCS may have been favoured by the presence of play equipment at school such as toy slabs of different sizes to construct structures such as pyramid whereby the slab at the bottom is the largest while the top one is the smallest. This type of experience may enable the subject to perform well. The availability of staircases both at home and school may also promote

thinking in terms of series. In other words the child is exposed to ordered things such as staircases which are made up of increasing or decreasing heights which may facilitate the child's achievement of seriation concept. The inability to construct the staircase however reflected the child's short memory of what the Experimenter's model looked like.

In most of the justification responses given, there was a language handicap in expressing oneself as had been suggested by Vernon (1965). He argued that the West Indian boys in his study did not perform as well as the English boys due to lack of well developed verbal concepts. In this study the children are too young to have developed verbal concepts to explain their responses. Furthermore in Kikuyu culture, there is no insistence that one explains what one believes. For example when a child says something at home and it is followed up by the question why, the child would get away with it even if he said there's no reason "ti kindu."

The hypothesis that older children would perform better than younger children was supported in number conservation and seriation tasks. Significance was not reached for length and Mass Conservation.

SEX DIFFERENCES

There were no significant differences in performance between boys and girls in number, mass conservation, and seriation tasks. However there was a greater number of boys in the transition stage

than girls for number, mass and seriation tasks. Lack of differences in performance agrees with Lester and Kleins (1973) and Fogeman's (1970) findings. For length conservation, boys performance was significantly better than the girls which agrees with (Goldschmidt's (1967) and Otaala (1970). For example, Goldschmidt argues that the boys' superior performance as compared to the girls' is attributable to the play activities of the boys which give them opportunity to perceive objects under different transformation. Also Otaala felt that the boys in his study were more encouraged by the society than girls, to play games different to those by girls. In the present study, boys are usually found constructing toy cars whereby sticks of certain lengths are needed while girls may be dealing with activities concerned with kitchen work. This may give boys the necessary prerequisite to length conservation.

In this study, lack of significant difference is probably due to the way children are brought up today. There are no specific roles for boys and for girls. The changing society has acquired changed attitude towards bringing up their children without any biases. A parent therefore would encourage a son just as he would encourage a daughter to excel in any of the activities performed by children. At school boys and girls perform the same type of activities and this could be a reason why there is no significant difference in the

performance between boys and girls. Unlike Mureria's (1974) and Otaala's (1970) subjects, the cultural set up from which the subjects in this study were drawn was such that the parents, having changed their attitudes and values, motivate their children to perform equally well both at home and at school irrespective of sex differences.

TYPE OF SCHOOL:

For number, length, and mass conservation, there was no significant differences in performance between subject attending HCS and LCS. However, there was generally a higher number of conservers and subjects in the transition stage in the HCS than in the LCS. In seriation task, the children attending HCS performed significantly better than children attending LCS. The HCS subjects may have an advantage over LCS children by having a variety of playthings both at school and at home which promote conceptual development. The former subjects are also taught in a manner that involves them through manipulating the objects. For example in one of their play time period these subjects were constructing a pyramid using blocks of different sizes. The results of seriation task in this study agree with Otaala (1970) Price William's (1961) and Vernon's (1969) results regarding the role of manipulation in conservation concepts. They emphasised that the environment was

important in enhancing the conservation concepts particularly where the subjects are involved in manipulating objects. Vernon argues that lack of manipulative activity hinders conservation. During the teaching process, the LCS didn't have enough materials and charts to display to the children and the children unlike at HCS recited phrases after the teachers without seeing these objects. The LCS classrooms were characterized by congestion whereby individual attention was not always possible. In the HCS individual attention was possible because the number of children in class was small. On the other hand, subjects in LCS have a number of unstructured toys such as sticks, wires, stones, maize cobs from which they can make a myriad of toys. In this process these subjects may form concepts of size, and length which would enhance the development of seriation. Probably the superior performance of the subjects attending HCS was due to past experience with structures such as staircases both at home and at school. This experience may help the children recall better the experimenter's model of the staircase which they were expected to construct. With regard to each child's eagerness to perform, those attending HCS felt more free with the experimenter as opposed to those attending LCS. This factor may have contributed to the superior performance of th_ HCS group. The teachers in the

HCS encouraged their children to perform well as the experimenter called each at a time. So in an attempt to please their teachers, these children were very motivated to perform well. Although the attitudes and values towards child rearing have changed among Kikuyu people, the greater change may have occurred among urban Kikuyu residents. Consequently the parents of children attending HCS may encourage their children to interact with adults as opposed to the suburban parents who are not very willing to allow children to join adults. The latter group feels that children are supposed to keep away from adults and this may hinder conceptual development through asking questions.

SUMMARY

The results of this study show that the hypotheses that were being tested were supported for some of the tasks only; these are:

1. that older children would perform better than younger children. This was significant for number conservation only.
2. that children attending HCS would perform better than those attending LCS. This was significant for seriation only.
3. that boys would do better than the girls

at all the tasks. This was significant for length only.

Limitations of this study:

The author feels that the close age range of the subjects may have been responsible for lack of significant differences. In the youngest group, the mean age was 4 years 2 months, a difference of only 9 months between this group and the next group. Not very much intellectual difference would exist between these two groups although they were treated as two groups.

This problem could not be avoided because children who are six years and over enter the primary schools yet the study was meant for pre-primary school children.

SOME EDUCATIONAL IMPLICATIONS AND RECOMMENDATIONS

From the results of this study, an appropriate curriculum would be the one that takes into consideration the stage of conceptual development at which the child is thinking and consequently performing. Older children in the pre-primary school who are about to conserve should be given in their syllabi problems that would enhance this development. At the same time younger children should be grouped together to avoid rote memorization to ensure that they understand what they say when they respond in a

chorus manner when they are together with older children.

In all the justification responses, it was evident that children lacked the language to express themselves. It would be to the advantage of the children at this age if both parents and teachers or in general the adults tried to use explanations for answers given. In the classroom situation, this will eliminate rote memorization by encouraging the children to give reasons for what they think. In this probing method the teacher or parent would identify the child with difficulties in learning. Furthermore some children are eager to know why some things are the way they appear and therefore their questions should be answered accurately to show both sides of a question or answer. This way intellectual development can be enhanced.

With regard to manipulation, learning at the pre-primary school level should be symbolized in play. This is a more effective and motivating method of teaching than verbal methods since young children have a very small span of concentration, and many of the concepts are not yet developed. As Piaget (1952) suggested, the child's participation in learning should be encouraged. Children should also be encouraged to explore their environment as this will foster intellectual development through making comparisons and arriving at equalities and inequalities.

The educationists should therefore emphasize the regrouping of the children in the pre-primary schools particularly in the self-help schools where older children shared a room with younger children. This will help the younger children to proceed at their own pace without being dragged among the whole group. The educationists should also try to reduce the number of children in a class so that individual attention can be possible. This individual attention will make teachers understand the kind of learning problems which each child is experiencing. Fewer children per class means that there is more space left to display charts and toys for play as well as greater accessibility to these toys.

The teachers themselves should be able to create teaching materials from the environment, for example use sticks, stones or clay and toys to symbolize learning through use of wall charts. These teachers should if possible be occasionally attending in-service courses where they would be taught how to promote learning among the children.

The parents also should assist the teachers by going to school on occasions with their children to observe how they are taught. This will give the parent an idea as to what the child needs at home for play so that the school and home environment are not entirely different. An awareness by the parents

of what the teachers are doing at school is important so that they can emphasize what the teachers are doing.

However, more research is required in this area of cognitive development to enable the educationists to draw proper conclusions.

BIBLIOGRAPHY

1. Beilin, H. and Franklin I - "Logical Operations in Length and Area Measurement : Age and Training effects". Child Development 1962 33 607-618.

2. Caldwell, B.M. (ed.) - Review of the Child Development research. Ricciuti. Chicago University. Chicago Press.

3. Dasen, P.R. 1972 Cross Cultural Piagetian research: A Summary.

4. Dasen, P.R. - Piagetian Psychology: Cross-cultural Contributions, Ed. by P.R. Dasen Garden Press News York 1977.

5. Dodwell, P.C. (1960) - Children's understanding of number and related Concepts. Canadian J. Psychol.., 14, pp. 191-205.

6. Dodwell, P.C. (1961) - Childrens understanding of number concepts; characteristics of an Individual and of a group test. Canadian J. of Psychol.., 15. pp. 29-36.

7. Dodwell, P.C. - Relations between the understanding of the logic of classes and of cardinal number in children. Canadian Journal of Psychology, 16, 152-160 1962.

8. Dodwell, P.C. (1963) - Children's Understanding of spatial concepts. Canadian J. of Psycholl.., 141-161.

9. Elkind, D. (1961) - Children's discovery of the Conception of mass weight and volume. Piaget Replication Study II Journal of General Psychol.., 98, 279-87.

10. Elkind, D. Koegler, R.R. (1964) - Studies in perceptual Development II. Whole-part perception. Child Development, 35, 81-90.

11. Fischbein, E. et al - Effects of age and Instruction on combinatory ability in children. British Journal of Educational Psychology 1970 Vol. 40 pp. 261-270.

12. Flavell, J.H. (1963) - Developmental psychology of Jean Piaget Princeton N.J. van Nostrand.

13. Fogelman, K.R., Piagetian tests and sex differences Educational Research Vol. 39 1970 No.12 pp. 154-155.

14. Fraisse, P. and Vautrey (1952) - La perception de l'espace de la vitesse et du temps chez l'enfant de cinq ans l'espace et la vitesse: Enfance 5 1-20.

15. Goodnow, J.J. (1962) - A Test of Milieu effects with some of Piagets' tasks. Psychol.., Monograph 76 (36) Whole No. 555 in Sigel and Hooper, Ed (1968).

16. Goodnow, J.J. and Gloria Bethon (1966). Piagets tasks; the effects of schooling and intelligence. Child Development 37 573-581.

17. Gelman, R. (1969) - Conservation acquisition: A Problem of learning to attend to relevant attributes. Journal of Experimental child Psychology, 1969 7 167-187

18. Goldschmidt, M. Different types of conservation and non-conservation and their relation to age, sex, and IQ. M.A. and Vocabulary, Child Development 38 pp. 1229-1246.

19. Greenfield, Patricia M. On Culture and Conservation. In Bruner et al 1966 - Studies in Cognitive growth N.Y. Wiley, pp. 225-256.

20. Gruen, G.E. (1966). Note on Conservation Methodologic and definitional considerations. Child Development, 36, 977-983.

21. Griffiths, Judith A. Carolyn U Shantz and I.E. Sigel (1967). Amethodological problem in Conservation Studies. The use of relational terms. Child development, 38, 841-848.

22. Heron, A. and Dodwell W. - Weight Conservation and matrix solving ability and Papuan Children. Journal of Cross-cultural Psychology, 1973 4,207-219

23. Hunt, J. McV. (1961) Intelligence and Experience N.Y. Ronald.

24. Sigel, I.E. and Frank H. Hooper (Eds. 1968) Logical thinking in children Research based on Piaget's theory.

25. Inhelder, B. and Piaget (1958). The growth of Logical thinking from childhood to Adolescence. N.Y. Basic books.

26. Kagan, J. and Kogan, N. (1970) - Individuality and Cognitive performance in Mussen, P.H. (Ed.) Carmichael's Manual of Child Psychology vol. one: New York, Wiley.

27. Kelly, M. (1971) - Some aspects of conservation of quantity and length in Papua New Guinea in relation to language, sex and years at school. Papua New Guinea Journal of Education 1971 7 55-60.

28. Kelly, M. and Philip, H. (1975) - Vernacular test instructions in relation to cognitive task behaviour among highland children of Papua New Guinea. British journal of Educational Psychology, 45, 189-197.

29. Kelly M. (1977) - The Development of Conservation in Aboriginal children. In Dasen, P.R. (Ed.) Cross-cultural Piagetian Research. Gardner Press. Inc. New York.

30. Kiminyo, D.M. (1973) - A cross-cultural study of the development of conservation of mass, weight and volume in Kenyan children. A thesis submitted to the faculty of Graduate studies and Research in Partial fulfilment of the Requirements for the degree of Doctor of Philosophy. Edmonton, Alberta.

31. Klein, R.E. (1973) - Cross cultural perspectives on early development. American Psychologist (1973), 28, 947-61.

32. De Lemos, M.M. - The development of conservation in Aboriginal children - International Journal of Psychology 1969, 4, 2 255-269.

33. Lester, B.M. and Klein R.E. - The effects of stimulus familiarity on conservation performance of rural Guatemalan children. Journal of Social Psychology 1973 Vol. 90 pp. 197-205.

34. Lister, C.M. (1968) - The development of Educationally Subnormal children's (ESN's) understanding of conservation in a range of attribute situations. British Journal of Educational Psychology 1968 vol. 38 pp. 14-22.

35. Lloyd, B.B. - Intellectual development of Yoruba children. An examination Journal of cross-cultural psychology 1972 (b) 2, 29-38.

36. Lloyd, B.B. - Studies of conservation with Yoruba children of differing ages and experience. Child development, 1972(a), 42, 415-428.

37. Lovell et al (1962) - An experimental study of the growth of some logical structures. British journal of psychology, 53, 175-188.

38. Lovell, K. and Ogilvie, E. (1960) - A study of the conservation of substance in the junior schoo child. British journal of educational Psychology, 3(109-118.

39. Mallory, W. (1975) - Psychology in Africa.

40. Meronelstein, E. and L.S. Shulman (1967) - Lack of formal schooling and the acquisition of conservation. Child Development 38 39-52.

41. Mureria, M. (1974) - The acquisition of some Geometric concepts among Kikuyu Primary school children M.A. thesis submitted to the University of Nairobi.

42. Ngini, L.N. (1979) - A study of Pre-school children's comprehension of some mathematical concepts in Nairobi Kenya, M.Ed. thesis submitted to the University of Nairobi.

43. Ngiti, R.M. (1977) - Conservation among Meru Children of Tanzania. In Okatcha (Ed.) pp. 39-38.

44. Ohuche, R.O. - Conservation of quantity and Traditiona values (mimeo) Njala University College - Nja Sierra Leone.

45. Okatcha, F.M. (ed) - Modern Psychology and cultural Adaptation.

46. Okonji, M.O. (1970) - The effects of special training on the classificatory behaviour of some Nigerian Ibo children. British journal of Educational Psychology 40 221-226.

47. Otaala, B. (1970) - Conservation, Seriation and classificatory abilities of Iteso primary school children in Piaget for Teachers Department of Educational psychology, Makerere University, Kampala.

48. Owock, (1973) - On culture and conservation in International Journal of Psychology. 1973 vol. 8 No. 4 pp. 249 - 254.

49. Piaget, J. (1926) - The Child's conception of the world. Routledge and Kegan Paul, London. French version.

50. Piaget, J. (1937) - The Construction of reality in the child. Routledge and Kegan Paul. London

51. Piaget, J. (1941) - The Children's conception of number. Routledge and Kegan Paul. London.

52. Piaget, J. (1946) - The Child's conception of Movement and speed. Routledge and Kegan Paul. London.

53. Piaget, J. (1947) - The Psychology of Intelligence. Routledge and Kegan Paul. London.

54. Piaget, et al (1948) - La geometric spontanee de l'enfa Paris, Presses Universitaires.

55. Piaget, J. (1950) - The Psychology of intelligence. Routledge and Kegan Paul Ltd. London.

56. Piaget, J. (1952) - The child's conception of number. Routledge and Kegan Paul Ltd. London.

57. Piaget, J. (1953) - La genese de l'idee de hasard chez l'enfant; Paris Presses Universitaires.

58. Piaget, J. (1953a) - How children form Mathematical Concepts. Scientific American Journal, 189, 74-79.

59. Piaget, J. (1957) - logique et equilibre dans les compartments du sujet. In Apostel et al, Logique et equilibre. Etudes d'espitemologie genetique vol. 2 Paris. Presses Universitair 27-117.

60. Piaget et al, (1960) - The child's conception of geometry. Routledge and Kegan Paul Ltd. London.

61. Piaget, J. (1964) - Cognitive development in children - Development and Learning - Journal of Research in Teaching 1964 2 176-186.

62. Piaget, J. (1970) Science of Education and the Psychol of the child. New York, Grossman.

63. Piaget, J. and Inhelder (1947) - Diagnosis of Mental Operations and theory of Intelligence. American Journal of Mental Deficiency 5 401-6.

64. Philip H. and Kelly M. (1974) - Product and Process in Cognitive Development. Some Comparative data on the performance of school age Childre in different cultures. British journal of Educational Psychology 44, 248-265.

65. Pinard et al (1969) - "Stage", in Piaget's Cognitive development theory. In Elkind D. and Flavell H. (Eds.).

66. Poole, H.E. (1968) - The effects of urbanization upon scientific concept attainment among Hausa children of Northern Nigeria. British journal of Education Psychology 1968 vol. 38 pp. 57-63.

67. Price, J.R. - Science concepts in New Guinea and European children. Australian Journal of Education 1968, 12, pp. 81-89.

68. Price, J.R. - On cultural Bias - Papua New Guinea Journal of Educational Psychology 1976, 12. pp.26-31.

69. Price-Williams, D.R.A. (1961) - A study concerning concepts of Conservation of quantity among primitive children. Acta. Psychology. 18, 297-305.

70. Rawlinson, R.B. (1974) - A crosscultural study of Intelligence - New Guinea Psychological Monograph supplement 1974 No. 6.

71. Richmond, P.G. (1970) - An introduction to Piaget. Routledge and Kegan Paul. London.

72. Shihundu, J.A. (1977) - An investigation into Mathematical concept development among Kenyan primary school children. M. Ed. thesis submitted to the University of Nairobi.

73. Smedslund, J. (1961) - The acquisition of conservation of substance and weight in children II. External reinforcement of conservation of weight and of the operations of addition and subtraction. Scandinavian Journal of Psychology, 2, 71-84.

74. Smedslund, J. (1964) - Concrete reasoning - A study of intellectual development - Monograph sociological Research. Child Development 29. (2) 3-39.

75. Smedslund, J. (1965) - The development of transitivity of length - Child Development 36 577-580

76. Uzigiris, I.C. (1964) - "Situational generality of Conservation. Child development; 35, 831-41.

77. Vernon, P.E. (1965) - Environmental handicaps and intellectual development. British, Journal of Educational Psychology, 35, 1-22.

78. Vernon, P.E. (1969) - Intelligence and Cultural environment. London. Methuen.

79. Vygotsky, L.S. (1962) - Thought and Language Translate by E. Haufman and G. Vakan. New York Wiley

80. Wallach et al (1967) - Number conservation the roles of reversibility, addition subtraction and misleading perceptual cues. Child Development, 38 425-42.

81. Wohlwill, J.F. (1960) - A study of the development of the number concept by scalogram analysis. Journal of Genetic Psychology, 97. 345-377.

82. Wohlwill, J.F. and Lowe, R.C. (1962) - Analysis of the development of the conservation of Number. Child Development, 33, 153-67.

ADMINISTRATION OF THE TASKS

I. Number Conservation

1. Haha ndina sweet (theremende). Ici na ici.
2. Ici sweet iri haha ni cigana ici ingi?
3. After transformation (elongation of one row): Riu ici sweet ni cigana ici iri haha?:

Yes _____ No _____

Reason _____

II. Length Conservation

1. Haha ndina tumiti, (sticks displayed on table) Nyonia turia tuiganaine.
2. (After placing the two equal sticks in a T-illusion). Riu ni tuiganaine?

Yes _____ No _____

Reason _____

III. Mass Conservation

1. Haha ndi na ngima ithondeketwo ta tumibira.
2. Nyonia tumibira twa ngima turia tuiganaine.
3. After deformation into a flat piece and the other into a long 'sausage-like' shape - Riu ngima iria iri haha na iyo ndakunee, niciganaine?

Yes _____ No _____

Reason _____

IV. Seriation

Haha ndina tumiti twa guthondeka ngathi ya kwambata (kuhaica iguru). Riu thondeka yaaku ta ino thondekete.

Able _____ Unable _____

Riu hari tumiti tugutigarite haha thi ndirenda wikire hau ngathi-ini yaaku.

Able _____ Unable _____

Raw Scores

1. Scores for number for boys attending LCS.

Table 37

Group	Scores														
1	3	3	3	3	3	3	3	2	2	2	2	2	1	1	1
2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

2. Scores for number for girls attending LCS.

Table 38

Group	Scores														
1	3	3	3	3	3	3	2	2	2	1	1	1	1	1	1
2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3. Scores for number for boys in HCS.

Table 39

Group	Scores														
1	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1
2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1

4. Raw scores for number for girls in HCS

Table 40

Group	Scores														
1	3	3	3	3	3	3	3	3	2	2	2	1	1	1	1
2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

5. Raw scores for length for boys in LCS.

Table 41

Group	Scores														
1	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

6. Raw scores length for girls in LCS.

Table 42

Group	Scores														
1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

7. Raw scores for length for bovs in HCS.

Table 43

Group	Scores														
1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1

8. Raw scores for length for girls in HCS.

Table 44

Group	Scores														
1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

9. Raw scores for mass for boys in LCS.

Table 45

Group	Scores														
1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

10. Raw scores for mass for girls attending LCS.

Table 46

Group	Scores														
1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

11. Raw scores for mass for boys in HCS.

Table 47

Group	Scores														
1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

12. Raw scores for mass for girls in HCS.

Table 48

Group	Scores														
1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

13. Scores for seriation task for boys in LCS.

Table 49

Group	Scores														
1	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

14. Scores for seriation task for girls attending LCS.

Table 50

Group	Scores														
1	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

15. Scores for seriation task for boys in HCS.

Table 51

Group	Scores														
1	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
2	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1
3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

16. Seriation task for girls attending HCS.

Table 52

Group	Scores														
1	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1
2	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1
3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Tables for t-Test

53. The t test for conservation of number for boys attending LCS.

$$t = \frac{X_1 - X_2}{s.d.m}$$

$$t = \frac{\frac{34}{15} - \frac{17}{15}}{0.2678}$$

$$\frac{\frac{17}{15}}{0.2678}$$

$$t = \frac{1.1333}{0.2678}$$

$$t = 4.2320$$

$t = 0.05$ is 2.048

attained $t = 4.05$ is significant

54. t test for seriation task for boys attending LCS.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.2666 - 1.0666}{0.1356}$$

$$t = 1.4739$$

t 0.05 df 28 = 2.048

Observed $t = 1.4739$ is not significant

55. t test for conservation of mass for girls attending LCS.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.1333 - 1.000}{0.0908} = 1.4680$$

$t_{0.05}$ df 28 = 2.045

Observed $t = 1.4675$ is not significant.

56. t test for conservation of mass for boys attending HCS.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.1333 - 1.0666}{0.0908}$$

$$t = 0.7345$$

t 0.05 df 28 = 2.048

Observed t is not significant.

57 t test for conservation of mass for girls attending HCS.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.2 - 1.00}{0.1069}$$

$$t = 1.8708$$

t 0.05 df 28 = 2.048

Observed t = 1.8708 is not significant.

58 t test for conservation of number for boys and girls.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.5333 - 0.0889}{0.1140}$$

$$t = 0.7798$$

t 0.05 df 178 = 196

Hence observed t is not significant.

59. t test for conservation of length for boys and girls.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.3222 - 1.1888}{0.0646}$$

$$t = 2.0650$$

t 0.05 df 178 = 1.96

Hence observed t = 2.0650 is significant.

60. t test for mass conservation for boys and girls.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.0555 - 1.0888}{0.0387}$$

$$t = 0.8604$$

t 0.05 df 178 = 1.96

Hence observed t was not significant.

61. t test for seriation task for boys and girls.

$$t = \frac{1.4222 - 1.3555}{0.0592}$$

$$t = 1.1266$$

t 0.05 df 178 = 1.96

Hence observed t was not significant.

62. t test for number conservation with respect to type of school attended.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.5111 - 1.5555}{0.1142}$$

$$t = 0.3887$$

Hence observed t was not significant.

63. t test for length conservation with respect to type of school attended.

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.2777 - 1.2333}{0.0653}$$

$$t = 0.6799$$

t 0.05 df 178 = 1.96.

Hence observed t was not significant.

64. t test for mass conservation with respect to type of school attended.

$X_1 = 1.0888$

$X_2 = 1.0555$

sdm = 0.0387

$$t = \frac{X_1 - X_2}{sdm}$$

$$t = \frac{1.0555 - 1.0722}{0.0387}$$

$$t = 0.8604$$

t 0.05 df 178 = 2.048

Hence observed t was not significant.

65. t test for seriation task with respect to the type of school attended.

$$t = \frac{1.15333 - 1.2444}{0.0583}$$

$$t = 4.9555$$

$$t\ 0.05\ df\ 178 = 2.048$$

Hence observed t was significant.