EFFECTS OF LANGUAGE CHARACTERSTICS ON CHILDREN'S COGNITIVE REPRESNTATION OF NUMBER: COMPARISION OF HINDI AND ENGLISH MEDIUM CHILDREN

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Certificate

This is to certify that the dissertation titled **"Effects of language characteristics on children's cognitive representation of number: comparison of Hindi and English medium children"** submitted by Rajni Aggarwal is in partial fulfillment of the requirement for the award of **Degree of Master of Philosophy** of **Jawahar Lal Nehru University**. This dissertation has not been submitted for any other degree of this University and is her own work.

We recommend that this dissertation be placed before the examiner for evaluation.

(Prof. DEEPAK KUMAR)
(Chair person)

(Supervisor)

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Abstract

The present study was undertaken to explore the effect of language characteristics on children's cognitive representation of number:comparison of Hindi and English medium children.There were four objectives of the study. Firstly to study the effects of numerical language characteristics on cognitive representation of number. Secondly to study the effect of instructions in understanding number representation. Thirdly to study the difference between Hindi and English medium students in cognitive representation of number. Finally to study the gender difference in the cognitive representation of number.

Hypotheses for this study were as follows: there will be significant effect of numerical language characteristics on cognitive representation of number; instructions significantly affect the cognitive representation of number; the numerical language characteristics of Hindi and English language would affect the cognitive representation of number; there will be a significant difference amongst boys and girls performance on the task of cognitive representation of numbers.

A sample of 100 students was taken from three schools. Two were MCD primary schools in Madipur and Paschim Vihar for Hindi medium 25 boys and 25 girls respectively. For 25 English medium boys and 25 girls C R Saini Private school, Nangloi was selected. The children belong to the age group 6 to 8 years. An adopted version of the test framework used by Miura (1994) was implemented to test the number representation ability of children. Moreover, six number cards having numbers 11, 13, 28 , 30, 39 and 42 respectively were used to show the numbers. Both quantitative and qualitative techniques were used to analyse the data. χ^2 and percentage comparison through critical ratio were used to see the significant difference among the groups.

Results reveals that Hindi numeration system is comparatively difficult from English numeration system but strategic approach make students skilled and even enable them to perform better. Hindi medium children use more tens than English medium but difference is not significant. Instructions help in improving performance of children. So, one must keep encouraging children.While manipulation of material

children learn and show a gradual pattern of developing better number representation. Mostly girls perform better than boys on number representation tasks.

Hence, knowing numeration system is not enough to predict the successful acquisition of number concept. So, teachers should not only practice number system but also give activities side by side to develop the concept of number and place value. Place value concept should come before introduction of 2 digit numbers. Teachers must take this as a pre requisite while planning lessons on introduction of numbers. Since Hindi numeration system is quiet complex especially when it comes to ninth position number names. Teachers must clarify this number naming system while teaching because some children had number concept but since they recognised them wrongly they represent in a wrong manner. Teachers should lay stress on using teaching aids because all the children who are part of sample belong to school. They have also learnt counting but still they don't have number concept because they have just done written work. When they are exposed to teaching aids they showed a gradual development in number concept during the experiment. In bilingual context teachers can prefer English system of numeration as it is simpler as compared to Hindi numeration system. Still they should use activities and teaching aids to clarify the number concept. Both girls and boys perform well on number task. Even girls perform better. So, teachers should expect equally well performance from both the groups.

It is easy to state competency based models but difficult to implement them. So, one must not only state competencies but also explain which materials and how it should be used. Researchers should be carried out further on number concept and it should be treated as very important unit rather than just taking it as one of many arithmetic abilities.

CHAPTER ONE

Introduction

Mathematics is tied inseparably to notation and symbolism. Mostly mathematics learning starts with development of number concept, especially counting. Even the ability to compute mentally at school level reflects a grasp of the number system, which is both fundamental to mathematical thinking and also necessary for sensible calculations. It is usually introduced by showing pictures of 10 objects i.e. bundles of sticks or beads etc. During these presentations, it is presumed that children can mentally manipulate pictured objects, mentally join collections and remove objects from collections and recognize the number property of a collection as being the same as the sum of the number properties of the constituent parts. Secondly they can also understand one-to-one correspondence and cardinality concept.

In the present study representation of number is considered as an area of research. Hence, this chapter is meant to explore what is number, numeration system and its psychological representation. Moreover, theoretical views about number concept, models of early number development and significance of present study are also discussed here.

1.1 Understanding of Number and Numeration system

1.1.1 Number

"Number words are cultural symbols." (Saxe et al., 1989, p.468). They are arbitrary in the sense that number word three is used to represent three objects. This arbitrary property of number is a fundamental principle of counting. "Number is assumed to be the product of set of rules applied to real world quantitative phenomenon" (Smitsman, 1982, p.1).

Specific instruction in ordinal relations and ordinal concepts should foster the child's understanding of natural number. Cardinal number theories in turn consider the child's understanding of concrete representations of the quality of collections and his or her ability to compare various aggregates of objects (via counting or one-to-one correspondence) as the fundamental prerequisite for the number concept. Thus the child's experience with comparison operations in the pre school period should be functionally relevant to the natural number idea and its applications.

Piaget described the concept of number as a synthesis of two concrete operational systems, namely seriation and classification. The first operational system concerned asymmetrical relations; the second operational system concerned symmetrical relations or relations of equality. To Piaget, the serial nature of the natural number system could be explained by the logical principles of seriation. But Piaget's views of number and number development have been seriously criticized.

Brainerd (1979) has questioned the hypothesised synchronous development of the ordinal and cardinal properties of number. More serious and fundamental criticisms concern Piaget's view of the logical foundation of number, that is, the hypothesized relation between number and seriation and classification. MacNamara (1975) argued, for example, that classification could not be a basis for understanding number because a logical class-structure differed in several respects from the structure of natural numbers.

Research of Gelman (1972) and Gelman and Gallistel (1978) showed that counting by preschoolers can not be characterized as a rote skill. Moreover, it was suggested that children learn to understand mathematical properties of number on the basis of counting and it was further asserted that counting by children as young as 2-3 years of age reflects a rudimentary understanding of those properties. Gelman's research on number development undermines the validity of Piaget's view about the logical foundation of number.

1.1.2 Theoretical views of various theorists on number concept

According to Piaget's theory of number concept development, before a child is able to develop correct operations on numbers, he must develop some basic operations on classes and some on serial relations. The operations on numbers are a special subset of these operations, involving relations of both class equivalence and serial order conjointly. Indeed, it seems plausible on common-sense grounds to expect that a child will have some idea of classes of objects and subclasses within a more general class, before he can deal with the rather stricter conditions which hold when one deals with the special classes called cardinal numbers.

For one thing, the child has frequent occasion to use hierarchical classificatory systems (as: cat and dog are both animals; rose, daisy, and tulip are all flowers) before he learns to use number words to apply to specified but very general- classes. To quote Piaget's own words, "Our hypothesis is that the construction of number goes hand in hand with the development of logic, and that a pre- numerical period corresponds to the pre- logical level....logical and arithmetical operations therefore constitute a single system... the second resulting from generalization and fusion of the first, under the complementary headings of inclusion of classes and seriation of relations, quality being disregarded... the fusion of inclusion and seriation of the elements into a single operational totality takes place, and this totality constitutes the sequence of whole numbers, which are indissociably cardinal and ordinal" (Piaget, 1952, p.viii). This implies that the development of operations on classes must precede the ability to reason correctly about numbers. However, Piaget also says, "hitherto, we have considered number as a seriated class, i.e., as the product of class and asymmetrical relation. But this in no way implies that class and asymmetrical relation come before number. On the contrary, number can be regarded as being necessary for the completion of truly logical structures, as we shall attempt to show... Instead of deriving number from class, or the converse, or considering the two as radically independent, we can regard them as complementary, and as developing side by side, although directed towards different ends" (Piaget, 1952, p. 161). Perhaps it will be thought that these two quotations reflect some inconsistency in Piaget's thinking about the relations of the logical structures for class composition and for number. The natural interpretation of the first quotation would seem to be that the former develops to a considerable degree before the latter. Be that as it may, we should certainly expect, on the basis of the theory, a strong relation to hold between the states of development of the two.

While Vygotsky emphasized the role of language on concept development. Vygotsky (1962) had shown that young children believe that the word used to refer to an object can not be changed without changing substantial properties of the object which it refers. Additionally, Werner and Kaplan (1963) have suggested a particular developmental progression in which conventional symbols and particular functions are only gradually differentiated and distanced from each other. If these tendencies extend to number words, children may believe that the standard number words are the only words that can serve numerical functions like counting.

This reveals the fact that the standard number words can be replaced by another symbol set in counting operations is one aspect of the conventional nature of cultural symbols for numbers. A second aspect is that the same symbols may represent different numbers. This second aspect places a central role in our numeration system. For example, the symbol 1 may represent unity or ten times unity, depending on the column in which it appears. Another example is that one shell may be equivalent to five beads in Tribe A and five shells may be equivalent to one bead in Tribe B. The development of both aspect (knowledge of the substitutability of number words and knowledge that the same symbols may be used for different numbers) may be seen as the *progressive distancing* of symbols for number from the function that they serve (Werner and Kaplan, 1963).

1.1.3 Numeration systems

"Most counting systems are organised in such a way that saying the number words in a fixed order becomes a relatively simple task. *When we understand the logic of a number system, we can generate numbers which we have not heard before.*" (Nunes and Bryant , 1996, p.45) To understand the language of numbers one need to decompose, combine and recompose them. One has to understand various number naming properties with prior knowledge of its base structure. These properties are addition composition or minus compositions. Additive composition explains that 23 can be decomposed into two tens plus three ones, and the words used with 'twenty' and 'three' highlight this particular way of breaking up this number. It is also important to clarify the idea of the order in numbers. ' Six' is not simply the first word label after 'five'. The counting sequence means that 6 is greater than 5 and that 5 is a possible subset of 6 but 6 is not a possible subset of 5. Therefore, when we wish to explore children's understanding of the numeration system we need to know much more than whether children can say number words in a fixed order.

As we use a base-ten system, when we have ten units of any size we regroup these in to units of the next size. For example, we count ones up to ten. Ten ones make up one ten and then we combine tens and ones until we have nine tens and nine ones. Ten tens make up one hundred and then we combine hundreds, tens, and ones until we have nine hundreds, nine tens and nine ones. A new class of units, the class of thousands, is then introduced and we can repeat the same reasoning indefinitely. Similarly it goes up for hundred, thousands and so on. In case of Hindi system an inverted relation exist for each new name after twenty. For example for 21 instead of twenty-one it is one twenty i.e. *ikkis*. Moreover, at each ninth position minus relation is found i.e. for 39 instead of thirty nine it is forty minus one i.e. *untis*.

After understanding the properties of the number system it is important to relate it to counting, as it is a prerequisite for learning counting.

1.1.4 Counting

Many theories explained how children learn to count but they differ with respect to development of counting processes. Fuson and Hall (1983) have emphasized the role of language patterns as children acquire the conventional number word sequence. Gelman and Gallistel (1978) proposed five counting principles for successful counting. These are believed to be prerequisite for accurate counting. These five principles are:

(1) The one-one principle-each item in an array must be tagged with one unique tag. (2) The stable-order principle-the tags assigned must be drawn from a stably ordered list.

(3) The cardinal principle-the last tag used for a particular count serves to designate the cardinal number represented by the array.

(4) The abstraction principle-any set of items may be collected together for a count. It does not matter whether they are identical, three-dimensional, imagined, or real, for in principle, any discrete set of materials can be represented as the contents of a set.

(5) The order-irrelevance principle-the order in which a given object is tagged as one, two, three, and so on, is irrelevant as long as the stable-order and cardinal principles are honored.

These principles are important for children as they guide the young children's acquisition of skills at counting as they can self correct their counting errors. Moreover, they will apply counting procedures to a variety of activities i.e. classification, fractions, addition etc. They can also invent their own counting algorithms. (Gelman, 1978;

Ginsberg, 1982). Groeno and Resnick (1977) showed this is a study to use a counting algorithm to solve simple addition problems. The algorithm consisted of first counting two separate groups of objects, then combining groups of objects into one collection, and then counting the number of objects in that group. Across session, half of the employ a more efficient algorithm then they had been taught. This was to count on from the cardinal value of the greater of the to be added numbers.

There are three models of early number development. The Riley et al. (1983) model constructs problem representations by mapping verbal problem statements onto a change schema in memory. Briars and Larkin's (1984) CHIPS model relies more on its knowledge of relations between operators to augment a basic problem of representation, ultimately resulting in mathematical representations that are structurally similar to those produced by the Riley et al. Model. Steffe et al. (1983), in contrast, initially analyzed the units or conceptual entities that children construct when they count to solve a variety of arithmetical tasks. The counting types model documents five increasingly sophisticated types of units that children create when they count. These are *perceptual, figural, motor, verbal, and abstract* units. Children are classified as being counters of a particular type on the basis of the most sophisticated type of unit that they can count. Only at the fifth level children can understand number words or numerals. This signify conceptual entities that appear to exist independently of the child's actual or represented sensory-motor activity.

Cobb (1984) extended the counting type model by suggesting two further conceptual levels. Children at the first of these, double integration, can establish implicit part-whole relations in a bottom-up manner by taking two numbers as a unity. Children at the highest level, part-whole, can establish explicit part-whole relations in a top-down fashion and can express them in a variety of ways.

It is found that each model embodies the notion that cognitive development involves the acquisition of the ability to operate on the entities of lower levels. In the developmental path outlined by Steffe et al. (1983), the child first constructs number as an arithmetical object and then gradually develop the ability to establish relation ship between numbers. All three models attempt to account for qualitative changes in children's arithmetical thinking. Riley et al.'s and Briars and Larkin's models account for qualitative change by adding conceptual abilities rather than by dealing with qualitative changes in particular conceptual entities. Steffe et al.(1983), in contrast, specified five qualitatively distinct types of number word meanings, only the most sophisticated of which corresponds to a set with a numerical value. In the Riley et al. model, the problem text is mapped on to a change schema in memory, were as in the Briars and Larkin's model, a basic representation is constructed. It is clear that they did not attempt to give complete account of the encoding process. Instead, they addressed the more limited problem of modeling processes whose products, problem representation, are the same as those attributed to children. Each model has dealt with this process only to the extent necessary to achieve their respective goals. The models developed by Riley et al.(1983) and Briars and Larkin (1984) account for general developmental trends in children's ability to solve word problems. Steffe et al.(1983) offers a collection of organized constructs that are used to explain individual children's arithmetical activity.

1.2 Significance of the present study

Many researches have revealed that Asian students perform better on mathematics tasks as compared to their American counter parts. Researches have shown that these differences arise due to innate ability and other social factors i.e. family beliefs, parental support and cultural emphasis on education along with financial success and recognition (Lynn and Hampson, 1987,Stigler et al. 1982). But Miura (1987) found that these are not the only differences. The major reasons lie in mental representation of number system in various cultures.

Series of researches reveal that the better correspondence of spoken and written form of number, the easy it is to represent in memory (Miura, 1987; Miura and Okamoto, 1989; Miura, Kim, Chang and Okamoto 1988). Mainly language cultures from ancient Chinese group (among them, Chinese, Japanese and Korean) were compared with French, Swedish and English language. The structure of these Asian numerical systems with base 10 is quiet transparent. Children speaking these languages must learn the numerical names from 1 to 10. Then, numbers between 11 and 20 are formed by compounding the decade value with a unit value. Eleven, twelve and thirteen are spoken as "ten-one", "ten-two", and "ten-three". Twenty is spoken as "two-ten (s)". "Fourteen" and "forty", in English, are phonologically similar. In these Asian languages, 14 and 40 are spoken as "ten-four" and "four-ten(s)". Thus, the spoken numerals in these Asian languages correspond exactly to their written form English- language speakers, on the other hand, must memorise the numerical names between one and nineteen; they must also memorise the decade names. The lack of a systematic generation of numerical names is also found in French and Swedish. French has an added complication in that there is a switch to multiples of 20 (quatre-vingts) at eighty.

Result reveal that the performance of the groups of Asian language speakers was similar to each other and differed significantly from the English- speaking sample. The Asian- language speakers showed an initial preference for using a canonical Base 10 construction, that is, one that reflects the Base 10 system precisely (e.g. 4 tens and 2 units for 42), to represent numbers concretely; English-speaking children showed a preference for representing numbers concretely with a collection of units (e.g. 42 units for 42).

In Indian context also there are two common mediums of instructions i.e. Hindi and English. Hindi belongs to Asian language pool while English is a western language. Both Hindi and English number systems are base 10 but differ in their number naming system English numeration system is quiet simple and transparent but Hindi system is quiet complex. In English number words from 1 to10, teens and tens need to be memorized while all others can be generated by a single additive composition after twenty. For example 24 will be named as twenty-four, which is direct additive composition. In case of Hindi number words from 1 to 10 are unique names while after 10 there are names derived from earlier number. They hold an inverted relation i.e. for 28 it is '*aththais*' which is eight and twenty. Complexity increases at ninth position as it holds a minus relation i.e. for 39 number word is '*untalis*' which is one less than forty. These types of relations are also explored by Pal, Pradhan and Natrajan (1997). Moreover, such language characteristics were found to produce mathematical problems while doing simple arithmetic tasks. Hence, this research study is undertaken to explore further whether these language characteristic produce differences in cognitive representation actually. Moreover, it can be of interest to pedagogy experts and teachers in the field to find which language can be used in a better way while teaching in bilingual classes. Modification while teaching can also be done to improve the cognitive representation of numbers.

This research work has also examined the gender difference to find whether girls actually differ from the boys in number representation or not. This will help teachers to justify their equal expectations from both the sexes.

Since, how to give instructions is a burning issue in Indian research context. This research work also has two small instructions to encourage children to produce novelty in their representation. Hence, the result of these instructions will also help pedagogy experts and teachers to determine how small instructions enhance the learning ability of the child.

CHAPTER TWO

Reviews of related literature

This chapter comprises of the reviews related to the researches done on number, numeration system, counting, gender bias in mathematics achievement and effect of instructions on mathematics learning. This is an important chapter as it provides research context to the present study.

2.1 Number concept, Numeration system and teaching counting in school

The development of numeration (the assignment of numerals to elements regarded as classed and ordered) parallels the development of seriation and classification (Elkind, 1964) because the co-ordinations involved in forming series and classes are also involved in forming seriated classes (numbers). The co-ordinations involved in forming series and classes are differentiated from those involved in forming seriated classes by the fact that, in attempting to construct a number conception, the child is dealing with elements that, at once, can be ordered and classed. Thus, the development of number can be viewed as an attempt to coordinate asymmetric (series) with symmetric (class 0 relations). This view clears the essential unity between the three processes of seriation, classification, and numeration. Elkind (1964) did a replication study taken from Piaget's book *The Child's conception of number* to support Piaget's discussion on the development of seriation and numeration with the aid of concepts and examples familiar to American psychologists. Subject was taken from Nursery and Elementary schools in the age group 4-6 years. Children were provided slates and blocks to prepare a staircase. They were required to count the stairs climbed by a doll. The results of the study revealed that at the first stage (usually age 4), the child has only a global impression of seriated class in which the quantitative differences and the similarities among the elements are undifferentiated. The child at the second stage (usually age 5) has a differentiated representation of seriated class. The co-ordinations that appear at the second stage are due to the matching of mental images and perceived configurations and do not represent a prior understanding. At the third stage (usually ages 6-7), the child has attained what Piaget calls an *operational* conception of an ordered class. Counting achieves the transformation of elements into units only after classification and seriation have become internalized. For only their operational character makes their simultaneous coordination possible. Counting merely provides the concrete materials (units) on which this coordination can operate and, as the preceding discussions of the first and second stages show, does not spontaneously give rise to numerical relations. Put differently, only after seriation and classification become operational is counting regarded as attributing a unit character to each element counted. Finally, in contrast to the elements of classes and series, the elements of number are constructed by the child's own actions and are not given in immediate perception or in intuition.

Many researches interpreted that the preschoolers perceive differences in numerosity without actually understanding number. For example young child can accurately jüdge that a set size of 11 items is greater in numerosity than one with 7 items. Gelman and Tucker (1975) worked on representation of numbers. They found that the 3-years old tended to use the number words two, three, four, five, six, ten, and eleven to represent set sizes of 2, 3, 4, 5, 7, 11, and 19 respectively. Older children were more accurate, although they too made errors in assigning numerical values. Such results hardly fit with the characterization of numerical ability. To the contrary, they suggest that young children know something about counting. Successful counting involves the coordinated application of five principles (Gelman & Gallistel, (1978). These are as follows: (1) The one-one principle-each item in an array must be tagged with one unique tag. (2) The stable-order principle-the tags assigned must be drawn from a stable ordered list. (3) The cardinal principle-the last tag used for a particular count serves to designate the cardinal number represented by the array. (4) The abstraction principle-any set of items may be collected together for a count. It does not matter whether they are identical, three-dimensional, imagined, or real. Any discrete set of materials can be represented as the contents of a set. (5) The order-irrelevance principle-the order, in which a given object is tagged as one, two, three, and so on, is irrelevant as long as the stable – order and cardinal principles are honoured. Number words are arbitrary tags. The evidence clearly supports the conclusion that preschoolers honour these principles. They may not apply them perfectly, the set sizes to which they are applied may be limited and their count lists may differ from the conventional list. But nevertheless the principles are used. Thus, a 2 1\2- years olds may say "two, six" when counting a two-item array and "two, six, ten" when counting a three-item array (the one-one principle). The same child will use his or her own list over and over again (the stable-order principle). When asked how many items are present, will repeat the last tag in the list. In the present example, the child said "ten" when asked about the number represented by a three-item array (the cardinal principle).

The fact that young children invent their own lists suggests that the counting principles are guiding the search for appropriate tags. Such " errors" in counting are like the errors made by young language learners (e.g. " I runned"). In the latter case, such errors are taken to mean that the child's use of language is rule governed and that these rules come from the child. We are not likely to hear speakers of English using such words as *runned, footses, mouses, unthirsty, and two-six-ten.* We use similar logic to account for the presence of idiosyncratic counting lists. Further facts about the nature of counting in young children support the idea that some basic principles guide their acquisition of skill at counting. Children spontaneously self-correct their counting errors and perhaps more important, they are inclined to count without any request to do so. If we accept the idea that the counting principles are available to the child, the fact that young children count spontaneously without external motivation fits well. What's more important, the self-generated practice trials make it possible for a child to develop skill at counting.

Although Gelman and Gallistel (1978) claim that even 21\2-years-olds can obey the how-to-count principles, they do not mean at that children this age have explicit knowledge of the principles. Gelman and Gallistel (1978) found that the number of items in a set interacts with the tendency to apply the cardinal principle. As set size increases, the tendency to use the last tag to index the cardinal value of the set drops off. Some have suggested that this mean the child does not yet have the cardinal principle as part of her counting scheme. Gelman and Gallistel maintain they do but once again its application is at first variable. What evidence is there that the cardinal principle is available, even if it is applied sporadically? If Gelman and Gallistel are correct then the variable use of the cardinal principle in a young child derived from the performance demands of applying the counting that elicit its consistent use. And when attention is drawn to the role of counting in quantification, the likelihood of its use should increase.

Gelman and Meck (1982) conducted a direct test of the idea that performance demands limit the young child's tendency to apply the cardinal principle. In their study, 3- and 4- years old children watched a puppet count displays of 5, 7, 12,and 20 objects. Children were told the puppet often made mistakes when counting and their job was to tell the puppet whether it was right or wrong. They were also encouraged to correct the puppet's errors. Note that the children did not have to generate the counting performance themselves; they only had to monitor it for conformance to the counting principles. Children did very well. For example, the 4- year olds attempted to correct 90% of the puppet's errors and did so correctly 93% of the time. The comparable figures for the 3-year olds were 70% and 94% respectively. Gelman and Meck failed to find an effect of set size. It means the children did as well on set size 7 as they did on set size 20. Obviously, the children had implicit knowledge of the cardinal principle.

According to Piaget's theory of number concept development before a child is able to develop correct operations on numbers, he must develop some basic operations on classes, and some on serial relations. Piaget also devised experiments on "logical composition of classes " but failed to specify the number of children studied and generalizability of responses at different ages. So, Dodwell (1962) devised an experiment to support Piaget's finding. The aim of the experiment was to assess the generality of the sorts of response young children between the ages of five and eight make when asked about the composition of simple groups of objects. The specific hypothesis investigated concerns the relations between these responses and some of the responses made on the number concept test, that is, that some understanding of class composition is a necessary condition for dealing "operationally" (that is, consistently) with numbers. 60 subjects in age range 5 – 8 years were taken as sample. He used toy dolls, garden books etc. which children are familiar with for the experiment. Children were given these materials and asked questions i.e. are there more rakes or more tools son on to test their understanding of number.

Hendrickson (1979) devised a study to make an inventory of the responses made by first graders to apply in simple situations involving counting, number, computation, and place value. 30 boys and 27 girls from six elementary schools were interviewed individually. Each child was presented with 17 tasks on counting, number computation and place value to find out how the children would respond to the tasks, instead of comparing them under absolutely controlled standardized conditions. It was revealed that entering first-grade children show variations in counting ability and style. Their ability to count objects falls off rapidly as the number of objects becomes greater than 15 or so. In particular, the ability to count orally does not guarantee the ability to count objects. In considering situations in which a group consists of two or more identifiable parts, a large number of these children seemed drawn to comparing the parts with each other or to identifying with the larger part rather than with the whole. Many entering first-grade children can use manipulative materials to represent the object in orally stated problems; they can form groups, compare them, join them, separate them, and decompose them, as needed, to solve problems involving all four arithmetic operations.

Lemoyne and Favreau (1981) explored Piaget's concept of number development and its relevance to mathematics learning. The aim of this study was to find the characteristics of the processes used by operational and pre operational children in solving simple addition and subtraction problems. Secondly, is concrete operational thought necessary to understand and be successful in the basic operations on numbers. Moreover why do the operational children achieve greater success in arithmetic than pre operational children. 18 children in age group 6 to 7 years were tested on classification, seriation, conservation, and ordinal correspondence tests. Results of the study revealed that the numerical strategies of the operational children present several operational characteristics, they seem to reveal a good comprehension of the ordinal and cardinal aspects of number. Equivalence is made between addition and subtraction and displacement in the sequence of natural numbers. They also demonstrate an understanding of the additive composition of numbers. This knowledge was, in part, responsible for their success in many problems and accounted for the good retrieval of number facts. Their strategies further exhibited a first level of operational reversibility. The fact that all these children used, at least in some problems, a compensation process and that only two of them applied the inverse operation was evidence in support of this interpretation. The numerical strategies of almost half the pre operational children in the sample show the same operational characteristics as those of the operational children.

This result would seem to indicate that numerical structures are constructed before or at least concomitantly with class and relation structures.

Bednarz and Janvier (1982) wrote an article on the understanding of numeration in primary school. This article presents results of a research project concerned with primary level pupils' understanding of numeration. The two main objectives of this research were to clarify the notion of numeration and to make explicit as much as possible, what an understanding of this concept implies. They were also concerned not to limit to only a theoretical study but to make research results usable by teachers. One of the major out come of this analysis was the discovery of a striking similarity between the processes involved in numeration and in measurement. Numeration involves associating a collection with the representation of the corresponding number. While in measuring, one associates a number with some magnitude of a physical object. These association processes are isomorphic in nature. The action of making groupings corresponds to that of covering with a connected chain of basic units. We easily see that counterparts of groupings and groupings of groupings are working with basic units and working with units built from basic units. Some of the items show how the notion of measure can be effectively used to develop the concept of numeration. For instance, as the rule of grouping is generally given in learning situations involving numeration, the idea of measuring would more naturally guide the pupils to finding for themselves the rule of grouping which is then more basically suggested.

Number is assumed to be the product of a set of rules applied to real world quantitative phenomena. Piaget described the concept of number as a synthesis of two concrete operational systems, namely seriation and classification. The first operational system concerned asymmetrical relations. The second operational system concerned symmetrical relations or relations of equality. To Piaget, the serial nature of the natural number system could be explained by the logical principles of seriation. But Piaget's views of number and number development have been seriously criticised.

Brainerd (1979) , has questioned the hypothesized synchronous development of the ordinal and cardinal properties of number. More serious and fundamental criticisms concern Piaget's view of the logical foundation of number, that is, the hypothesized relation between number and seriation and classification. Mac Namara (1975) argued, for example, that classification could not be a basis for understanding number, because a logical class-structure differed in several respects from the structure of natural numbers. Later Piaget was criticized on his number experiments. Studies on subitization and estimation were also done.

Smitsman (1982) did a series of studies on perception of number by using estimation amongst children and adults. He used configurations varying in arrangement of elements, which were constructed to assess whether number is abstracted in estimation tasks. In some configurations, circles (or squares) were placed in separate groups of two or four, and interspersed randomly among single randomly placed squares (or circles). Other configurations consisted of single circles and squares randomly placed. Besides arrangement, the proportion of circles or squares varied from 0.40 to 0.60. It was expected that estimations would systematically favour the category that was arranged in separate groups. This effect was found in all experiments, but was not larger for group 4 compared to group 2 arrangement. Moreover, the effect occurred for eight year olds and older subjects, and could be induced in six year- olds who did not show the effect prior to training by training them to abstract number. Results were interpreted in terms of the perception of a higher order structure of number.

Cobb (1987) wrote an interesting paper to compare and contrast three recent attempts to construct conceptual models of early number development. These are a model of children's counting types (Steffe, Von Gleserfeld, Richards & Cobb, 1983) and its extension to thinking strategies (Cobb, 1984) and two models of the development of children's ability to solve arithmetical word problems (Briars & Larkin, 1984; Riley, Greeno & Heler, 1983). It is important to study them because all three models specify a possible developmental route by which children construct the part-whole concept. Riley et al. (1983) and Briars and Larkin (1984) have developed computer-based models to account for general developmental trends in children's ability to solve addition and subtraction word problems by manipulating objects. It is a schema-based model (Greeno & Johnson, 1984). Successful problem-solving performance is accounted for by the availability of an appropriate schema in memory, where a schema is an organized structure consisting of elements and relations. The process of constructing a problem representation involves mapping the verbal problem statement onto the schema with an appropriate assignment of specific quantities to the slots of elements of the schema structure. The Riley et al. (1983) model constructs problem representations by mapping verbal problem statements onto a change schema in memory.

Briars and Larkin's (1984) CHIPS model relies more on its knowledge of relations between operators to augment a basic problem representation, ultimately resulting in mathematical representations that are structurally similar to those produced by the Riley et al.(1983) model. Steffe et al. (1983), in contrast, initially analyzed the units or conceptual entities that children construct when they count to solve a variety of arithmetical tasks. The counting types model documents five increasingly sophisticated types of units that children create when they count. These are perceptual, figural, motor, verbal, and abstract units. Children are classified as being counters of a particular type on the basis of the most sophisticated type of unit that they can count. Only at the fifth level, abstract counting, can number words or numerals. This signifies conceptual entities that appear to exist independently of the child's actual or represented sensory-motor activity. Cobb (1984) extended the counting types model by suggesting two further conceptual levels. Children at the first of these, double integration, can establish implicit part-whole relations in a bottom-up manner by taking two numbers as a unity. Children at the highest level, part-whole, can establish explicit part-whole relations in a top-down fashion and can express them in a variety of ways.

Three research teams studied the models and found that each model embodies the notion that cognitive development involves the acquisition of the ability to operate on the entities of lower levels. In the developmental path outlined by Steffe et al.(1983), the child first constructs number as an arithmetical object and then gradually develops the ability to establish relationship between numbers. All three models therefore, attempt to account for qualitative changes in children's arithmetical thinking. Riley et al.'s and Briars and Larkin's models account for qualitative change by adding conceptual abilities rather than by dealing with qualitative changes in particular conceptual entities. Steffe et al. , in contrast , specified five qualitatively distinct types of number word meanings, only the most sophisticated of which corresponds to a set with a numerical value.

In the Riley et al.(1983) model, the problem text is mapped on to a change schema in memory, were as in the Briars and Larkin's model, a basic representation is constructed. Both teams make it clear that they did not attempt to give complete account of the encoding process. Instead, they addressed the more limited problem of modeling processes whose products, problem representation , are the same as those attributed to children. Each model has dealt with this process only to extent necessary to achieve their respective goals. The models developed by Riley et al.(1983) and Briars and Larkin (1984)account for general developmental trends in children's ability to solve word problems. Steffe et al. offer a collection of organized constructs that are used to explain individual children's arithmetical activity.

Children's understanding of number, as well as the numerical understanding indicated by children's use of number words, has been the subject of debate. Piaget (1952) claimed that young children's understanding of a one-to-one correspondence is limited to situations in which that correspondence is perceptually available to the children. Sophian (1988) and Becker (1989) have demonstrated that children use number words to denote whether the items of the two sets have a one-to-one correspondence relation even when the correspondence, or lack of it, is not perceptually available. These investigators presented children with two kinds of tasks. In one kind of task, children knew the cardinal value of each of two sets and were asked to determine weather the items of the two sets could be match one-to-one. In the other kind of task, children knew weather items of two sets could be matched one-to-one and were asked to determine weather the same number word appropriately described both sets. Many pre-school age children performed well on both task, providing direct evidence that they understood the relation between one words and quantity in these situations and could use number words to reason numerically about one-to-one correspondences that were not perceptually available.

Becker (1993), extended his work on numerical use of number words by another study to determine whether young children can use number words to reason numerically many-to-one correspondences that are not perceptually available. Forty-eighth preschoolers in age group 4-6 years were tested on two tasks of counting in many to one situation. Children performances on these tasks demonstrate that, give a perceptually available set of dolls, children can use number words to determine the quantity of a hidden or non-existent set of items in a known ratio to the present set (2 or 3 items for each doll). Children appropriate use of counting in these many-to-one situations develops during the period from 4 to 5.5 years old.

In another study Sophian (1988) extended her work on numerosity and one-to-one correspondence. Sophian et al. (1995) examined pre school children's ability to draw inferences about numerosity from correspondences between sets through two experiments. In experiment 1, 3- and 4- year-old children made numerical inferences about the hidden set from their own counts of the corresponding visible set and also from numerical information about that set state by the experimenter. Experiment2 contrasted a count condition with a move condition, in which children's attention was not explicitly drawn to the numerosity of the visible set. Again, children were make able to make numerical inferences as early as three years of age. However, differences between the two conditions implicate production deficiencies in young children use of counting as problem-solving strategies when they are explicitly told to count.

Most early mathematics learning is concern with developing whole number knowledge, especially counting. Children from an early stage spontaneously practice counting skills, including the conventional number-name sequence. The cognitive skills of both counting and sharing seem to develop during the early childhood years. Both skills require action on discrete elements, entailing the logic of one-to-one correspondences. Davis and Pitkethly (1990) argued that although pre school children will use a dealing strategy in a structured situation, they are unaware that dealing in it self is adequate to establish fair shares. Frydman and Bryant (1988) went further to claim ,"if children have full explicit understanding of a quantitative significant of sharing , they should be able to infer the number of items in shared set when they know the number in the other".(p.325). Fuson and Hall (1983) has emphasized the role of language pattern as children acquire the conventional number-word sequence. Accounting in which the young child's developing counting skill are principal-driven has been proposed by Gelman and Meck, (1983).

Pepper (1998) focused on how counting and sharing relate to one another. She conducted an experiment in which applications of counting skills, of visual cues such as subitizing, and of informal measurement skills were made more difficult step by step. Children exhibited alternative strategies suggesting the use of a recipient as a mental cycle marker and an adjacent recipient strategy, with pauses between allocations suggesting a representation of lots corresponding to the number of recipients. Result supported the view that dealing competence does not relate directly to counting skill.

2.2 The role of language characteristics on number system

Any counting system consists of a set of ordered number names. If these names are applied in serial one-to-one correspondence to a set of objects they can be used to symbolize cardinal and ordinal values. Various studies were done on accuracy and counting behaviour of children. Some reveal that 3-and 4- year olds can accurately count small arrays (e.g. three and four objects) but infrequently count large arrays accurately. While others interpreted that the young children did not understand the "cardinality" rule, that is, for these children the last numeral recited did not represent the cardinal value of the array. Later studies were devised to explore these aspects furthur. Saxe (1977) studied the developmental changes in the way children use counting as a notational symbol system to manipulate numerical information. Two studies were conducted. Study 1 reports cross-sectional findings on children's counting behavior on the tasks and study 2 reports a follow-up study using the same counting tasks. In study 1, 3-, 4-, and 7- year olds' use of counting to compare and reproduce arrays numerically was analyzed with respect to 2 features: (1) counting accuracy, and (2) Counting strategy. In study 2, 9 of the 3-year- olds who participated in study 1 were re-tested 12 and 18 months following their initial assessments. As predicted, in both studies there was an age- related improvement In accuracy which was interrelated with a progression from the use of pre quantitative to the use of quantitative counting strategies to compare and reproduce number.

Later studies came up on sociogenesis of cognition i.e. inter relation between socio-historical events and cognitive adaptation. How it leads to development of complex arithmetic thought which in turn leads to concomitant change in the complexity of numeration systems. In another study Saxe (1982) documents the emergence of new forms of arithmetical thought among the Oksapmin, a cultural group that resides in a remote area of Papua New Guinea. The Oksapmin counting system consists of a set of 27 body parts; there is no traditional context in which it is used for arithmetical computation. With the introduction of a money economy, some Oksapmin must solve arithmetic problems inherent in economic exchange as a part of their everyday activities. To determine the effect of the money economy on arithmetical thought, four groups of Oksapmin with varying levels of experience with economic exchange were interviewed about the addition and subtraction of coins when the coins were available to count and when they were not. An analysis of subject's strategies revealed that why traditional people effectively extended their use of the body system to solve addition problems with coins present, they did not do so on the other problems. With increasing participation in the money economy, individuals solved all problems with increasingly sophisticated computational procedures. An analysis of these procedures revealed both cognitive structural changes in development of correspondence operations and functional shifts in the way in which body parts were used to effect solution to the arithmetic problems.

Research on language development suggests that children may have difficulty understanding that the relation between number words and the values they represent is arbitrary. Number words are cultural symbols, which are arbitrary in the sense. Vygotsky (1962) have shown that young children believe that the word used to refer to an object can not be changed without changing substantial properties of the object which it refers. This reveals the fact that the standard number words can be replaced by another symbol set in counting operations is one aspect of the conventional nature of cultural symbols for numbers. A second aspect is that the same symbols may represent different numbers. This second aspect plays a central role in our numeration system. For example, the symbol 1 may represent unity or ten times unity, depending on the column in which it appears. Another example is that one shell may be equivalent to five beads in Tribe A and five shells may be equivalent to one bead in Tribe B. The development of both aspect (knowledge of the substitutability of number words and knowledge that the same symbols may be used for different numbers) may be seen as the *progressive distancing* of symbols for number from the function that they serve (Werner and Kaplan, 1963). Many researches has been done on this aspect.

Both Briars and Siegler (1984) and Gelman and Meck (1983) have documented children's understanding that some features of counting are necessary where as others are optional. To study children's understanding of optional and necessary features of counting, Briars and Siegler (1984) presented children with puppets that may two types of departure from standard correct counts. In the first type the puppet counted correctly but violated adjacency and start-at-end conventions. In the second type, the puppet counted incorrectly, violating the necessary one-to-one correspondences between number words and objects. Briars and Siegler's analysis revealed that 3-and 4- year olds generally failed to distinguish between necessary (one-to-one correspondence) and optional (adjacency and start-at-end) features of counting, where as 5- year- olds did make this distinction.

Briars and Siegler argued, on the basis of their findings, that induction is the basis for children's differentiation between the necessary and optional features of counting. They suggested that the majority of counts observed by children incorporate both the necessary feature of one-to-one correspondence and the optional strategies like start- at-end. Therefore, children first induce that all these features are necessary. Only later, as children accumulate observations about counts that do not incorporate the optional features, do they come to induce the optional nature of these features.

Gelman and Meck (1983) conducted a study similar to that of Briars and Siegler. They found that even 3- year olds tended to accept counts that did not incorporate the optional features (adjacency and start-at-end) and to reject counts that violate the necessary (one-to-one correspondence). They cited these data as support for the view that children as young as 3- year know the principles to which counting procedures must conform. For Gelman and Meck(1983), there is no need for the child to induce the distinction between necessary and optional feature; the knowledge of the principles is part of the child's early competence. In order to study developmental differences in children understanding that symbols for number are arbitrary conventional. Children between 3 and 12 years were presented with tasks in which they had to made judgement about (a) the adequacy of puppet's counting activities when puppets used standard as opposed to non standard number words in counting and (b) the adequacy of puppet's token exchanges when the values of the same tokens varied across numerical systems. In both tasks, the findings revealed developmental shifts in children's ability to distance numerical meaning from conventional symbols. In the number words task, children increasingly appreciated that provided the principle of one-to-one correspondence between symbol and counted item is maintained, any symbol list may be used for counting. In the token-exchange tasks, children increasingly appreciated that the same tokens could represent different values in the different systems.

Nunes (1992) reviewed studies to explore two alternative hypothesis derived from the ideas put froth by the Russian developmental psychologists, Vygotsky and Luria(1976), on the role of culture in cognitive development. The first hypothesis is that culturally transmitted systems of signs alter people's basic psychological functions (such as perception, memory, logical reasoning), thereby segregating those who have learned to use certain important systems of signs as mediators and those who have not. The second hypothesis is that systems of signs influence the functional organisation of people's activities as they use the systems without necessarily producing generalised effects. This implies there is no prediction of a "great divide" between instructed and non-instructed people. It is an empirical question as to whether one or the other hypothesis will hold for any particular system of signs. The fact that one of these hypotheses is verified with respect to one system of signs does not imply that it will also hold with respect to another system.

In support of first hypothesis a series of studies done by Vygoysky and Luria (1976) on literate and non-literate adults through a series of tasks i.e. categorisation, arithmetic problem solving and syllogistic reasoning was reviewed. It was revealed that non-literate adults displayed a mode of thinking which relied on operations used in practical life whereas literate subjects demonstrated a willingness to work with linguistically created realities, a form of theoretical attitude which disregarded particular relations existing in practical life. But Mehan (1979), criticized above studies by arguing that it is not possible to separate out the effect of literacy from those effects of schooling which are not directly related to literacy. Schooled subjects would not have simply acquired literacy but also a whole set of social assumptions about how to behave in such situations and general cognitive techniques for solving problems. Differences between literate and non-literate in the above studies might not result might not result from influences of literacy on general cognitive functioning. But later Scribner and Cole (1981) worked with three types of literacy group. One literate and two out side school with same tests done by Vygotsky and Luria(1976). It was found that there is no general effects of literacy on intellectual processes. Hence, Scribner and Cole (1981), open the way for this second hypothesis.

In order to test the second hypothesis, it was necessary to compare subjects working in the oral mode with others working in the written mode. It can be tested across cultures that use different systems of signs, across groups of subjects within the same culture and also within subjects across situations. For example, perhaps learning a numeration system has specific effects on counting and calculating but learning literal representation for mathematical sentences has general effects. In support of second hypothesis studies were reviewed from the field of mathematics i.e. on counting and calculating. Vygotskian work on numeration revealed. Numeration and counting allows human beings to work beyond their natural capacities. Gelman and Gallistel (1978) support the same. Saxe (1982) also supported above while studying Oksapmin in Papua New Guinea. It was revealed that someone counting in English will outperform the Oksapmin from Papua New Guinea, who count with the support of a body-part numeration system, when very large numbers of items are involved. Hence, English speakers develop better memory than the Oksampmin in a general way.

Miller and Stigler (1987) also supported Saxe's findings. They compared Chinese and U.S. children with respect to their ability to count while they were, using their different counting systems. Chinese system is regular; its organisation is likely to be easily understood even by children who were taught how to count only up to 20 or 30 while English system is not so transparent. It was found that Chinese children perfomed better than their U.S. peers but Chinese children do not appear to have greater control of the counting principles than do American children. Thus, we can observe differences in performance between children using different systems of signs although they are relying on the same psychological processes.

Similarly for calculating Carraher, Carraher, and Schliemann (1985) observed the existence of two different practices of arithmetic among working class children in Brazil, an oral practice used in the streets and a written tradition which is systematically transmitted in school. Later Grando (1988) confirmed the trends observed during error analysis in a study, which compared the performance of farmers and students from a rural area in the south of Brazil solving arithmetic problems involving decimals. Results showed that subjects in the oral condition performed significantly better than those in the written condition. Finally it revealed oral and written arithmetic deal differently with the representation of the type of value, debt \ profit, and the operation, addition \ subtraction. The written system uses the same representation for both meanings and is likely to create difficulty for novices. Hence, the specific effects of the systems of signs on performance can be predicted from the nature of the systems and thus do not seem to reflect a simple effect of amount of practice.

Nunes (1990) investigated whether children with no previous school instruction on the number system could understand three different aspects of numeration systems: (1) the ability to distinguish between relative and absolute value; (2) the ability to sequentially count coins of the same relative value taking number of coins and total sum into account; and (3) the ability to combine token coins of different values into a single total. The subjects were 72 Brazilian pre-schoolers from two schools, in age group 6\7 years and 5\6 years respectively. Children were initially pre-tested on their counting ability above number 10. Children were asked to solve three tasks with money in a fixed order due to the fact that the tasks became increasingly more complex as the interview went on. These tasks are (1) a relative values task; (2) a counting money with some values task; and (3) a counting money with different values task. Interesting results came up from the study. First, only a little more than half of the children who are able to generate numbers correctly were also able to display knowledge of basic conceptual aspects of the numeration system. Generating number labels systematically does not seem to be a sufficient condition for understanding the underlying principles. Second, a small number of children showed a good understanding of the conceptual aspects they were not able to generate number labels systematically. It indicates that knowing number label is not a necessary condition for understanding the numeration system. Thirdly a sequence of a acquisition is found which is important for teaching purpose. Finally the context of counting money can be effectively used for starting counting with pre-schoolers.

Nunes (1996) worked with 72 preschool children in age group 5-7 years entering the preschool in Brazil and 20 adults from a poor background who had never attended school. The children did not know how to write multi-digit numbers but some of the adults did. In order to investigate their understanding of the concept of unit and additive composition in the context of money, two tasks were used. These tasks were based on a shop situation where one goes to buy sweets with two arrays of pretend coins. Sixty percent of the children succeeded in this task. Among them were some who could not even count the total amount of money in the arrays but were able to recognize that four 10c coins buy more sweets than four 1c coins. The unschooled adults made no mistakes at all in this task. We can conclude that children and adults can attain an understanding of the concept of units of different size in the context of money without going to school and also without knowing how to write multi-digit numbers. The second task was about additive composition and the decade (i.e. base-ten) structure. Its purpose was to measure the children's ability to combine different denominations (tens and ones) in order to reach a particular number. Only 39 per cent of the children succeeded in the second task. However, their rate of success, indicates clearly that it is not necessary for children to learn to write numbers in order to understand additive composition. Approximately 70 per cent of the adults answered all three items correctly and not one of them answered all three incorrectly.

These two studies led to the following conclusions. Firstly, knowing how to count and understanding the relative value of counting units and their additive composition are not one and the same thing. Children who know how to count may still not be able to understand the relative value of units and compose totals with different-value units in the context of dealing with money. Secondly, neither schooling nor the ability to write numbers is crucial for the understanding of these aspects of number. They can be mastered from the use of the oral numeration system at least in coordination with familiarity with monetary systems.

Nunes et al. (1996) also examined children's productions of written number in England. They asked the English children to write a single-digit number (8), three two-digit numbers (14, 25, 47), two three-digit numbers (108, 129), and one four-digit number (2569). They also asked them to write round numbers (10, 60, 100, 200, 1000). They were also asked to read numbers chosen in an analogous way. The most important hypothesis were: First, they expected that the size of the number would not be the best predictor of its difficulty for the children either in the reading of writing task. Round numbers, such as 0, 100, 200 and 1000 might be seen more frequently by children in everyday life and also involve fewer difficulties because the notion of additive composition is not necessary. Thus more children may write 100 correctly than 47, or 200 than 129, even though 100 and 200 have larger values than 47 and 129 respectively. Second, they expected that children would be active learners of the written numeration system and try to generate written representations although they had not been taught how to write two-digit numbers and had not mastered the system. This hypothesis has based on their view that learning mathematics involves the acquisition of generative systems rather than the learning, of isolated facts.

Almost all the children were able to write 8 (93 per cent) and 10 (85 per cent) correctly. Only a few children (about 15 per cent) refused to try to write most of the other numbers. About half of the children said that they could not write 2569 but only about 30 per cent said they could not write 129. Some children (4 per cent) appeared to use a one – to – one correspondence between a number word and a digit. Many of the children seemed to use two systems, one for the two-digit numbers and one for writing 108, 129, (sometimes) 200 and 2569. The two-digit numbers (25 and 47) plus the round numbers (100, 1000, and sometimes 200) were often written correctly. It is unlikely that all two – digit numbers could be memorized without a system that helped the children in their production. Their second system consisted of concatenating a string of numbers corresponding to the number labels, just as we had observed with Brazilian children. Thus 108 is written as 1008 and 2569 was written as 200050069. Sometimes the number of zeros was either increased or decreased. For the numbers 108 and 129 about 40 per cent of the children produced this type of writing. A third type of response included productions that involved other mistakes-such as writing a wrong digit (for example, 129 may have appeared as 159) or inverting the right to left position of the digits (e.g. 47 written as 74). These errors account for a relatively small percentage of productions and don't exceed 21 per cent in any case. A small portion of children's errors in writing numbers was the result of using the wrong digit or the wrong relative position of digits. This study gives a new perspective on how representation affects understanding of a numeral.

Many recent reports of standardized test results has documented the superior mathematics performance of Asian Americans. It has also been supported by cross-national comparisons of mathematics achievement. Mostly cultural emphasise on education, parental support and IQ have been reported as contributing factors.

Lynn (1982) suggested superior innate ability to account for these differences at least for native Japanese. Evidence from 27 samples indicates that the mean IQ in Japan is higher than in the United States by around one-third to two-third of a standard deviation. Analysis of results from the standardization in Japan in 1975 of the new revised version of the American Wechsler intelligence scale for children shows that the Japanese-American disparity in mean IQ has increased during the twentieth century. Among the younger generation the mean Japanese IQ is approximately 111.

In another study Lynn and Hampson (1987) analyzed the structure of abilities of Japanese children in terms of the Burt-Vernon hierarchical model of intelligence. The data are derived from the Japanese standardization of the Wechsler Preschool and Primary Scale for Intelligence. It was found that Japanese children do not differ significantly from white American children on Spearman's g, are significantly inferior on the group verbal factor and superior on the group perceptual factor. On the primary abilities, Japanese children are inferior on verbal comprehension, not significantly different on perceptual speed, and superior on number spatial ability. It is suggested that this pattern of Japanese cognitive strengths and weaknesses help to clarify a number of conflicting findings on Japanese intelligence.

Stigler et al.(1982) wrote an article on curriculum and achievement in mathematics. This article describes a method for constructing a test of mathematics achievement for use in a cross-national study. The mathematics curricula as presented in elementary school textbook series from Japan, Taiwan, and United States were analyzed according to the grade level at which various concepts and skills were introduced. The Japanese curriculum contained more concepts and skills. Moreover, introduced these concepts and skills earlier than the curricula of Taiwan and the United States. The curriculum was somewhat more advanced in the United States than in Taiwan. The test was administered to 240 first-grade and 240 fifth-grade children randomly selected from 40 classrooms in each of the three countries. Children from Japan and Taiwan consistently performed at a higher level than their American counterparts. Level of achievement in elementary school mathematics appears not to be closely related to the content of the curriculum. Hence, it supports the notion that these differences were due to variations in cognitive functioning.

Hess, McDevitt and Chang (1987) examined beliefs about children's performance in mathematics through interviews with mothers and their sixth-grade children in the People's Republic of China (PRC) and in Chinese-American and Caucasian-American groups in the United States. Explanations for relatively high and low performance were indicated by attribution to ability, effort, training at home, training at school, and luck. They also asked mothers about specific instances of unusually high or low achievement. The group showed different patterns of attribution. Mothers in the PRC viewed lack of effort as the major cause of low performances. The Chinese Americans also viewed lack of effort as important but assigned considerable responsibility to other sources. The Caucasian-Americans distributed responsibility more evenly across the options. PRC mothers offered partial reinforcement to children who brought home a good grade. American mothers, both Chinese and Caucasian, were likely to offer unqualified praise. National differences in performance may occur in part because of such cultural variations in beliefs.

But Miura (1987) compared American and Japanese children residing in the United States to know the ethnic difference amongst children. He took the perspective of differential cognitive organization of number resulting from difference in primary language characteristics. There were 21 children from Japanese Saturday school and 20 children from private grammar school. They were tested on an experiment involving number cards and blocks for units and tens. Results showed that the cognitive representation of number for children whose only language was English differed from those whose primary language was Japanese. The relation between cognitive representation of number and mathematics achievement was also explored.

Miura, Chang and Okamoto (1988) compared the cognitive representation or number of American, Chinese, Japanese and Korean first graders and Korean kindergartners, to determine if there might be variations in those representations resulting from numerical language characteristics that differentiate Asian and non-Asian language groups. Children were asked to construct various numbers using base 10 blocks. Chinese, Japanese and Korean children preferred to use a construction of tens and ones to show numbers. Place value appeared to be an integral component of their representations. In contrast, English- speaking children preferred to use a collection of units, suggesting that they represent number as a grouping of counted objects. More Asian children than American children were able to construct each number in 2 ways, which suggests greater flexibility of mental number manipulation.

Miura, Okamoto (1989) in their another study examined the argument that differences in mathematics performance between students from the United States and Japan may be due to fundamental variations in cognitive representation of number that result from differences in numerical language characteristics that differentiate the two groups. Twenty-four first graders from each country participated in the study. The results suggest that first graders in the United States and Japan differ in their cognitive representation of number and that this difference may positively affect the Japanese children's understanding of place value and their subsequent mathematics performance.

Miura et al. (1994) did a study an comparisons of children's cognitive representation of number: China, France, Korea, Sweden and United States. Same methods used in earlier studies were used again for number representations (Miura et al. , 1988). The results from this study supported the earlier findings (Miura, 1987; Miura and Okamoto, 1989; Miura et al., 1988) which suggested that Asian-language speakers appear to represent numbers differently than non-English-language speakers. The Asian-language speakers showed an initial preference for using a canonical Base 10 representation to construct numbers. Place value appears to be more clearly represented in these constructions. Asian-language groups were also more likely than the non-Asian-language speakers to use a non-canonical construction, which may indicate greater facility with number quantities. The Chinese, Japanese and Korean children were better able than the French, Swedish, and US children to make two correct constructions for the five numbers. The ability to think of more than one way to show each number suggests greater flexibility of mental number manipulation. The results of this study appear to support the hypothesis that numerical language characteristics may have a significant effect on cognitive representation of number. This, in turn, may contribute positively to Asian children's performance in mathematics number manipulation, especially computation tasks.

2.3 Gender difference in mathematics performance

Gender differences has attracted a lot of researchers who work in field of mathematics. Mathematics abilities has always remained debatable when it comes to female mathematics competence. Marrett and Gates (1983) found no gender differences in enrolment. Enrolment patterns in different schools seemed to vary more by school than by sex. In Indian context Delhi public schools, Mayo College and other elite institutes may have equal number of girls and boys studying mathematics. But the number of girls in other schools, particularly, in the schools of rural areas or in semi-urban areas is very low. Mostly cultural and social factors affect girls under representation in mathematics. Several investigations and reviews reveal that class VI and beyond, boys are somewhat superior to girls in arithmetic reasoning, spatial abilities and problem-solving (Aiken, 1970; Fennema and Sherman, 1977; Armstrong, 1980; Fennema and Carpenter, 1981; Marshal, 1984) and girls are somewhat superior to boys in verbal ability, arithmetic fundamentals and rote learning (e.g. computations). But sex differences in abilities are less pronounced in the earlier classes, and there is a general differentiation of abilities with age and experience.

Women were found superiors to men in Hashaway's (1981) study. Men, on the other hand, tended to surpass women in ratio, proportion, and in percentage in Hashaway's (1981) study. Ethington and Wolfe (1984) reported that women scored somewhat lower than men in a combined test of mathematics even after controlling for the effects of parental education, spatial and perceptual abilities, high school-grades, attitude towards mathematics and exposure towards mathematics course. They concluded that there is a complex interaction among sex, other selected variables, and mathematics achievements. In a recent study, Patel (1997) also reported boys better than girls in achievement in mathematics.

Data from the Second International Mathematics Study were used by Hanna (1986) to examine sex differences in mathematics achievement of Canadian Class VIII students. Five areas were surveyed: arithmetic, algebra, probability and statistics, geometry and measurement. No significant differences were reported in the performance of boys and girls on the first three subjects. In geometry and measurement, the boy's mean was somewhat higher than that of girls. The differences, though not large, were statistically significant at the 0.01 level.

In the area of mathematical creativity, very few studies have been conducted. Tuli (1982) reported that boys scored higher in mathematical creativity test than girls. While Vora (1984) reported that males were not invariably superior to females on any dimension of mathematical creativity.

Byrnes and Takahira (1993) used a cognitive process approach to explain gender differences on the math sub-test of the Scholastic Aptitude Test (SAT). The approach specifies that gender differences exist because male students may carry out certain cognitive operations (e.g., knowledge access, strategy assembly) more effectively than female students. High school students were given SAT items and measures of their prior knowledge and strategies. Results showed that male students performed better than female students' n the SAT items. Regression analyses, however, showed that whereas prior knowledge and strategies explained nearly 50% of the variance in SAT scores, gender explained no unique variance. These findings suggests that it is not one's gender that matters as one's prior knowledge and strategies.

Pal and Natrajan (1997) did a study focusing on; (i) the gender differences on mathematics achievement and mathematics-related social and affective factors and (ii) the gender specific variations in the relationship between mathematics achievement and mathematics-related variables. Using a sample of 326 primary students of class IV, it was seen that mathematics achievement score were in favour of girls and significantly differed from that of boys. Some of the mathematics-related factors significantly correlated with each other as well as with mathematics achievement for both boys and girls. There were a few gender specific variations in the correlates of mathematics achievement.

2.4 Studies done in Indian context

Most of the Indian studies focused on instruction techniques, competency based mathematics teaching, strategies of problem solving and teaching aid effectiveness are there.

Pandey (1980) studied the effectiveness of programmed instructions as compared to traditional mode of teaching. Sixty fourth graders from a central school in Bhutan were studied. Three groups were there. One was control group having no assignments. Other two were experimental groups in which one had programmed instructions while other had traditional instruction with assignments. Results of the study reveal that group having programmed instruction performed better than other two groups. The income and interaction did not affect achievement. Hence, he suggested that programmed instructions are useful in classroom teaching. Bhatia (1992) also supported Pandey's findings as students getting programmed instructions performed better in fractions tasks during post-test as compared to other group

Singh, Ahluwalia and Verma (1991) worked on effectiveness of computer Assisted Instructions (CAI) and Convetional Method (CM) of instruction while teaching mathematics. In total 220 students from higher secondary school were instructed on the basis of mathematics syllabus for class IX. The topics were taken from algebra, statistics and geometry. The results of the study showed significant differences between the mathematics achievement of the students who used the computer for specific topics in the class IX syllabus of mathematics, compared to the students taught through the conventional method. The students who used the computer scored significantly higher on the post-test than those who did not used the computer. No, significant difference in achievement scores of male and female students was established. The students who used the computer showed significantly highly favourable attitude towards mathematics than those who did not use the computer. Change in attitude towards mathematics was found independent of the sex factor.

Singh and Verma (1992) studied the attitude of high school students towards mathematics. There were 220 IX grade students as sample. A rating scale, a general intelligence test and a scale for measuring attitude towards mathematics was implemented. Findings suggest that the students of the higher intelligence group have more favourable attitude towards Mathematics, in comparison to the students of both the average and low intelligence groups attitude towards Mathematics is a function of intelligence so, the attitude towards Mathematics is independent of sex. More over, the students of the age 13+ show more favourable attitude towards Mathematics in comparison to the students of the ages 14+ and 15+, but the students of 14+ do not have more favourable attitudes towards Mathematics in comparison to the students of 15+.

Sahoo (1996) worked on a competency based mathematics teaching programme. He revealed that children learn the competencies very well through activities that apeal to them and by interacting with their teachers and fellow students.

Dayal (1996) did a study focusing upon identifying varying levels of number understanding of pupils of grade I and II and their intellectual strategies adopted in solving problems of addition. He investigated the influence of both the levels of number concept maturation and addition strategy adopted on scholastic number conservation test, addition strategy test and achievement test in addition were implemented on 97 subjects studying in grade I and II. Major finding of the study were (1) Children of ages six plus and seven plus years studying in Grades I and II could be identified as non-conservers, transitionals and conservers. (2) As the age of the child increased, the number concept maturation level tended to improve qualitatively and so was the state in case of grade levels. (3) The addition strategy adopted tended to be commensurate with the level of number concept maturation i.e. lower order addition strategy was adopted by children operating at lower level of number concept maturation and so on . (4) Children tended to use the same addition strategy in oral as well as written problems. (5) Type of problem did not result in a change of strategy for lower order addition strategy users. (6) The level of number concept maturation as well as the addition strategy adopted both tended to influence achievement in addition. (7) There was a moderate correlation between the level of number concept maturation and addition strategy adopted. (8) There was a high correlation between the level of number concept maturation and achievement in addition. (9) There was moderate correlation between addition strategy adopted and achievement in addition.

Pal, Pradhan and Natrajan (1997) explored the errors made by primary students on each concept of mathematics on minimum levels of learning (MLL) curriculum. 326 VI graders from Maharashtra were tested on a Mathematics Achievement Test (MAT) based on MLL. On analysing the errors made by children on this test it was found that major reason for errors were rooted in an alternative pattern of rules. Secondly errors were the result of incorrect induction from examples. Thirdly most of the errors were produced by a process of dualism i.e. a different rule when zero involves as seen earlier in case of place value, subtraction and multiplication. Finally, errors triggered due to inadequacy of language used in the definitions, rule or procedure names.

It is often heard that mathematics is a difficult subject. This is the feeling not only of students but also of some of the teachers teaching mathematics at the primary level. It is also generally experienced that teaching of mathematics is not very effective and interesting. However, there are some teachers who are capable of generating interest among children in the classroom, thereby creating an environment for better learning. Its essentially a subject where doing is more prominent than reading. So, teaching aids in schools are very important. Our schools suffer heavily due to lack of funds and we cannot afford to go in for commercially produced sophisticated learning aids. So the teacher must know how to prepare teaching aids without any cost by using ordinary, cheap, waste materials. So, Perisamy (2001) devised a study which aims to evaluate the effectiveness of the no-cost teaching aids in writing the numerals at the beginning stage in mathematics. The sample consisted of 31 students studying in Class I. children used the teaching aids made of cardboards to learn numeral writing. Results shows that number cut-outs have helped the Class I students to write the numerals. This further shows that writing of numerals using number cutouts and seeds through activity is the best and easiest way. More over, it would improve the achievement of Class I students.

All the above researches have dealt with number concept, its conservation, teaching numbers and counting mostly. Most of the researches during 70's and 80's replicated the various experiments done by Piaget (1952) and were explained in his book title, 'child's conception of number. These researches some how reached the aspect of numeration system but never clearly specified the effect language on number. But even during this period two Russian psychologist Vygotsky and Luria (1962) started revealing the effect of cultural symbols for numbers on number understanding.

Only during 80's and 90's Miura in his series of experiments explored cross-cultural differences which explicitly revealed the differences in number representation occuring due to language characteristics. But still he never explicitly quoted Vygotsky's beliefs or findings as the basis of his research. It only during 90's Nunes looked into Vygotsky's findings and emphasized how the language characteristics affect the actual understanding of number.

Similarly a contemporary psychologist of Vigotsky, Saxe explored the sociogenesis of number system through his study on a primitive system of numeration used by a cultural group of New Guinea. His socio-historical approach clarified the evalutionery events in the evaluation of traditional number systems when it comes in contact with modern number systems.

In case of Indian studies only learning strategies gender difference were focused. It is only during late 90's work on addition subtraction problems and errors. It is only Pal (1997), who cited how the complexity of number name increase the difficulty of child in understanding problem of simple arithmetic.

Hence, all the above studies have not specifically touched upon the effect of language characteristics on number representation in Indian context. In Indian context also a group of Asian and Western languages exist in which Hindi and English are most prevalent. In order to fill this gap. This study has been designed to explore how the difference in Hindi and English numeration system effects the cognitive representation of number. Gender difference and effect of instruction has also been examined to make the study useful for teaching which is a burning issue in Indian research on education.

CHAPTER THREE

Methodology

This chapter comprises of details about the methodology and analyses techniques for present study. It is divided into nine sections. First section contains the statement of the problem for present study. Second section contains the objectives of the study. Third section deals with statement and justification of four hypotheses laid for the present study. Fourth section comprises of the sample of the study and rationale behind the selection of schools. Moreover, selection procedure of subjects is also explained. Fifth section deals with description of tools utilized for the experiment. Design of study is described in section six. Variables are described in section seven. Eighth section deals with the organization of study and the method of scoring utilized for the study. Finally, analysis techniques are discussed.

3.1 Problem statement

The problem statement for the present study is

"The effect of language characteristics on children's cognitive representation of number: comparison of Hindi and English medium children."

3.2 Objectives

The objectives of present study are

(i) To study the effects of numerical language characteristics on cognitive representation of number.

(ii) To study the effect of instructions in understanding number representation.

(iii) To study the difference between Hindi and English medium students in cognitive representation of number.

(iv) To study the gender difference in the cognitive representation of number.

3.3 Hypothesis

1. Many researches done in the area of Mathematics attribute better performance on mathematical tasks to IQ or family beliefs mostly (Lynn, 1982; Stigler et.al, 1982).

But now a different explanation is arising in the horizon of mathematics achievement research i.e. the function of language. This area of research was pioneered by Miura, (1987). He revealed that its not just the family belief or IQ but how the Asian languages numerical systems are organised "so that numerical names are congruent with the traditional base 10 numeration system," (Miura, 1987,p.79). It is how exactly a numeral is spoken corresponds to how its written plays an important role in mental representation. This facilitates a person while doing higher functions of mathematics. The better the correspondence of spoken and written form the easy it is to represent in memory. For example 37 which is numerical 3 at tens place and 7 at unit place correspond exactly to English numeral name thirty seven. The languages, which he studied, were Japanese, Chinese and Korean which also possess similar congruence. But here in our Indian context Hindi has a completely reverse relation with additive as well as minus relation.

Moreover, as the number system proceeds from unique names to composite names there can be difference in cognitive representation complexity. For example, 12 and 14 are two simple numbers with unique names while 45 is a big number with composite name. The uniqueness of name can affect the mental representation of number. Numbers such as 20 are perfect tens and are repeated in next line to denote tens place can also affect understanding. These numbers may be found easy to represent with tens blocks. Nunes (1996) also revealed similar findings during one of her studies.

Hence, it is assumed that the prevalent numeral systems will also show effect of language characteristics on cognitive representation of number. Hence, the first hypothesis of this study is that *there will be significant effect of numerical language characteristics on cognitive representation of number.*

2. Instructions play a very important role in performance of students in various mathematics tasks. They actually mobilise the teaching learning process in a right direction. Pandey (1982) revealed that the use of programmed instruction in mathematics teaching enhances the immediate achievement of students at Primary level. Singh, Ahluwalia and Verma (1991) also revealed that Computer Assisted Instructions (CAI) prove to be better than conventional Method for teaching class IX mathematics syllabus.

Bhatia (1992) also supported that students receiving the programmed instructional material perform better in post-test as compared to the other group in her study on fraction for students of class V. A study on handicapped children done by Das (1999) also found that activity based instructions on multiplication enhance learning achievement of class II deaf children.

In the present study there is a small instruction set between trial1 and trial2 to explore the other possible ways of number representation. Hence, the second hypothesis of the study is that *instructions significantly affect the cognitive representation of number.*

3. Many researches on language development suggests that the children may have difficult in understanding that the relation between number words and the values they represent is arbitrary. These are actually cultural symbols Vygotsky and Luria (1976) revealed that culturally transmitted symbols of signs alter people's basic psychological functions i.e. perception, memory and logical reasoning. These three aspects only become the basis for understanding the numeration system. Hindi and English refer to two different cultural set ups but they exist together in our system and can affect understanding also. Scribner and Cole (1981) also supported Vygotsky's perspective on number acquisition. This study is meant to find out whether cultural symbols for naming numbers in two different languages affect the cognitive representation of number.

For the present study Hindi and English are selected for comparison as they represent two entirely different systems. In Hindi system there is a continuous reverse relation to construct next number after ten. While there is a direct relation in English after twenty. Here we find unique names for each number till hundred in Hindi but in English after twenty a new number is formed at each tense place and later at 100,1000 and so on. In Hindi one to ten are unique names which were recomposed as "*gyarah*" for 11 i.e. one ten, '*barah*' for 12 i.e. two ten while it is very different from names for 2 and 10 i.e. '*do*' and '*das*' respectively. Similarly in English also it is eleven, twelve i.e. one ten, two ten respectively and is very different from actual one, two and ten. But after twenty counting moves as twenty-one i.e. direct relation. While in Hindi it is still *'ikkis'* i.e. one twenty, which is a reverse relation. Moreover, the complexity increases when it is the ninth position in each vertical column of counting. 39 is denoted as before forty rather than taken as nine thirty which normal progression of Hindi counting. It is represented as *'untalis'* which is one less than forty. Instead of additive it is subtraction from next number. This can create problems in understanding due to its minus relation, which is different from one simple pattern. This increases the complexity of Hindi counting. This study is devised to study whether this difference in number representation affects understanding of numbers or not. Hence, third hypothesis for present study is that *the numerical language characteristics of Hindi and English language would affect the cognitive representation of number.*

4.In recent years learning mathematical skills has become a major research focus due to increasing feminist concern about jobs and learning abilities of females. Generally, studies reveal that boys scores higher than girls on problem solving measure (Fennema and Sherman, 1977). But later debates came up about methodological flaws in researches. It was found that if sex differences in mathematics achievements are reduced then mathematical experiences and attitude towards mathematics are equated for boys and girls, it does not prove that there is no gender difference in aptitude towards mathematics. The analysis techniques used in Fennema's study does not control gender difference in mathematics aptitude and leaves such variance in sex.

In Indian context Tuli (1982) reported boys scored higher in mathematical creativity test than girls but Vora (1984) revealed males were not superior to females on creativity tests.

Singh and Verma (1992) revealed that attitude towards mathematics is independent of sex. About number concept also Sinha (1990) found that number conservation task was equally difficult for the boys and girls of the tribal and non tribal origins of four to five and seven to eight years of age.

Pal and Natrajan (1997) gave encouraging results by showing that girls not only perform significantly better in mathematics but also have a more positive attitude towards mathematics than boys. Since this study is also touching upon gender difference in number concept. Hence, the fourth hypothesis for the present study is that *there will be a significant difference amongst boys and girls performance on the task of cognitive representation of numbers.*

3.4 Sampling

Three schools were selected for the present study. These were M C D Primary School, Madipur, MCD Primary School, Paschim Vihar and CR Saini Public School, Nangloi. Hindi medium boys and girls sample was drawn from MCD Primary School, Madipur and MCD Primary School, PaschimVihar respectively. English medium both boys and girls sample was drawn from CR Saini Public School.

All these three schools belong to rural belt of west zone of Delhi. Hindi medium schools are in Madipur and Paschim Vihar which are adjoining areas.Both the schools cater to children living in colony of Madipur. While English medium school is in Nangloi which is also apart of this rural belt. This school caters to children living in Nangloi area.

Besides this, all three schools cater to the middle or lower middle class children in these rural areas. These areas are developing in to the sub-urban area but still not fully urbanised. Parents mostly work as daily wage labour or in low paid jobs in private or public sector.

Moreover, researcher has good access to schools as she has been in direct contact with these people through her initial sampling and piloting work. These schools were personally known and understanding has already been there for the study. The school principles also showed keen interest for this research work after listening to the framework of the study. They readily extended their help also whenever required in terms of both space and sitting arrangements.

100 students in the age group of 6 to 8 years studying in class I, II, III were selected as sample from these three schools.

The students were selected on the basis of a small interview, as it is a prerequisite for the study that the child should be able to recognise numbers. Hence, each child was interviewed individually. They were asked to recite counting 1 to 100. In addition, they were shown 5 cards having numbers 5, 16, 23, 37 and 45 respectively to confirm if they can recognise numbers properly.

Moreover, the researcher was compelled to take sample from class III in case of MCD School because even after doing class II children could hardly recognise numbers properly after 20. It is only in class III that children start recognising numbers in random order. They still use the strategy of counting that whole column to recognise the number. For example, for 45 they will count from 40 till 45 to recognise it. In total there were 50 boys and 50 girls. 25 girls were selected from MCD Primary school Paschim Vihar. 25 boys were selected from MCD Primary School, Madipur. In addition, 25 girls and 25 boys were selected from CR Saini, Public School.

3.5 Tools

An adopted version of test framework used by T. Miura (1994) is taken as tool for the present study as it is an already standardized procedure. He used commercially available 100 unit and 20 tens blocks. Researcher has also used wooden blocks of equal size made for the study. There were 200 green unit blocks and 20 red coloured tens blocks showing clear units inside. One can easily visualize that 10 units can be united to make are tens due to clear demarkation between two units.

Miura, (1994) has used number cards to show numerals. In the present study 6 numbers cards were shown. The numbers were 11, 13, 28,30, 39 and 42. There are six numbers in order to get a clear conception of number representation. Two simple numbers with unique names in both Hindi and English number systems i.e. 11,13 are used to see effect of unique number name representation. 28 is such a number which has a unique name in Hindi i.e. '*aththais*' i.e. eight twenty and in English it is twenty eight. Then 30 is the number which can be made by using tens only as it is a perfect tens number with unique name. This number is included because Nunes (1996) revealed that children perform better on tens numbers.39 is incorporated in the list of numbers given by T.Miura, (1994) as we have a minus relation i.e. one less than forty in case of Hindi which increase the complexity of its naming while in English it is still having additive relation i.e. thirty plus nine. 42 are given to provide a bigger number to increase difficulty level as it is a comparatively bigger number.

3.6 Design of the study

The ex-post facto research design is used for this study as here we were comparing two presumed to be the different groups. The two group pre-test and post–test design was planned for this study.

3.7 Variables

There were two matching variables i.e. language and sex. The two groups belong to Hindi medium and English medium respectively. Here it is expected to show a language effect on the performance of the students amongst the groups. Both Hindi and English medium groups had equal number of boys and girls, which were compared for the gender difference within the group and the difference amongst total boys, and girls. There was one measured variable i.e. cognitive ability versus numerical representation of the numbers. In context of present study, *"cognitive ability"* refers to the understanding of complexity of number representation structures for each number presented to a student. This refers to how well a child uses units and tense blocks while representing a number. The difference can be seen in terms of which group uses more tense blocks i.e. comparatively complex representation and student comes to know the rules of tens and units place. How much novelty is there in his/her representation during the two trials?

There can be one to one correspondence or canonical base 10 representation where child uses adequate number of tense and units perfectly. Besides this, non-canonical base 10 representation where the student uses more than units which depicts that they know concept of units and tense place but it is in the process of acquisition. *"Numerical representation"* refers to in how many ways a child represents a number perfectly. There are three possible ways of representation described above.

3.8 Organization of the study/ data collection

Trial-1

Children were tested individually and instructed in their mother tongue i.e. Hindi. They were shown readymade base 10 blocks which are designed so that 10 unit blocks are equal to 1 tens block. It was like a rod having clear ten segments. Children were told that the blocks could be used for counting and to make (construct) numbers. The researcher explained, "See these blocks. You can use them for counting." Then the researcher counted 10 of them putting in a single row of 10 units. Then she explained its equivalence with 1 tens block by saying, "Ten of these green blocks are the same as one red block." The researcher then did a demonstration of the equivalence by lining up the 10 unit blocks to show their equivalence to1 tens block.

Children were then asked to read a numeral written on a card and to show the number using the blocks. Coaching was done if required on two practice items (the numerals 2 and 7) to be sure that children know what to do. There were 200 unit blocks and 20 tens blocks available, more than adequate for the task so that there would be no constraints on which blocks to use. The numerals 11,13,28,30,39 and 42 were presented on cards in random order. There were two trials of six numbers each.

Trial-2

Immediately following the first trial, children were reminded of the equivalence between 10 unit blocks and 1 tens block. Then, children were shown their first constructions for each number and asked if they could show the number in a different way using the blocks. They were encouraged to use additional blocks from the pile if they close simply to rearrange their first constructions. They were free if they want to repeat the earlier arrangement only. (see further details of instructions in appendix I)

Scoring-

Responses were considered correct if the blocks summed to the whole numeral. In a few cases a correspondence error e.g. a block not being fingered. So, that the final construction contained 27 instead of 28 blocks such instances were scored as correct because the procedure was designed to examine cognitive representation rather than to assess counting accuracy. Moreover, some children used tens blocks but counted all units inside one by one in their trial 2 were considered as one to one correspondence instead of canonical or non-canonical base-10 because they still don't have concept of tens otherwise they would have counted as ten, twenty, thirty so on. Hence, one-to-one correspondence is there and answer was categorized in that category number. The responses were coded on the nominal scale and categories are those given by T. Miura (1994). Correct responses were categorised as follows. Code (1) one to one collection-the construction used only unit blocks (e.g., 39 unit blocks for 39) code (2) canonical base 10 representation - the construction used the correct number of ten and unit blocks with no more than 9 units in unit place (e.g. 3 ten blocks and 9 unit blocks for 39); code (3) non-canonical base 10 representation-the construction used the correct number of ten and unit blocks allowing for more that 9 units in the one's place (e.g. 2 ten blocks and 19 unit blocks for 39). In correct responses were coded as (4).

3.9 Analysis techniques

Both qualitative and quantitative analyses were done. Qualitative analyses were done on the basis of responses given by students. Quantitative analyses were done on the frequency of responses or percentages of responses in each category after doing content analysis. Moreover, χ^2 was used to see the significant level of difference. Moreover, qualitative analysis involved the analysis of mistakes, developmental pattern and other minute details after the content analysis of each response sheet.

CHAPTER FOUR

Analysis

This chapter comprises of the data tables and their quantitative and qualitative analysis. More over, this chapter presents the detailed results of the study. It is divided into five sections. First section deals with analysis of full sample through percentages, frequency and χ^2.

Digit- wise analysis is done in section two by using χ^2. Section three deals with tables on incorrect responses and qualitative analysis of incorrect responses. Section four displays the repetition table which shows the pattern of novelty during trial-2.

Finally section five deals with analysis of the responses given by children and their pattern is explored.

4.1 Analysis of full sample

This section is meant to analyse the complete sample of the study. This is done in three ways. Firstly by using percent of occurrence of each type of response in each group. Secondly, by using the pattern of use of tens it is explored that which group use more complex level of representation amongst the groups. Finally, full sample is analysed by using χ^2 to know the significance of difference.

4.1.1 Analysis of Percentage (%) of representation in each category

Table-4.1 Frequency and percent distribution of responses in each category.

GROUPS	HINDI			ENGLISH			TOTAL	
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls
Trial - 1								
One to one correspondence	84.7 (127)	90.0 (135)	87.3 (262)	80.7 (121)	86.0 (129)	83.3 (250)	82.7 (248)	88.0 (264)
Canonical base 10	2.7	3.3	3.0	9.3	3.3	6.3	6.0	3.0

	(4)	(5)	(9)	(14)	(5)	(19)	(18)	(10)
Non canonical base10	1.3 (2)	0.7 (1)	1.0 (3)	0.7 (1)	0.0 (0)	0.3 (1)	1.0 (3)	0.3 (1)
Incorrect	11.3 (17)	6.0 (9)	8.7 (26)	9.3 (14)	10.7 (16)	10.0 (30)	10.3 (31)	8.3 (15)
Trial - 2								
One to one correspondence	40.7 (61)	24.0 (36)	32.3 (97)	36.0 (54)	42.7 (64)	39.3 (118)	38.3 (115)	33.3 (100)
Canonical base 10	40.0 (60)	44.7 (67)	42.3 (127)	41.3 (62)	31.3 (47)	36.3 (109)	40.7 (122)	38.0 (114)
Non canonical base 10	6.7 (10)	22.7 (34)	14.7 (44)	8.0 (12)	15.3 (23)	11.7 (35)	7.3 (22)	19.0 (57)
In correct	12.7 (19)	8.7 (13)	10.7 (32)	14.7 (22)	10.7 (16)	12.7 (38)	13.7 (41)	9.7 (29)
Trial – 1+2								
One to one correspondence	62.7 (188)	57.0 (171)	59.8 (359)	58.3 (175)	64.3 (193)	61.3 (368)	60.5 (363)	60.6 (364)
Canonical base 10	21.3 (64)	24.0 (72)	23.0 (138)	25.3 (76)	17.3 (52)	21.3 (128)	23.3 (140)	20.6 (124)
Non canonical base 10	4.0 (12)	11.7 (35)	7.8 (47)	4.3 (13)	7.3 (23)	6 (36)	4.1 (25)	9.6 (58)
In correct	12.0 (36)	7.3 (22)	9.6 (58)	12.0 (36)	10.7 (32)	11.3 (68)	12 (72)	9 (54)

Note:- Frequencies in each category are given in brackets.

It is quiet clear from the table that during trial 1 there were more one-to-one correspondence responses. There were very less canonical and non-canonical responses but English medium boys showed 9.3% canonical responses as compared to 2.7%, 3.3% and 3.3% canonical responses of Hindi medium boys and girls and English medium girls respectively. This brings English medium students better at overall performance during trial 1 as they showed double the percent of canonical responses as compared to Hindi medium students.

During trial 2 the number of responses shifted from one-to-one correspondence to canonical and non canonical categories. This reveals that there is a positive effect of instructions on the performance of child as they use the more refined ways of representing numbers. Both Hindi medium and English medium girls showed a shift from one-to-one correspondence to non canonical representation besides giving equally good number of responses in canonical representation. But still as compared to English girls, Hindi medium girls performed better. There is a difference of almost 10% in both canonical and non-canonical categories. In case of one-to-one correspondence also Hindi medium girls showed 10% less responses as compared to English medium girls. This actually compensated into other two categories producing better performance of Hindi medium girls.

In total Hindi medium students showed a 7% less response in one-to-one correspondence as compared to English medium students. This trend is reversed in case of canonical representation showing a compensation effect during trial 2.

On combining both trial 1 and 2 data it is revealed that canonical representation showing more use of tens blocks. But in case of English medium boys performed better than the girls. English medium boys show more canonical responses while girls show more non canonical responses revealing boys are better but girls are also developing the concept of tens place.

In overall performance girls used 9.6% non-canonical representation as compared to boys and doing lesser % of incorrect trials. Hindi medium students showed a small difference but they used more % of canonical and non-canonical representations. Hindi medium students perform better but difference is not very large.

If we look at the general trend of mistakes done in trial 1 and trial 2. Number of incorrect responses increased during trial2 in case of both Hindi medium boys and girls. English medium boys also showed an increase in incorrect responses during trial 2. But English medium girls did equal number of mistakes during both trial 1 and 2. In overall boys and girls showed an increase in incorrect responses during trial 2. But in all the cases i.e. trial 1, trial 2 total boys and girls, girls gave lesser percentage of incorrect responses as compare to boys. These show that girls are more careful in their performance than boys

4.1.2 Pattern of using tens

Table-4.2.1 Distribution of use of tens responses.

Type of representation → Group Sample Size( ) ↓	No. of children showing canonical representa -ion n(C)	No. of children showing non-canonical representa-ion n(NC)	No. of children showing both n(C∩Nc)	No. of children using tens.
Hindi boys, (N=25)	14(56%)	5(20%)	4(16%)	15(60%)
Hindi girls, (N=25)	22(88%)	15(60%)	14(56%)	23(92%)
Total, (N=50)	36(72%)	20(40%)	18(36%)	38(76%)
English boys, (N=25)	18(68%)	7(28%)	7(28%)	17(68%)
English girls, (N=25)	13(52%)	10(40%)	9(36%)	14(56%)
Total ,(N=50)	30(60%)	17(34%)	16(32%)	31(62%)

Note: % given in bracket.

Formula = How many children used tens block whether using canonical or non-Canonical representation

Number of children using tens block = $n(C) + n(NC) - n(C \cap NC)$

,where $n(C)$ = number of children using canonical base 10 representation

$n(NC)$ = number of children using non-canonical representation

$n(C \cap NC)$= number of children using both canonical and non-canonical

representation using trial 2

Analysis of above table reveals that 88% girls used canonical base 10 representations compared to 56% boys in Hindi medium. While 68 % boy used canonical representation as compared to 52% girls. Hence, in Hindi medium girls outperformed while in English medium boys performed a little better than girls in using canonical representation. Overall 72% Hindi medium children used canonical base representation as compared to 60% English medium children.

In case of non-canonical representation also 60% girls used non-canonical representation as compared to just 20% boys. In English medium also 40% girls used non-canonical representation as compared to 28% boys. In total girls performed better than boys and are in intermediate stage of developing cognitive representation of number. Overall 40% Hindi medium children used non-canonical representation as compared to 34% English medium children. This difference is not very big and can be a by chance factor.

Children who use canonical representation also show a tendency to use non-canonical representation in order to reach canonical representation. Moreover, either to avoid failure or to make the task more familiar children tend to use non-canonical representation for bigger numbers. Now it is revealed that 56% girls used both the types of representation as compared to 60 % boys in Hindi medium. This difference reveals that Hindi medium girls are quiet better than boys in overall performance. Similarly, girls performed better than boys in English medium but difference is very little i.e. just 8%. In overall 36% Hindi medium children used both the types of representation as compared to 32% English medium children.

If we look at overall trend of using tens blocks then it is found that 92% girls used tens blocks successfully as compared to 60% boys. This implies Hindi medium girls excelled while boys shown an average performance. Whereas in English medium 68% boys performed better but the difference is quiet small. In overall performance, 76% Hindi medium children used tens as compared to 62% English medium children. But this difference between the percentage is not significant at .05 level (CR=1.513). (Table Given below)

Table 4.2.1 Comparison of % of use of tens responses

Hindi Medium	English Medium
N1=50	N2=50
P1=76%	P2=62%
CR=1.513 , df=98 t value at .05 level =1.99	

CR= Critical Ratio

4.1.3 Analysis of full sample in various groups.

This section deals with the analysis of responses on each digit.

Table 4.3.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	127	61	135	36	6.123*
Canonical base 10	4	60	5	67	0.033
Non-canonical base 10	2	10	1	34	0.029

*Significant at .05 level

If we look at the frequencies it is revealed that boys and girls differ significantly in use of one to one correspondence. But in subsequent rows it is revealed that there may not be significant difference in use of canonical and non-canonical representation but in case of girls compensation has been done by using more of non-canonical representations during trial2. This implies that Hindi medium girls perform better than boys, as non-canonical representation is a better strategy than one to one correspondences.

Table 4.3.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	121	54	129	64	0.22
Canonical base 10	14	62	5	47	1.26
Non-canonical base 10	1	12	0	23	0.086

There is no significant difference in pre-test and post-test in all 3 cases but still in trial2 frequencies reveal that girls use more non-canonical representation while they used less number of canonical representation. This reveals that boys are better in using canonical representation which means they have a more clear conception of units and tens place.

Table 4.3.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	248	115	264	100	1.55
Canonical base 10	18	122	10	114	1.59
Non-canonical base 10	3	22	1	57	2.09

There is no significant difference in pre-test and post-test in all 3 cases but still in trial2 frequencies reveal that girls use more non-canonical representation while they used less number of one to one correspondence and canonical representation. This reveals that boys are better in using canonical representation which means they have a more clear conception of units and tens place but the difference is not significant. But still girls have used more than double of non-canonical representations done by boys.

Table 4.3.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	262	97	250	118	2.22
Canonical base 10	9	127	19	109	4.71*
Non-canonical base 10	3	44	1	35	0.06

*Significant at .05 level

The Hindi and English students differ significantly in use of canonical representation. It is found that Hindi medium students used less one to one correspondences while more canonical and non- canonical representations. The frequency distribution also reveals that there is not a big difference but Hindi medium students did almost ten more performances in both canonical and non-canonical representations respectively. In terms of percentages it is 23% of responses of Hindi medium students as compared to 21.3% responses of English medium students respectively in case of canonical representation. Moreover, it is 7.8% of responses of Hindi medium students as compared to 6% responses of English medium students respectively in case of non-canonical representation.

4.2 Digit-wise Analysis

4.2.1 ANALYSIS OF EACH DIGIT

FOR DIGIT 11

Table 4.4.1.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	23	13	24	10	0. 36

Canonical base 10	2	12	1	15	0. 54
Non-canonical base 10	0	0	0	0	0

From the table it is revealed that at both one-to-one correspondence and canonical representation both groups gave almost equal number of responses. There is no non-canonical representation, which is not possible with such a small number. Hence, no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.1.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	23	9	23	10	0.04
Canonical base 10	2	15	1	13	0.03
Non-canonical base 10	0	0	0	0	0

From the table it is revealed that at both one-to-one correspondence and canonical representation both groups gave almost equal number of responses. There is no non-canonical representation, which is not possible with such a small number. Hence, no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.1.3

TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	46	22	47	20	0.099
Canonical base 10	4	27	2	28	0.002
Non-canonical base 10	0	0	0	0	0

From the table it is revealed that at both one-to-one correspondence and canonical representation both groups gave almost equal number of responses. There is no non-canonical representation, which is not possible with such a small number. Hence, no significant difference is found in any of the cases in trial 1 and 2.

Table 4. 4.1.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	47	23	46	19	0.21
Canonical base 10	3	27	3	28	0.15
Non-canonical base 10	0	0	0	0	0

This table reveals that Hindi medium children give more one-to-one correspondences during trial 2 in case of number 1. In case of canonical and non-canonical not much difference is there. No significant difference is found in any of the cases in trial 1 and 2.

FOR DIGIT 13

Table 4.4.2.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	20	11	24	6	1.82
Canonical base 10	1	10	1	18	0.13
Non-canonical base 10	0	0	0	0	0

In case of digit 13 during trial to girls give almost half the one-to-one correspondences as compared to boys. This decrease here is compensated in canonical category as girls show 18 canonical representations as compared to 10 by the boys. No significant difference is found in any of the cases in trial 1 and 2. But girls used more canonical representations as compared to boys during trial2.

Table 4.4.2.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	21	8	22	10	0.098
Canonical base 10	3	13	1	12	0.101
Non-canonical base 10	0	0	0	0	0

In case of all the categories here is a difference of either 1 or 2 representations only. So,No significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.2.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	41	19	46	16	0.51
Canonical base 10	4	23	2	30	0.43
Non-canonical base 10	0	0	0	0	0

In case of one-to-one correspondence no much difference is there in frequencies. The boys show 41 responses as compared to 46 by girls in trial. Similarly boys show 19 responses as compared to 16 given by girls in trial 2 in first category. No significant difference is found in any of the cases in trial 1 and 2 but English medium girls gave 30 canonical representations as compared to 23 by boys.

Table 4.4.2.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	44	17	43	18	0.04
Canonical base 10	11	19	4	25	2.95
Non-canonical base 10	0	0	0	0	0

In case of one-to-one correspondence Hindi and English medium children differ by only one, one performance. But English medium children used more canonical base representation showing a sign of comparatively better performance during trial2 but not differing significantly. But finally, no significant difference is found in any of the cases in trial 1 and 2.

FOR DIGIT 28

Table 4.4.3.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	25	12	23	8	0.36
Canonical base 10	0	11	1	9	0.002
Non-canonical base 10	0	1	0	8	0

In case of trial 2 girls have shown a compensation effect as they have lesser one to one correspondence and canonical representations but more non-canonical representations. But no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.3.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	21	8	22	11	0.24
Canonical base 10	2	10	1	6	0.27
Non-canonical base 10	0	2	0	6	0

English medium boys made more canonical representations while girls balanced in both canonical and non-canonical representations. Hence, boys performed better here but do not differ significantly. Still no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.3.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	46	20	45	19	0.006
Canonical base 10	2	21	2	15	0.045
Non-canonical base 10	0	3	0	14	0

In total boys and girls, girls showed a slightly better performance by giving 6 more canonical representations as compared to boys. Girls also out performed by using more non-canonical representations during trial2, which is a better strategy than one to one correspondences. Still no significant difference is found in any of the cases in trial 1 and 2

Table 4.4.3.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	48	20	43	19	0.023
Canonical base 10	1	20	3	16	0.40
Non-canonical base 10	0	9	0	8	0

No major difference is found in case of one-to-one correspondence in trial 1 and 2. But during canonical construction English medium children show 3 responses as compared to 1 give by Hindi medium in trial one. But in trial 2 English medium children gave 16 responses as compared to 20 given by Hindi medium children. No significant difference is found in any of the cases in trial 1 and 2.

FOR DIGIT 30

Table 4.4.4.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one	22	10	24	4	2.40

correspondence					
Canonical base 10	0	11	1	12	0.0003
Non-canonical base 10	2	4	0	9	1.18

Girls performed better by showing a compensation effect from one to one correspondences to non-canonical representations during trial2. But still no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.4.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	21	11	21	12	0.03
Canonical base 10	3	9	1	7	0.013
Non-canonical base 10	1	3	0	4	0

In case of one-to-one correspondence both groups show almost equal frequencies during trial 1 and 2. But in case of canonical representation boys showed 2 frequencies more in both trial 1 and 2 as compared to girls. Still no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.4.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	43	21	45	16	0.65
Canonical base 10	3	20	2	19	0.012
Non-canonical base 10	3	7	0	13	2.23

Girls performed better by showing a compensation effect from one to one correspondences to non-canonical representations during trial2. Still no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.4.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	46	14	42	23	2.35
Canonical base 10	1	23	4	16	0.0006
Non-canonical base 10	9	2	1	7	6. 36*

* Significant at .05 level.

The difference is not significant in case of one-to-one correspondence and canonical representations. But in case of non-canonical representation both groups differ significantly at .05 level because the Hindi medium students showed a drop in using non-canonical representations while English medium students showed a reverse trend.

FOR DIGIT 39

Table 4.4.5.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	19	6	19	2	1. 66
Canonical base 10	0	8	1	7	0
Non-canonical base 10	0	2	0	7	0

There is not much difference in the frequency distribution of boys and girls in trial 1 and trial 2. Moreover, zero frequencies make the results of χ^2 zero. Hence, no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.5.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	18	9	19	8	0.09
Canonical base 10	2	9	0	4	0.003

Non-canonical base 10	0	2	0	7	0

There is not much difference in frequency distribution in one-to-one correspondence. But boys show more canonical representations as compared to girls during both trial 1 and trial 2. But, no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.5.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	37	15	38	10	0.004
Canonical base 10	2	17	1	11	0.18
Non-canonical base 10	0	4	0	14	0

Boys used more canonical representation as compared to girls. But girls also showed a compensation effect by giving more non-canonical representations. But no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.5.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	38	8	37	17	2.63
Canonical base 10	1	15	2	13	0.003
Non-canonical base 10	0	9	0	9	0

In case of 39 English medium students have performed badly by using a more straightforward strategy of one to one correspondences more while canonical and non-canonical representations are almost equal. Hence, no significant difference is found in. any of the cases in trial 1 and 2

FOR DIGIT 42

Table 4.4.6.1 HINDI

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	18	9	21	6	0.83
Canonical base 10	1	7	0	6	0.022
Non-canonical base 10	0	3	1	13	0.037

Girls showed a compensation effect by giving more non-canonical representations during trial2. Girls use thirteen non-canonical representation as compared to three given by boys. There is almost equal distribution during trial 1 and trial 2 in case of one-to-one correspondence and canonical base 10 categories. But no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.6.2 ENGLISH

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	17	9	22	13	0.04
Canonical base 10	2	6	1	5	0.08
Non-canonical base 10	0	5	0	6	0

In case of one-to-one correspondence both groups show a reduction effect in case of both boys and girls during trial 1 and trial 2. But girls showed more one-to-one correspondence responses as compared to boys. But no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.6.3 TOTAL BOYS AND GIRLS

GROUPS	BOYS		GIRLS		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	25	18	43	19	1.399
Canonical base 10	3	13	1	11	0.06
Non-canonical base 10	0	8	1	16	0.16

Girls showed better performance by giving more non-canonical representations during trial2. Moreover, frequency distribution reveals that boys did more incorrect responses in case of number 42. But no significant difference is found in any of the cases in trial 1 and 2.

Table 4.4.6.4 TOTAL HINDI AND ENGLISH

GROUPS	HINDI		ENGLISH		χ^2
	TRIAL1	TRIAL2	TRIAL1	TRIAL2	
One to one correspondence	39	15	39	22	0.90
Canonical base 10	1	13	3	11	0.29
Non-canonical base 10	1	13	0	11	0.02

There is not much difference in frequency distribution but Hindi medium children showed fifteen responses as compared twenty two responses given by English medium children in one-to-one correspondence. Hence they use more one-to-one correspondence as compared to Hindi medium children. But no significant difference is found in any of the cases in trial 1 and 2.

4.2.2Analysis of canonical and non canonical representation across digits

Table 4.5 Frequency distribution in canonical and non canonical representation categories

Number→ Language↓	11	13	28	30	39	42
Hindi	C=30 NC=0 Total=30	C=30 NC=0 Total=30	C=21 NC=9 Total=30	C=24 NC=11 Total=35	C=16 NC=9 Total=25	C= 14 NC=14 Total=28
English	C=31 NC=0 Total=31	C=29 NC=0 Total=29	C=19 NC=8 Total=27	C=20 NC=8 Total=28	C=15 NC=9 Total=24	C=14 NC=11 Total=25

C= Canonical Representation

NC= Non-Canonical Representation

Total = Total canonical and non-canonical

Analysis of this table reveals that Hindi medium children use more canonical and non- canonical representation as compared to English medium across all the digits. A common pattern reveals that there is a reduction in use of tens blocks as the bigger number came. In case of 30 in Hindi medium there is maximum use of tens. This reveals Hindi medium children has a greater tendency to use tens for perfect tens number.

4.3 ANALYSIS OF IN-CORRECT RESPOSES

4.3.1 Number of incorrect responses

Table 4.6 Frequency distribution of the incorrect responses

GROUPS	HINDI			ENGLISH			TOTAL	
Digit ↓	BOYS	GIRLS	TOTAL	BOYS	GIRLS	TOTAL	BOYS	GIRLS
11	0	0	0	1	3	4	1	3
13	8	1	9	5	5	10	13	6
28	1	1	2	7	4	11	8	5
30	1	0	1	2	5	7	3	5
39	15	14	29	10	12	22	25	26
42	11	6	17	11	3	14	22	9
TOTAL	36	22	58	36	32	68	72	54

In case of 11 Hindi medium students gave no incorrect response but English medium students gave 4 incorrect responses. In case of 13 Hindi and English medium children hardly differ but Hindi medium girls excelled by giving only 1 incorrect response as compared to 8 done by boys. In case of 28 Hindi medium children gave only 2 as compared to 11 incorrect responses given by English medium students. English medium girls gave 4 as compared to 7 incorrect responses given by boys. In case of 30 Hindi medium students excelled by giving only 1 as compared to 7 incorrect responses given by English medium students. In case of 39 Hindi and English medium students and boys and girls hardly differ but incorrect responses were very high as compared to earlier numbers. In case of 42 Hindi and English medium students hardly differ but still girls excelled in both Hindi and English medium children. If we look at overall trend as the complexity of number increases the number of incorrect responses also increases but in case of 30 there were very less incorrect responses. In case of 39 and 42 Hindi medium students gave more incorrect responses revealing that in Hindi medium it becomes more difficult to understand the number.

Hindi girls gave lesser incorrect responses as compared to boys in all the cases. In overall also Hindi girls gave lesser incorrect responses as compared to Hindi boys. English boys and girls do not differ much but still girls gave lesser incorrect responses. Hindi medium students gave lesser incorrect responses as compared to English medium students. In case of total boys and girls, girls excelled by giving lesser incorrect responses.

4.3.2 Qualitative analysis of incorrect responses

This section presents the results from content analysis of all the incorrect responses in case of each digit.

Digit-11 Only one English medium girl counted 11 tens one by one instead 11 units. She did not possess concept of tens and regarded tens as units

Digit-13 In case of digit 13, Hindi medium 4 boys recognise 13 as 31 and even represented as either 31 units or 3 tens blocks and one unit only one child recognise 13 as 23 and even represented that wrongly and refused to try further. While only one Hindi medium girl recognise 13 correctly but represented as 31.

In English medium children two boys and two girls recognise 13 as 31 and also represented in the same manner. One boys recognise 13 as 31 but represented as 13 one boy took 13 red blocks instead of giving units showing that he doesn't have the concept of tens.

Digit 28 In Hindi medium there was no important error found but in case of English medium one boy took 28 as 2 and 8 and represented 2 units on left side and 8 units on right side. While one English girl represented 28 as 20 units and 8 block. She actually counted 8 blocks as units to make a different representation.

Digit 30 Only English medium girl took 3 units to represent tens place and 1 block to represent 0 at unit place. She is trying to tell 30 as three and ten.

Digit 39 In Hindi medium 4 boys recognised 39 as 29 out of which 3 gave 29 units and 1 gave 19 units. Three children recognised 39 correctly but gave 29 units. Two boys recognised 39 as 49 but one gave 49 and other gave 29 units. One boy recognised as 29 but represent wrongly nearly 39. One boy got confused while counting and refused to try to give any proper arrangement.

Amongst Hindi medium girls, 4 girls recongnised 39 as 29 and even represented as 29. Four girls recognised correctly but they gave 3 blocks, 29 units, 4 units and 2 blocks plus 20 units respectively. One girl recognised it as 49 but gave 21 units.

Above analysis reveal that both boys and girls in Hindi medium are not clear about the name of number and it is highly confusing. They either mistook it as previous ninth position i.e. 29 *(untis)* or next ninth position i.e. *(untalis)*.

In case of English medium one boy and one girl took 39 as digits 3 and 9 and represented as three units on left and 9 units on right side. One boy recognised the number but left when the row is long enough according to him. One girl used tens while representation but counted them as *units* i.e. 20 blocks plus 19 units.

Digit 42 In Hindi medium one boy recognise 42 as 24 and also gave 24 units. One boy recognised correctly but gave 32 units saying its 42. Other boy recognised it as 32 and gave 24 units. While 3 girls showed mistakes due to skipping or due to getting tired of counting.

In English medium one boy represented 42 as 4 units on left and 2 units on right. Another boy recognised it as 24 but gave 42 units. Another boy skipped from 30 to 40. One girl took blocks and said it is 40 and did a careless mistake. One child recognised correctly but left when he is tired of counting and row is long enough.

In case of English medium girls there is no important incorrect response.

4.4 ANALYSIS OF REPETITIONS

The pattern of repetition during trial 2 is analysed here to reveal the novelty of responses given by children.

Table 4.7 Frequency distribution of repetition across the digits

GROUPS	HINDI			ENGLISH			TOTAL	
	BOYS	GIRLS	TOTAL	BOYS	GIRLS	TOTAL	BOYS	GIRLS
11	13	9	22	11	11	22	24	20
13	10	5	15	11	7	18	21	12
28	12	7	19	10	12	22	22	19
30	9	4	13	11	10	21	20	14
39	4	2	6	10	7	17	14	9
42	8	6	14	8	13	21	16	19
TOTAL	56	33	89	61	60	121	117	93

Results of repetition table reveal that Hindi medium student do less repetition as compared to English medium students. This implies Hindi medium students show more novelty in their performance. Hindi medium girls do lesser (33) repetition as compared to boys. Hence, they show more novelty in their performance. English medium boys and girls do not differ at all. In total girls do lesser repetition as compared to boys. This shows girls more novelty in their performance. Hence, Girls show a positive effect of instructions and perform better.

In case of 39 there are very less repetition which implies that they are more novel but if we look at correct responses there are lot of incorrect responses reducing correctly counting repetition. Hence, it is not an indicator of more novelty in case of Hindi medium children. In case of 28 maximum repetition are there in both Hindi and English medium, Showing that children tend to repeat same pattern for small numbers.

In overall pattern there is less novelty in case of smaller number in Hindi medium revealing that when a big number is encountered in order to avoid counting children use more tense. While amongst English medium children repetition is always equally distributed.

4.5 Qualitative analysis of the responses given by children

4.5.1 Observation about use of tens blocks

There are 3 types of patterns of responses observed about use as tens blocks. They are as follows:

(1) Two boy and two girls from Hindi medium where as one boy and four girls recognised that 1 red block is equivalent to 10 units. They tend to use it over all the number representations during trial 2 in order to bring out different type of representation. This use of one red block as standard to vary representation increase non-canonical representations during their responses.

(2) In order to vary the representation of a number during trial 2 children use tens blocks but here also they count each unit present in block expressing it as one to one correspondence instead of canonical or non canonical representation even after using tens. They actually don't have the concept of tens. Six boy and three girls from Hindi medium. While eleven boy and six girls from English medium shown this behaviour hence, one can infer that this pattern of behaviour led to low performance of English medium children as they gave more number of such responses.

(3) Here tens blocks are used by children but they count them as one instead of ten. None of Hindi medium child shown this behaviour. Two boys and two girls from English medium shown this behaviour.

4.5.2 Developmental pattern during trial 2

Before trial 2 children are instructed to represent the number in a way different from earlier representation made during trial 1. Pal (2000) found that once you give proper instruction to children they tend to proceed to abstract thinking with a faster rate. Hence, this analysis is done to explore the capacity of children to use canonical or non-canonical representations. There can be three possibilities in this exploration. They are as follows

(1) **One-to-one correspondence→ non-canonical representation**.

While doing trial 2 child realises that one tens block carries 10 units and start using tens without counting and take it as 10. But they are able to show only non-canonical representation and are not able to give canonical representation during all six number representations during trial 2. Only one Hindi medium boy shown this behaviour.

(2) One-to-one correspondence →canonical base representation.

In this child first uses one to one correspondence once but later realises how to use tens blocks and show canonical representation. For example Rahul from Hindi medium used units first in trial 1 and started using tens but counted units in side and later stopped counting tens and took them as 10, 20,30 and gave perfect canonical represetnations during trial 2. Two boys and three girls from Hindi medium while 3 boys from English medium shown this pattern of behaviour.

(2) **One to one correspondence→ non canonical representation → canonical representation**

In this case child display a gradation from using one to one correspondence to non canonical use to canonical representation after exploring the property of tens block. Three boys and seven girls from Hindi medium. While six boys and six girls displayed this behaviour.

All these patterns reveal that due to instruction and due to trial children learn the use of tens blocks. There is also an effect of instructions as these behaviours are shown. Mostly during trial 2 after instructions.

4.5.3 Tendency to use non-canonical representation for big numbers

Instead of using just units children want to vary the representation but they don't use perfect number of tens. They either select 2 tens blocks or 1 tens block and fill in units further to complete the number representation. The behaviour occurs mostly for 39 and 42. Three boys and nine girls from Hindi medium while three boys and seven girls displayed this pattern of behaviour.

4.5.4 Using counting to recognise number

Thirteen boys and eight girls from Hindi medium shown a tendency to count before recognising the big numbers. For example Rahul from Hindi medium counted from 30 to 39 to recognise 39. There is a possibility that children are instructed to recognise numbers in such a manner. This also systematized and lesser the possibility of mistake in recognising numbers. This tendency is completely missing from English medium children.

4.5.5 Special cases

Case I- One girl from English medium recognised all numbers correctly but while representing. She stops putting blocks when the row is long enough according to her. She gave not even a single correct response. This shows that she does not know what number carries even after knowing the name correctly.

Case II- One girl in English medium also shown a tendency to skip teens while counting. This shows that this child find these numbers difficulty which made her to skip them.

Case III- One boy from English medium took tens initially but later put that back showing preference to use units only. He may want to practice with units more rather than using tens.

Case IV- One boy from Hindi medium repeated all the responses but in case of 30 which is a perfect tens number he put 3 tens blocks straight away while repeated all other responses as one-to-one correspondence. Nunes (1996) also found that children write round numbers i.e. 10, 100, 30 etc. correctly. This finding also reveal that not only writing but children tend to represent round numbers with complex representation i.e. canonical and non-canonical representations.

CHAPTER FIVE

General Discussion

This chapter deals with the discussion of the results of the study.It is divided in to five sections. First section tries to justify the effect of language characteristics on cognitive representation of number by using results from the analysis of children's performance on each digit and their preference to use tens blocks. . Second section explores the specific differences among Hindi and English medium children over the whole range of results. Third section tries to justify the effect of instructions by using results from analysis of percent of responses, incorrect responses and repetition factor. Fourthly gender difference is explored. Finally other important findings are discussed.

5.1 Effect of numerical language characteristics on cognitive representation of number

The results of the table 4.5 reveals that the smaller the number more the canonical representation. But less non-canonical representations are there.This justifies that in case of smaller numbers (i.e. 11,13) it is easy to make canonical representations as only one tens block is required because only some units need to be added. Moreover, non-canonical representations are not possible. Hence, we can not get such responses. From table 4.6 it is evident that there are very less incorrect responses as compared to bigger numbers. Hence, smaller the number less the complexity leading to lesser incorrect responses. During qualitative analysis also smaller numbers does not show big counting errors or refusal during representation. But interestingly 13 is recognised as 31 and fell in incorrect category. This is an orthographic error. Khan (2001) also found such responses during her study. But table 4.7 gives a striking finding that smaller the number lesser the novelty of response. This is because of the tendency of children to repeat the earlier response only to ensure their success. They give their mastered correct response to avoid failure.

In case of 30 which is perfect tens number it is revealed that maximum children show canonical and non-canonical responses amongst the big numbers. Even table 4.6 reveals the least number of incorrect responses. This implies children find perfect tens numbers easier as compared to other big numbers. This can be further supported by a special case in which a child repeated all other number responses but in case of 30 he straight away gave 3 tens blocks.

From 4.5 it is evident that bigger the number lesser the use of canonical representation but more is the tendency to use non-canonical representation. Maximum number of incorrect responses occur in case of 39 and 42. Qualitative analysis also reveal that in case of 39 children recognise it wrongly in case Hindi because they confuse it for previous or next ninth position number. Hence the language characteristic of 39 i.e. minus relation ship (i.e. 39 as *untalis* means one minus forty) increases the complexity and affect the performance of children. Similarly, Pal, Pradhan and Natrajan (1997) found that the difficult logic of naming number affect the understanding of children on simple arithmetic problems. In case of 42 also bigger number show more recognition and counting mistakes (i.e. children tend to skip numbers while counting). Hendreickson(1979) also found that children's ability to count objects fall rapidly as the number become larger than 15 or so on. Even orthographic error exist in case of 42 (i.e. 42 is recognised and represented adds 24). This means children find 42 more like ' *chaubis*' (i.e. four twenty) than *'biyalis'* (i.e. two forty) while recognition of number. Hence, it is revealed that the numerical language characteristics affect the cognitive representation of number.

5.2 Difference in Hindi and English medium children's number representation

As Briars and Seigler (1984) found that the children used one-to-one correspondence first similarly children used one-to-one correspondence first and then used canonical and non-canonical representations in this study also. It is revealed from overall quantitative analysis that Hindi medium children use more canonical representation than English medium children (see table 4.4.1.2). Even they use more tens but this difference is not very significant. Similarly, in χ^2analysis also revealed that difference is not significant in one-to-one correspondence and non-canonical representation. But here difference in canonical representation is significant at .05 level. (see table 4.3.4). This difference is not easy to express because in trial 1 Hindi medium children gave 9 responses while 127 in trial 2 in this category. But English medium children gave 19 responses in trial 1 and 109 in trial 2. Still from overall 136 responses by Hindi medium and 128 responses by English medium children, we can say that Hindi medium students use more tens even after being a complex system of representation children perform better. This finding is in contrast with pre-assumption of the third hypothesis. This also goes in contrast with assumption presented by an Indian study by Khan (2001). But these findings are similar to earlier research which says that children belonging to Asian language pool perform better on cognitive representation and other mathematical tasks (Hess et.al., 1987; Miura, 1987; Miura, Kim, Chang and Okamoto, 1988; Miura and Okamoto;1989).

Even if we look at table 4.6 it is revealed that Hindi medium children give lesser incorrect responses as compared to English medium. But here from the pattern of distribution of incorrect responses it is evident that Hindi medium students give more incorrect responses on number 39. In qualitative analysis it is revealed that here children are most confused due to language characteristics as they mostly recognise 39 as either 29 or 49 due to its complex naming. Children mistook it for precious ninth position (i.e.29) mostly and while representation also they do the same thing. This finding is unique to this study as it is not noticed by any other research till now. Gelman and Gallistel (1978) gave five principles to successfully count. They reveal that the children use the tags when numbers are bigger but they don't talk about language characteristics explicitly. Nunes and Bryant (1996) also gave similar findings. In case of 13, 39 and 42 there is an existence of an orthographic error i.e. 13 is recognised as 31 and represented as 31. In case of English medium also it exists but Hindi medium children show this behaviour more number of times. Hence, based on quantitative analysis Hindi medium children perform better but qualitative results suggest that various language characteristics increase the incorrect responses. This finding have support the findings of Khan (2001). Finally it is revealed that difference in numeration system of Hindi and English affect the understanding of children but this difference is not significant quantitatively. This finding clearly support the view of Vygotsky and Luria (1976) which says that it is the signs of a system which mediates the understanding of number system.

5.3 Effect of instructions on numerical representation of number

It is clearly evident from table 4.1 that after instructions the distributions of frequencies turned completely across the 3 categories of representation. Children in both Hindi and English medium were using one-to-one correspondence mostly but after instruction during trial 2 children gave more canonical or non-canonical responses. This reveals that there is positive effect of instruction on the performance of child as they use the more refined ways of representing numbers. Even the qualitative analysis reveal that children show a developmental pattern during trial 2, which is a result of encouragement to use tens, blocks during instructions. In order to make a novel representation children try new ways and tens blocks leading to refinement. Hence, both qualitative and quantitative findings report that instruction effect positively. These findings are in congruance with researches telling positive effect of new instructional programmes. (Pandey, 1980; Singh, Ahluwalia and Verma 1991:Pal,2000).

5.4 Gender difference in the cognitive representation of number

Both table 4.1 and 4.2 girls performed better than boys. In case of Hindi medium girls excelled boys. While in case of English medium this difference is not very big. This finding further strengthen the earlier research findings which favour the better performance of girls over boys. (Pal and Natrajan, 1997; Vora 1984). Hence, these results contrast the other research findings which in early 80's supported male dominance over mathematics skills and achievement. (Harshaway, 1981; Ethington and Wolfe (1984); Patel (1997);Byrnes and Takahira 1993). The reasons for better or comparable performance of girls in number representation task actually lies in the fact that they were more attentive during these task. Some girls even look at the material carefully and organise them in straight lines to make their work more systematic. But this need to be researched further.

In case of incorrect responses also girls give less incorrect responses in both Hindi and English medium. As evident from table 4.7 also girls show more novelty. Hindi medium girl surpassed boys by showing almost half the repetitions done by boys. Hence, gender difference is in favour of girls clearly in this study.

5.5 Other important findings

Children show a tendency to take two digit numbers as separate units rather than as representing units and tens place. If we look at qualitative analysis of incorrect responses then in case of 30, 39 and 42 such responses occur. These are an English medium girls and a boy respectively. Children for example for 39 put 3 units on one left side and 9 units on right side. While for 30 they put 3 units on one side and 11 tens on right side. This reveals they take 3 and 9 for 39 and 3 and 10 for 30 as separate devotions irrespective of place value. This implies children does not have place value concept which is a prerequisite for understanding numbers. Pal, Pradhan, Natrajan (1997) also found similar error while finding the logic behind errors made by children on simple arithmetic tasks. Teachers must start recognising this as a prerequisite while planing lessons on teaching numbers.

Another important finding on developmental pattern reveal that while doing activities children learn the better strategies. Nunes (1996) also revealed that children show a pattern of development. Hence, one should give practice on using units and tens blocks to learn numbers. Pal (2000) also gave similar findings while exploring effects of instructions on understanding of children.

Another finding reveal that children use non-canonical representation for number. This may be done in order to reduce failure which is a possibility if one adds more blocks and non-canonical can be made by just earlier explored property of one or two tens block.

In another finding counting is used to systematize recognition. This can be done by Hindi medium children to systematized recognition for such a complex numerical representation system. This strategy can be used by Hindi teachers effectively but further result is required in this context.

Moreover, in special cases English medium child showed that number system is known fully but number concept is not there. This system is simple to learn but it is not a guarantee that child will be having number concept also. Nunes,(1990) also revealed that knowing number labels is not a necessary condition for understanding the numeration system.

Besides this, one English medium child showed a tendency to skip teens. There is a possibility of such behaviour in Hindi also. So, more research is required in this area.

CHAPTER SIX

Summary and Conclusion

6.1 Introduction

This study is aimed at exploring the effect of language characteristics on children's cognitive representation of number: comparison of Hindi and English medium children.

Following were the objectives of the present study :

(i) To study the effects of numerical language characteristics on cognitive representation of number.

(ii) To study the effect of instructions in understanding number representation.

(iii) To study the difference between Hindi and English medium students in cognitive representation of number.

(iv) To study the gender difference in the cognitive representation of number.

It was hypothesised that that :

1. there will be significant effect of numerical language characteristics on cognitive representation of number
2. instructions significantly affect the cognitive representation of number.
3. the numerical language characteristics of Hindi and English language would affect the cognitive representation of number.
4. there will be a significant difference amongst boys and girls performance on the task of cognitive representation of numbers.

6.2 Methodology

Three schools were selected for the present study. These were M C D Primary School, Madipur, MCD Primary School, Paschim Vihar and CR Saini Public School, Nangloi. All these three schools belong to rural belt of west zone of Delhi and cater to middle and lower middle class children. A sample of 25 Hindi medium boys and 25 girls was drawn from MCD Primary School, Madipur and MCD Primary School, Paschim Vihar respectively. A sample of 25 English medium boys and 25 girls was drawn from CR Saini Public School. All the children belong to the age group of 6 to 8 years studying in class I, II, III .

An adopted version of test framework used by T. Miura (1994) is taken as tool for the present study as it is an already standardized procedure. Researcher has used wooden blocks of equal size made for the study. There were 200 green unit blocks and 20 red coloured tens blocks showing clear units inside.

In the present study 6 numbers cards were shown. The numbers were 11, 13, 28,30, 39 and 42. There are six numbers in order to get a clear conception of number representation. Two simple numbers with unique names in both Hindi and English number systems i.e. 11,13 are used to see effect of unique number name representation. 28 is such a number which has a unique name in Hindi i.e. '*aththais*' i.e. eight twenty and in English it is twenty eight. Then 30 is the number which can be made by using tens only as it is a perfect tens number with unique name.39 is incorporated in the list of numbers given by T.Miura, (1994) as we have a minus relation i.e. one less than forty in case of Hindi which increase the complexity of its naming while in English it is still having additive relation i.e. thirty plus nine. 42 is given to provide a bigger number to increase difficulty level as it is a comparatively bigger number.

6.3 Analysis techniques

Both qualitative and quantitative analyses were done. Qualitative analyses were done on the basis of responses given by students. Quantitative analyses were done on the frequency of responses or percentages of responses in each category after doing content analysis. Moreover,$\chi^2$was used to see the significant level of difference. Moreover, qualitative analysis involved the analysis of mistakes, developmental pattern and other minute details after the content analysis of each response sheet.

6.4 Major findings

(1) This study reveals that Hindi numeration system is comparatively difficult from English numeration system but strategic approach make students skilled and even enable them to perform better.

(2) Hindi medium children use more tens than English medium but difference is not significant.

(3) Instructions help in improving performance of children. So, one must keep encouraging children.

(4) While manipulation of material children learn and show a gradual pattern of developing better number representation.

(5) Mostly girls perform better than boys on number representation tasks.

6.5 Implications for teachers

(1) Knowing numeration system is not enough to predict the successful acquisition of number concept. Hence, teachers should not only practice number system but give activities side by side to develop the concept of number and place value.

(2) Place value concept should come before introduction of 2 digit numbers. Teachers must take this as a pre-requisite while planning lessons on introduction of numbers.

(3) Hindi numeration system is quiet complex especially when it comes to ninth position number names. Teachers must clarify this number naming systems while teaching because some children had number concept but since they recognised them wrongly they represent in a wrong manner.

(4) Teachers should lay stress on using teaching aids because all the children who are part of sample belong to school. They have also learnt counting but still they don't have number concept bcause they have just done written work. When they are exposed to teaching aids they showed a gradual development in number concept during the experiment.

(5) In bilingual context teachers can prefer English system of numeration as it is simpler as compared to Hindi numeration system. Still they should use activities and teaching aids to clarify the number concept.

(6) Both girls and boys perform well on number task. Even girls perform better. So, teachers should expect equally well performance from both the groups.

6.6 Implications for curriculum planners

It is easy to state competency based models but difficult to implement them. So, one must not only state competencies but also explain which materials and how it should be used.

Researche:'s should be carried out further on number concept and it should be treated as very important unit rather than just taking it as one of many arithmetic abilities.

6.7 Limitations of the study

Sample of the study is quiet small if one can take larger sample, one may get more clear view about types of incorrect responses. Moreover, children from MCD schools do not know counting even at class III which limited the scope for further control while doing the study. Even there was a lot of trouble in restricting other children to see the execution of study which affect their responses during their own turn. Sometimes due to this some children need to be dropped from the sample. Since the time for this study was limited errors were not given much space during analysis or to do further review study.

6.8 Suggestions for future research

This study is limited to number representation only. So, one can also include the place value concept which is a prerequisite for the study of two digit numbers. Various aspects such as the tendency of children to skip teens and using accurate representation for perfect tens numbers i.e. 30 while repeating just one-to-one correspondence for other numbers. Hence, these aspects need further research. One can also look at the developmental patterns across various age groups.

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Appendix – I

Instructions for the experiment

General Information:

– आपका नाम क्या है ?

– उम्र "कितने साल के हो ?"

– आप कौन सी कक्षा में पढ़ते हो ?

Trial – 0

1. ये एक हरा ब्लॉक है। ये बराबर है एक के।
2. यदि हम ऐसे दस हरे ब्लॉक मिलाए तो यह एक लाल ब्लॉक के बराबर होंगे।

(Demonstrating side by side. Joining green unit blocks saying एक दो तीन चार .... For English medium one, two, three ....)

– अब मैं आपको कार्ड पर लिखा नम्बर / संख्या दिखाऊँगी आपको उसे पहचानना है। उसके बाद हरे और लाल ब्लॉक इस्तेमाल करके बनाकर दिखाना है।
– showing card having no. 2 to the child
– ये क्या है ? .... response of child.
– अब दो को हरे या लाल ब्लॉक इस्तेमाल करके बनाओ।
– If child does correctly then go for next number
– If child is not able to do. But recognising number then
– ये लिखा है दो तो हम दो हरे ब्लॉक दिखाएँगे।

  (Counting one, two / एक दो simultaneously)
– If child now undersand then go for next no.
– If required show for 7 also as above.

Trial – 1

- Showing the card to child in random order : for each child shuffle cards before showing.
- ये क्या है ? .... response of child
- अब (संख्या) को हरे और लाल ब्लॉक इस्तेमाल करके बनाओ।
- Similarly for all other 5 numbers.

Instructions while execution :

- If the child is not able to recognise the number. Then tell child to represent it.
  अच्छा, अब लाल और हरे ब्लाक इस्तेमाल करके बनाओ।
- If child recognises the number wrongly then also repeat above instructions. Give chance to do the task.

Trial – 2

- Repeat the instructions 1 and 2 with demonstration from trial 0.
- Show the card kept an earlier arrangement.
- Ask them to recognise it.
- ये क्या है ? .... response of child
- पहले आपने इस तरह (संख्या) को बनाया था। क्या आप किसी और तरह से (संख्या) बनाकर दिखा सकते हैं ?
- If child has used only green blocks earlier then encourage them to use red blocks.
- लाल ब्लाक भी इस्तेमाल कर सकते हैं।
- If child has used only red then gets struck then encourage them to use green blocks.
- हरे ब्लॉक भी इस्तेमाल कर सकते हैं।
- If child is repeating earlier arrangement then do not restrict him/her from doing so.