INFLUENCE OF NATURAL EXPERIENCE ON THE GROWTH OF MATHEMATICAL CONCEPTS - A PIAGETIAN STUDY WITH SRI LANKAN CHILDREN

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SUMMARY

This study attempted to measure the influence of natural environmental experience on the growth of mathematical concepts in children of the ages of 5-8 years. A sample of 80 subjects were chosen forming 40 matched pairs, in which 20 pairs of boys and girls of the four age levels (5, 6, 7 and 8 years) were represented. The subjects were selected and matched after assessing a large number of children on natural experience, achievement, intelligence, and socio-economic status. Standard Piagetian test items prepared in parallel forms were administered.

Analysis revealed that those who are high on natural experiences do not show any significant attainment in mathematical concepts to that of the ones who are low on natural experiences. The trends reveal that children of upper middle class homes though they were low on natural experiences tends to be better in mathematical concepts than the children with high natural experiences who usually come from the lower socio-economic homes. Boys showed a significant difference to girls in the growth of mathematical concepts. Also, it was found that the stages of mental growth as recognized by Piaget can be identified among Sri Lankan children as well.

INTRODUCTION

Piaget and his followers have formulated a connected and a plausible account of intellectual growth from birth to adolescence. It was assumed in early days even by Piaget himself that mental progression is a reflection of the maturation of the nervous system. Since then, Piaget and others have become increasingly aware of the part played by properly timed experience in the emergence of successive intelligence structures.

Diverse nature of experience can create differences in the nature of such intelligence structures or schemes and different rates of growth. Experience can be of different forms such as experience in the form of learning and training or constructed and organised. Many of the child's experience in the daily life are unorganized.

Unorganized daily experience which the child assimilates and accommodates may be classified again. On the one hand, experiences which the child receives in direct contact with the natural environment like playing with the natural substances of the environment such as sand and clay may be termed as first-hand experiences. These first-hand experiences or natural experiences are received by the child to a greater degree if the child is allowed to play out of doors in a free way without any objection or obstruction by the parents.

In a country like Sri Lanka, most children belonging to culturally deprived class enjoy this freedom of playing in the open more than the upper middle class children. It is observed that most children in the upper middle classes have less companions in play, they are allowed to mix with a selected group of children, or in most families where there is only one child, a child is forced to play alone by himself. Lower class children are compelled to do their daily household work such as carrying water and firewood, sweeping the house, and buying daily requirements from nearby boutiques. All these experiences can be grouped under first-hand experiences or natural experiences, and this type of experiences are seemed received more by the children of the lower socio-economic classes. Playing games which provide more opportunity of gaining experiences could be a favourable factor in the formation of mathematical concepts. Experiences gained by playing with manufactured toys enjoyed by upper class children may be termed as second-hand experiences and these experiences are not included under natural experiences.

With this background information, it is hypothised that children having a higher rate of natural experiences have a better understanding of mathematical concepts than children having a lower rate of natural experiences.

Experiences vary culturally too, and especially differences in the understanding and growth of concepts may vary in the developed western countries from under-developed countries like Sri Lanka. This leads to the second hypothesis that stages of intellectual growth recognised by Piaget and his followers can be identified among Sri Lankan children too. Thirdly, it was the curiosity of the researchers to find whether there is a significant difference in the growth of mathematical concepts between female and male children.

Harlem (1968), in dealing with Piaget's theory says that the relative importance of the roles of maturation and experience in determining the rate of passing from one stage of mental development to another has to be thoroughly explored. There are numerous researches dealing with how pre-training can affect the growth of mathematical concepts. These researches deal with pre-training in language, pre-training in the understanding of a particular concept and pre-training about the logical thought procedures leading to the understanding of mathematical concepts. In a research on pre-training in language conducted by Remmo Hamel, Vanderveer, Rennie Westerproof (1972), showed that only partial conservers benefitted by this training. Halford and Fulleston, Wallach and Sprott (1969), and Smedslund (1959), dealt with pre-training in the understanding of a particular concept showed that even. though an improvement in the understanding of the concept is seen immediately after training, this understanding is not permanent and is likely to become extinct after a short time.

According to Piaget, before the occurrence of conservation, child should be able to perform operations of multiple classification, multiple relationality and reversability (Piaget 1952). Siegal, Roeper and Hoepre (1966), in an experiment dealing with conservation of substance, provided pre-training in multiple classification, multiple relationality, and reversibility. Here, those who received the training showed an improvement in the understanding of the concept and in the use of situation language in explaining their knowledge of conservation especially concerning the concept of weight. Similar experiments have been conducted by Bell (1970), Smechlund (1961), Wohlwill and Lome (1969), and reached positive results. According to Piaget (1964), if a cetrain cognitive structure grows within the child and reaches a state of equilibrium that concept becomes permanent in him and will never forget it throughout his life.

Nita and Nagavo (1968), studied the influence of learning on the growth of mathematical concepts, especially concerning the concept of weight. It was found that practice and exercises in measurement of weight and knowledge about units of weight gained in a learning situation is helpful in understanding the concept of weight.

The influence of the experiences in daily life on the growth of mathematical concepts was shown by Lovell (1961), and his co-workers. In one of their studies on the conservation of weight, he found that children who showed conservation when dealing with one substancse failed to conserve when dealing with another substance. According to Lovell and Ogilvie a child who has conserved in the weight of a lump of plasticine failed to conserve the weight of a lump of butter. Some could not understand that the weight of a mass of ice and the weight of the water when it melted was equal. Hence, Lovell concluded that experiences in daily life plays a far greater part in the development of mathematical concepts than Piaget allowed. According to Lovell, in the experience of shopping for butter the child may notice and conserve the weight whereas plasticine may be manipulated with no attention to its weight. Hence, Harlam (1968), says that such conclusions are only tentative since no attempt was made to explore the effect of experience in a controlled experiment.

METHODOLOGY

(a) Composition of the Sample

The sample consisted of 80 school children in the age range of 5 years and 6 months to 8 years and 6 months consisting of two equal groups of high and low on natural experience. 20 girls and 20 boys were included in each group. The subjects belonged to four age groups 5 years and 6 months, 6 years and 6 months, 7 years and 6 months and 8 years and 6 months. Hence for the 4 age levels there were 16 groups (Age Level x Sex x High-Low Experience).

(b) Sampling

Through interviews a questionnaire was filled to amount the level of natural experiences. [1] Nearly 200 children were thus interviewed before the 40 matched pairs of subjects were selected from the top and the bottom ends of the ranked list on natural experiences. The children

1. High on Natural Experience — HNE
   Low on Natural Experidnce — LNE

were selected from the same grades to control the variable of learning experience. As the factor of intelligence had to be controlled, children were tested individually by using Raven's progressive matrics. Raven's coloured progressive matrices were used on children of 5 and 6 years age levels.

In the sample, 80 children were arranged in matched pairs according to age, grade achievement, sex, natural experience, and intelligence. Intelligence test marks and natural experience scales were subjected to re-testing to assure reliable matching. It was evident in the selection of the sample that the 2 groups showing high and low rates of natural experience clearly belonged to lower class and upper middle class of the social class structure respectively. The social class representation of the two groups were confirmed by the contents of a questionnaire dealing with socio-economic status which was filled up by the parents of the children concerned.

(c) Testing

All the experimental items that are used to test the six mathematical concepts that are selected were chosen and prepared from the experiments used by previous researchers including Piaget himself.

The experimental items were as follows :

1. Seriation (Beard 1968) and Hyde (1959).
   Apparatus used : Pictures of 10 boy scouts and 10 sticks to match their heights.

2. Class inclusion (Piaget 1952).
   Apparatus used :
   (1) 20 plastic beads, 18 black and 2 white.
   (2) 18 wooden blocks, 10 red and 8 white.

3. Classification: Piaget and Inhelder (1960)
   Apparatus used : Circles, squares and triangles, red, yellow and blue made out of cardboard.

4. Conservation of Substance : (Piaget 1953)
   Apparatus used :
   (1) Rice for continuous qualities and clay for discontinuous qualities.
   (2) Plastic cups of different sizes.

5. Conservation of length : (Piaget, Inhelder and Steminska) 1960.
   Apparatus : 5 pairs of sticks of different length.

6. Conservation of weight : (Piaget 1941)
   Apparatus used : 2 balls of clay and a small balance.

These experimental items can be regarded as having a high degree of validity as they were directly connected with the concepts concerned and have been subjected to experiment in a number of earlier researches.

Items were revised wherever necessary after identifying defects by a pilot test. The experimental items were separated into two parallel tests to make the statistics obtained more reliable. In each test there were 2 items for each concept. The second parallel test was conducted on each child on the same day as the first but separated by a suitable interval of time. The correlation of the marks obtained for the first and second parallel tests was 0.748. The testing situation was controlled by creating similar environments not only in the provision of light and ventilation, but also in minor necessities like table covers, desks and chairs.

(d) Scoring

Marks were given for the individual concepts and the total for all the concepts was not considered. Total for each concept was 8 marks with 2 marks for each item. Marks were given for each item in three levels, '2' marks for the full presence of the concept and '1' mark for partial presence. When there is no clue in any way to indicate the presence of the concept, '0' marks were given. In the analysis 6 marks or above or 75 per cent or above was considered the criteria level for the presence of the concept.

Analysis and Results

The mean and the variance of the marks received for each concept show that the concept of seriation occurs in the Sri Lankan child at the age of 7 years and 6 months followed by the growth of the concept of classification. Statistics show that LNE children obtained the concept of classification earlier than HNE children. For the 4 age levels starting from 5 years and 6 months the mean score of LNE children were 4.4, 4.7, 6.8, 6.9 whereas the mean scores of HNE children were 2.6, 3.9, 6.2 and 7.2. Even though LNE children obtain the concept of classification at 7 years and 6 months HNE children are seen to obtain the concept a little later.

In the concepts of class inclusion, conservation of substance, length and weight, a satisfactory number of children have not reached the expected criterian level of 75 per cent. Hence, in agreement with Piaget's views we can conclude that the concepts will grow gradually in children during the concrete operational period.

Concept of class inclusion is seen to grow more rapidly among LNE children as compared to HNE children. Among the HNE children, at the age level of 8, only 10 per cent have reached the criteria level, while among the LNE children 10 per cent at the age level of 7 and 30 per cent at the age level of 6 have reached the expected criteria level. Even in the concept of conservation of weight, the 6 which gained the criteria level is more in the case of LNE children than HNE children. Among HNE children, 0 per cent at the age level of 7 and 20 per cent at the age level of 8 have gained the concept, while among the LNE children the percentages of those who gained the concept were 20 per cent at the age level of 7 and 30

per cent at the age level of 8. The percentages of those who reached the expected criteria level in different age levels thus show the influence of social class on the growth of the concept of weight.

The concept of the conservation of length too is seen to develop late. It is not seen to develop at a satisfactory level till the age level of 8 at which in both groups 30 per cent have reached the criteria level. Hence, there is no indication of the influence of natural experience on the development of the concept of length.

Statistics show that the concept of conservation of substance also occurs late among the children. But here the concept is seen to occur more frequently among HNE children than LNE children. Among HNE children, the percentage of those who have gained the the criteria level is 10 per cent at the age level of 6 and 10 per cent at the 7 year level. While the LNE group showed 0% at both these age levels. At the age level of 8 both groups showed that 30 per cent have reached the criteria level.

Natural Experience and the Differences of Sex

There is no difference between HNE and LNE girls and between HNE girls and HNE boys in the presence of the concept of seriation. But, there are indications to show that LNE boys obtain the concept earlier than LNE girls and HNE boys. Influences of the differences of sex are seen in the concept of class inclusion. In this concept, at all four age levels, the mean score received by boys are higher than those received by the girls. LNE boys seem to be ahead of HNE boys in the presence of the concept of class inclusion. Among the LNE boys, 20 per cent have reached the criteria level at the age of 6 years and 6 months and 40 per cent at the age level of 8 years and 6 months.

Interaction of sex with the rate of natural experience is clearly seen in the growth of the concept of classification. LNE girls show higher mean score than HNE girls. LNE girls achieve the concept about a year ahead of HNE girls, i.e. at the age level of 7 years and 6 months. Among the LNE girls, 100 per cent reach the criteria level at the age level of 7 years and 6 months. The differecne between LNE and HNE boys is also very clear in the concept of classification. Out of the LNE boys, 80 per cent reach the criteria level at the age level of 7 years and 6 months. The LNE boys obtaining the concept more rapidly than HNE boys is shown by the fact that at the 6 year level itself 40 per cent reach the criteria level.

More marked differences are seen between males and females in the occurrence of the concept of conservation of substance. Only a few reach the criteria level among the girls at the age level of 8. But at the same age level, 60 per cent of the boys reach the expected criteria. Even in the occurrence of the concept of conservation of weight, boys seem to be ahead of girls. Among the LNE boys, 40 per cent reach the criteria level at the age level of 7 years and 6 months and 60 per cent at the age level of 8 years and 6 months.

In all the mathematical concepts dealt with in this experiment, boys seem to be ahead of girls. In the concept of classification at all four age levels, boys obtained higher mean scores than girls. In the concept of conservation of substance in 3 out of 4 age levels and in the concept of conservation of weight in 3 out of 4 age levels, boys showed higher averages than girls; only in the concept of the conservation of length in 3 out of 4 age levels, the girls obtained higher mean scores. Hence, on a general trend, boys seem to be obtaining the mathematical concepts more rapidly than girls. Figures indicating the variances of the marks obtained by boys show higher values than those of girls. Hence, we can arrive at the idea that development of mathematical concepts occur at an average rate among girls and at a more variable rate among boys. Differences in the mean scores of LNE girls and HNE girls are so small than influence of natural experience shown. Yet, in the concepts of conservation, of substance, length and weight, differences in the mean scores of LNE boys and HNE boys are noticeable.

When mean scores of HNE and LNE groups for different age levels are considered separately, two anomolous situations are seen at the 7 year level in class inclusion and in conservation of length. Apart from this, from the age level of 5 years and 6 months onwards up to 8 years and 6 months, the regular increase in mean scores clearly shows the gradual growth of mathematical concepts..

Table I shows the significance of the difference of means obtained by HNE and LNE children of different age levels. The differences are tested for their significance by using 't' test for correlated samples. According to Table I, there is no instance showing a significant difference at .05 level for the age level of 8 years and 6 months. Only at the age level of 7 years and 6 months, there are two instance showing a significant difference, i.e. for the concepts of classification and conservation of weight. Though the statistics show a positive trend towards upper middle class children in the presence of mathematical concepts, the differences are significant only in the concepts of classification and conservation of weight.

Table 2 shows the significance of the differences of the means obtained by LNE and HNE girls and LNE and HNE boys. According to this Table, out of the 24 situations studied in 19 situations, HNE girls are ahead of LNE girls. In 6 situations LNE girls are ahead of HNE girls and in 9 situations there is no difference. Similar statistics denoting the significance levels of HNE and LNE boys showed that, in 16 out of 24 situations LNE boys were ahead of HNE boys, in 4 situations HNE boys were ahead of LNE boys, and in 4 situations there was no difference. Hence, we can discern enough clues to indicate that the extent to which natural experience influence the existence of mathematical concepts is more in the case of boys than girls. Statistics show a significant difference only in two instances concerning girls in the concept of classification at 7 year level and concerning boys the concept of classification at the 5 year old level. Hence, clues are not sufficient to warrant the conclusion that there is an interaction between natural experience and differences of sex.

Table 3 shows the significance of the differences between boys and girls of the 4 age levels in the presence of mathematical concepts. Out of the 24 instances, 7 boys have shown higher mean scores than girls. Hence, we arrive at the idea that boys are ahead of girls in the development of mathematical concepts. But the differences are significant only in 5 instances at 10 per cent level and only in 3 instances at 5 per cent level.

Table 4 shows the significance of the differences in the development of mathematical concepts between various age levels. Statistics show a significant difference between children of 5 year age level and 6 years age level in the concept of seriation. Seriation, class inclusion, classification and conservation of substance, length and weight, indicated significant differences at the 8 year age level. According to Piaget, as the children from the pre-operational stage enters the concrete operational stage, there is a significant difference in the occurrence of mathematical concepts. Sri Lankan children too confirm this Piagetian theory.

Table 5 shows that out of the 20 males and females at each age level, the percentage which reached the 75 per cent criteria level at the age level of 7 years the concept of seriation is present in 100 per cent of the children. In the concept of classification, 65 per cent at the 7 year level and 85 per cent at the 8 year level reach the required criteria level. Conservation of substance, length and weight, gradually grows in children. The percentages being 5 per cent at 6 year level and 7 year level and 30 per cent in the 8 year level. Percentages concerning the concept of class inclusion are not found to be regular. Hence, conclusionary statement cannot be drawn from them.

FINDINGS

Analysis of results leads to following conclusions :

1. There are no significant differences in the growth of mathematical concepts between those having high and low rates of natural experience.

2. Influence of natural experience on the growth of mathematical concepts seem to be more significant among the boys.

3. Concept of seriation is soon to occur at the 7 year old level and concept of classification at 8 year old level. Concepts of class inclusion, conservation of substance, length and weight, are seen to occur at 8 year old level. But, in these concepts, only 30 per cent of the children reach the criteria level. The fact that only 35 per cent reach the criteria level at 8 year old level in conservation of weight indicate that this concept occurs much later.

4. There is a statistical trend to show that the boys assimilate the concepts more rapidly than girls. But, this is not indicated by a significant difference.

5. Different stages of intellectual development recognized by Piaget are seen to occur among Sri Lankan children as well. There is a significant growth in the concept of seriation between the ages of 6 and 7 years. Significant growth is shown in the concepts of classification, class inclusion, conservation of substance, length and weight, between 7 and 8 years.

Hence, these findings indicate that Sri Lankan child enters the stage of concrete operations after passing pre-operational stage between the ages of 7 and 8.

DISCUSSION

The main discovery of the research is that there is no significant difference in the growth of mathematical concepts between HNE and LNE children. But the statistics show a minor positive trend towards the LNE children, indicating that the growth of mathematical concepts may be a little more rapid among them.

According to Piaget's theory, the rate of natural experience should influence the formation of mathematical concepts. Then why do LNE children show a more rapid development of mathematical concepts? This clearly shows the influence of other variables. Since the LNE children belong to the upper middle class of the social structure, influence of social class structure on the growth of mathematical concepts is clearly seen. Therefore, a number of variables which can be included in the social class structure can influence the growth of mathematical concepts. Upper class children's way of life and their environment may be conclusive educational activities and hence even if the amount of natural experience is less, the few experiences that they receive may be in an organised form so that they can be easily assimilated and accommodated. The natural experiences which the HNE child receives may not in an organised form and the child has to organise them with his own effort. Hence, even if more experiences are received the child will need more time to assimilate them and form the necessary concepts.

Assimilation of natural experiences may occur in a meaningful way in an upper middle class child due to the motivation created and encouragement given by the members of the family. He will be in a better position physically and emotionally to assimilate the experiences and develop a firm logical structure conducive to the formation of the concepts. Upper middle class child may be in a better position in sustaining their attention on a stuation for a longer time. He may have the attitude of looking at a situation and dealing with it in a more analytical way. In other words, he may be in possession of a more favourable cognitive style. This idea was clearly experienced during the experiments when some HNE or lower class children, were questioned by the expeimenter they almost instantly provided an answer without pausing to think about the situation at all. The habit of arriving at an idea after careful thinking and consideration seem to be more prevalent among the upper middle class children.

The elaborate code of language which the upper middle class child is shown to possess (Bernctein 1961), may also help in the assimilation of natural experiences. The well balanced personality which most upper middle class children are seen to possess as a result of balanced physical, mental and emotional state will help them to assimilate their experiences meaningfully.

Physically and emotionally handicapped lower class child is not in a position to assimilate meaningfully the numerous natural experieces that he receives due to less attention, encouragement, and interest. When a child is physically weak and subjected to malnutrition, even if the child possesses a higher intellectual power, his intelligent activity is diminished. Joseph Klein (1971), says that children who come from deprived environments have a different cognitive style and less motivation. According to an experiment undertaken by Dorris Calloway referred to in the Unesco Publication, "*The Education on the Move*"

(1972), after a few days of complete protein deprivation with full calories of vitamin and mineral supply there are already signs of mental disabilities. Simple tasks such as recall of names and numbers and simple arithmetic exercises are noticeably affected. Accorfding to Calloway, the consequences of malnutrition are shortened span of attention, reduced mental powers, increased drowsiness, and prolonged sleep cycles, all contributing to a gross reduction of play and learning activities.

The experiences that the upper middle class children receive both within their homes and in the immediate environment such as weighing of different food items, measuring lengths and breadths etc., even though less natural, may be directly related to mathematical concepts. In the above mentioned type of experience, connection to mathematical concepts is already established, while in natural experiences the child has to interpret the connection to mathematical concepts.

Still, natural experience may be regarded as a contributing factor in providing the logical structure of thinking which permits the understanding of mathematical concepts. The fact that the children of the culturally deprived class even with so many variables against them did not show a significant difference to upper middle class children in the presence of mathematical concepts shows the importance of maturation as well as natural experience in the growth of mathematical concepts. Natural experience may be identified as a favourable contributing factor for mental activities of children in the lower income group of society.

In a research conducted by Jam T. D. Wel, Celia B. Lavatells, and R. Stewart Jones (1971), on the influence of social class on the mathematical concepts of class inclusion and classification, lower class children received lower marks than the children of the upper class. Upper middle class children had given more logically constructed answers as compared to that of lower class children. Piaget (1969) and Goodnow (1962), have shown that social class structure can influence the growth of mathematical concepts in children. Almie Miller, Chittenden and Paulo Miller (1966), showed that only a few children from the lower classes have gained the understanding to mathematical concepts. According to the results of their research, mathematical concepts are seen to occur among lower class children an year later than in middle class children. Hence, the present research has obtained results in accordance with Piaget's idea and in conformity to the results of the researches carried out by his followers.

The favourable learning history in the upper class primary schools may also contribute to the better understanding of mathematical concepts by upper class children. Nita and Nagavo in Japan (1966), in a research on the influence of learning history to the presence of mathematical concepts in children, have shown that to create a better understanding of the concept of weight, children should be taught about the units of measurements and given practice in weighing with a scale.

Piaget's ideas about cognitive development have been experimented in various cultures and the results of which have confirmed the idea of the successive stages of mental development. In a research carried out by Greenfield (1966), among the Bush Tribe in Africa, while recognising the different stages of mental development, found that these children differed from

French children in the nature of reasons given as explanations. Siegal and Meimelstein (1965), in an experiment carried out in Prince Edwards Islands found that there is no difference in the understanding of mathematical concepts between non-school going and school-going children. P. E. Poole (1968), in a research conducted with the Hansen tribe in North Algeria recognized the different stages of mental development but found that the English children had a better understanding of mathematical concepts. In researches conducted by Price Williams (1961), with Tiv tribe in Africa, and Frienfield with Wolof tribe in Africa found that the concrete operational stage starts at the age of 8. In a similar research undertaken by the Curriculum Development Centre in Sri Lanka found it true among Sri Lanka children as well.

In the present research too, different stages of mental development recognised by Piaget is evident. Significant differences are shown in the presence of mathematical concepts between age levels of 7 and 8 years. But, according to Table 5, even at the age level of 8, majority of children have not gained the criteria level in the occurrence of mathematical concepts. Table 6 shows the percentages of those who gained conservation for concepts of conservation of weight substance and volume, at different age levels in an experiment conducted by D. Elkind (1961). Comparison of these percentages with the similar percentages of Sri Lankan children show a noticeable difference. The growth of concept may be less rapid among children in countries like Sri Lanka as compared to Western countries due to different methods of bringing up children, unfavourable home and school environments, and due to the higher stage of scientific and technical development found in western countries.

The low reliability found in the statistics obtained for the concept of class inclusion may be due to unambiguous nature of the experimental items concerned. Hydo (1959) in his research, has pointed out that the experiment concerning white and brown beads can easily be misunderstood by the children.

Present research has shown that boys are ahead of girls in understanding mathematical concepts. Out of the 5 situations where significant differences are shown, 4 were to the advantage of boys, and even if there is no significant difference, out of the 24 situations 17 show a positive trend favourable to boys.

In a research conducted by Marian Goldschmid (1967) on the influence of age, sex, IQ, MA, and vocabulary on conservation has found that boys had performed better than girls. She showed that this is the result of more freedom enjoyed by boys as compared to girls. According to the way the children are brought up in our culture too, boys seem to enjoy greater freedom in play and environmental activities. Boys, because of their active nature and freedom, tend to think in a more practical way than the girls who are more imaginative. This practical way of thinking can aid in the understanding of mathematical concepts.

Reasons forwarded by children during the experiment also reveal their mental activity leading to the understanding of the concept. David Elkind (1961) has classified the reasons thus obtained by 4 kinds:

1. Giving irrelevant details (Romancing - Piaget 1951b)
2. Reasons connected with percep ion.
3. Specific reasons.
4. General reasons.

According to the results of Elkinds, experiment perceptional reasons decrease and specific reasons increase with age. This shows that the child gradually frees himself from perceptional thinking and starts thinking in terms of specific activities. In this research too, the reasons put forward for conservation were analysed and 4 kinds of reasons were discovered:

1. Reasons built on perception.
2. Reasons built on activities.
3. Reasons built on relationships.
4. Reasons built on reversibility.

The children at the 5 year old level put forward more perceptional reasons, and as the age increased, reasons built on activities and reversibility were common. Table 7 shows different kinds of reasons given as the percentage of the total number of correct replies. Sometimes, child's understanding of the concept was visible even though he was not able to give a reason. At 5 year age level, there were 18 such instances and only one such instance at 8 year old level. According to Table 8, there were 7 per cent of such instances in the LNE group and 11 per cent in the HNE group. Failure to put forward a reason even though the concept is understood may be taken as a result of language difficulty. Such language difficulty is seen to be more marked among the HNE or lower social class group. According to Table 8, LNE children are ahead of HNE children in reasons built on activities and reversibility, which shows a greater presence of logical thinking among upper middle class children.

Experiences received during experiments

Success of the experiments depends on the aptitude of the experimenter, and the interest and effort taken by him on the experimenter's way of thinking. It influence the nature of the reaction, importance of experimenting the whole group by one single experiment thus realised. Experimental situation is also seen to be influenced by the particular teaching methods prevalent in the school. According to the traditional teaching methods in most Sri Lankan schools, the reason is asked for by the teacher only when the teacher receives a wrong answer from the student. During the experiments there was a feeling among the children that the answer might be wrong when they were asked for a reason for their conservation. Hence, specific instructions had to be given to avoid this situation.

During the experiment, the children had no way of knowing whether the answer given by them was right or wrong. Hence, the children having a higher rate of self confidence may think that all the answers were right and *vice versa*. After the first test, as it is the general practice, children talk among themselves as to the nature of the replies that they had given. As a result of this conversation, children might accept a a wrong answer as a correct one. During the second test, there were enough clues to indicate the possibility of the occurrence of such a situation.

Validity of the findings of this research may be confirmed if they are subjected to further research. It will be possible to ascertain the direct influence of natural experience on the occurrence of of mathematical concepts if such past research makes an attempt in some way to control the social class of the children. In this research a lot of variables are given in explanation of the higher level of occurrence of mathematical concepts among upper middle class children. But the need to find out how the natural experience will directly influence the growth of mathematical concepts is evident.

The validity and reliability of the findings here is limited because a small sample is used which cannot be avoided in this kind of clinical method of research. However, these findings may be helpful in generalising the findings of later researches.

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TABLE 1: Significance of the Differences of Marks Obtained by LNE and HNE Children at Different Age Levels.

Concept	Age 5 yrs to 5 yrs & 6 m.	Age 5 yrs to 6 yrs & 6m.	Age 7 yrs to 7 yrs & 6m.	Age 8 yrs to 8 yrs & 6m.
Seriation	– 1.2	.58	00	– .85
Class Inclusion	– .26	1.35	1.00	– .425
Classification	– 1.82	– 1.06	– 6.74	.394
Conservation of Substance	– .32	.84	– .71	– .516
Conservation of Length	.557	1.24	– 1.6	– .59
Conservation of Weight	.16	.559	– 2.26	– .671

N = 10 P < 05 t df = 9 = Critical ratio = 2.26
df = N–1

TABLE 2: Significance of the Differences of Marks Obtained by LNE and HNE Girls and Boys.

Concept	M A L E S			
	5 yrs 6 m.	6 yrs 6 m.	7 yrs 6 m.	8 yrs 6 m.
Seriation	– 1.373	0.9669	0.000	– 1.000
Class Inclusion	0.4313	– 1.3719	– 1.0527	– 0.6910
Classification	– 3.000*	– 0.1363	– 0.6123	– 0.4082
Conservation of Substance	– 1.000	– 0.4082	0.000	– 0.5897
Conservation of Length	– 1.000	1.000	– 1.000	– 1.2418
Conservation of Height	0.000	0.000	– 1.6329	– 0.8346
Seriation	0.00	– 1.00	0.00	0.00
Class Inclusion	– 1.139	1.00	0.00	0.0788
Classification	– 0.602	1.299	– 6.50	0.1567
Conservation of Substance	0.00	1.290	0.00	0.0000
Conservation of Length	1.00	1.000	0.00	0.6123
Conservation of weight	0.00	1.000	1.632	0.0000

t ; df = 4 p < .20 — 1.476
„ < .10 — 2.015
„ < .05 — 2.776
„ < .01 — 4.604

TABLE 3: Significance of the Differences between Boys and Girls of the 4 Age Levels in the Presence of Mathematical Concepts.

Concepts	From 5 yrs upto 5 yrs 6m.	6 yrs upto 6 yrs 6 m.	7 yrs upto 7 yrs 6 m.	8 yrs upto 8 yrs 6 m.
Seriation	– .553	.535	.00	– 671
Class Inclusion	– .3	– 2.86**	– 1.00	– 1.47
Classification	.603	– .476	– .267	– .932
Conservation of Substance	– 1.00	.440	– 1.76*	– 3.11*
Conservation of Length	.142	.723	– 1.00	– 2.26*
Conservation of Weight	1.973*	– .66	– 1.34	– 1.411

N1 = 10 N2 = 10 C.R. * 0.10 t; df = 18 — 1.734
** 0.05 t; df = 18 — 2.10

TABLE 4: Significance of the Differences in the Development of Mathematical Concepts between the 4 Age Levels.

Concepts	5 yrs. 6 m. and 6 yrs. 6 m.	6 yrs. 6 m. and 7 yrs. 6 m.	7 yrs. 6 m. and 8 yrs. 6 m.
Seriation	1.76*	3.36*	– 2.09*
Class Inclusion	0.008	– 1.45	2.65*
Classification	1.204	3.102*	2.03*
Conservation of Substance	1.85*	0.355	2.86*
Conservation of Length	0.273	– 0.274	3.07*
Conservation of Weight	0.00	1.34	1.84*

* 0.05 t; df = 38 – 1.697
** 0.01 t; df = 38 – 2.423

TABLE 5: The Percentage which reached the Criteria Level in Different Concepts for the 4 Age Levels.

Concepts	5 yrs. to 5 yrs. 6 m.	6 yrs. to 6 yrs. 6 m.	7 yrs. to 7 yrs. 6 m.	8 yrs. to 8 yrs. 6 m.
Seriation	70%	70%	100%	100%
Class Inclusion	20%	00%	5%	20%
Classification	20%	20%	65%	85%
Conservation of Substance	00%	5%	5%	30%
Conservation of Length	00%	5%	5%	30%
Conservation of Weight	00%	00%	10%	25%

TABLE 6: Percentages of those gained Conservation at Different Age Lengths in D Elkind's Experiment (1961).

Concepts	Age Levels						
	5	6	7	8	9	10	11
Conservation of Substance	18%	51%	70%	72%	86%	94%	92%
Conservation of Weight	21%	52%	51%	44%	73%	89%	78%
Conservation of Volume	0%	4%	0%	4%	4%	19%	25%

TABLE 7: Different Type of Reasons put forward by Children in Explaining their Conservation

Nature of the Answer	Age Levels			
	8 yrs. to 8 yrs. 6 m.	7 yrs. to 7 yrs. 6 m.	6 yrs. to 6 yrs, 6 m.	5 yrs. to 5 yrs. 6 m.
No reason	1%	2%	12%	18%
Answers built on perception	38.5%	38%	47%	56%
Answers built on activities	16%	15%	6%	4%
Answers built on relationship	30%	40%	28%	22%
Answers built on reversibility	14.5%	5%	7%	—

TABLE -8 Percentages of Different Types of Reasons Put Forward by Children of the LNE and HNE Groups in Experiment of Their Conservation.

Nature of Responses	LNE Group	HNE Group
No reason	7%	11%
Answers built on perception	47%	44%
Answers built on activities	11%	6%
Answers built on relationship	27%	33%
Answers built on reversibility	8%	6%