

## Development of Classification, Seriation and Numeration Operations of Primary School Children in The Line of Piagetian Model

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### Introduction

Studies related to children's cognitive development, much of the attention is closely related with the invigorating ideas given by Jean Piaget. Jean Piaget (1952) was one of the most influential researchers in the area of the intellectual developmental approach. He was the noted Swiss psychologist who made extensive and intensive studies of child development. His work is primarily concerned with describing and explaining extensively on various aspects of children's cognitive development. Piaget began his ingenious study of child development considering his own three children as samples from which he collected data. From this beginning, his investigations were gradually extended to other children and have resulted in the publications of a vast number of research papers, monographs and books. It made him interested to know how the process of acquiring knowledge work, what constitute the necessary and significant conditions for the development of knowledge and also what comprises the limits of human competence in getting to know the world (Saha, Kaberi. 2001). Piaget studied the growth and development of the child. In his books, Piaget defines several stages through which a child passes, each new stage representing an improvement in reasoning. He provides examples of experiments and questions applied to different age groups that clearly display the changes, and describe the implications. Literature and new teaching methods have resulted from his works. What follows shall be a brief and general description of the stages important to psychological and mathematical development and some of the consequences of this knowledge. Yet, Piaget observed that, there is a distinct difference in the thinking process of every child. Their thought processes do not have a comparable continuity. It has discontinuous change and development. Every child after birth gradually tries to make adjustment with the outer world in which he lives and develop knowledge through the process of thinking. Piaget regarded this process of development of knowledge as Cognition or Cognitive Development.

According to Piaget, cognitive stages follow an invariant sequence. For example, a child whose reasoning is at the concrete operational level cannot be expected to succeed with formal operational tasks. The concept of Invariant sequence given by Piaget can be interpreted in three different ways - 1. Major developmental periods or global stages have an invariant sequence, that is, Stage A will be followed by Stage B, and stage B will be followed by Stage C without skipping any Stage and without reversing the progression. 2. There is a fairly reasonable with-in-stage development sequence of various operations. For example- the conservation of mass is acquired

before the conservation of weight and conservation of weight is acquired before the conservation of volume. 3. There is a with-in operational development sequence. Today Piaget's contributions are well known, although they are not entirely free from controversy. Piaget's assertion of "invariant sequence" and the age of acquisition of "global stages" and particular "with-in stage" operations has been the focus of most Piagetian cross-cultural research. Most of these have in general, supported Piaget's assertions like Elkind's (1964), but several have questioned its validity and universal application Doodwell (1960, 61, 62).

A large number of studies for finding out the concrete stage of development, using Piagetian tasks, have been conducted in many countries. The samples used in these studies have been the children studying in schools ranging in age from about 6 or 7 years to 10 or 11 years. It has been observed that about 50% to 75% of the subjects reach the concrete operational stage, while about 20% to 40% are at transitional stage from pre operational to concrete operational stage and the remaining are still at a pre operational stage (Piaget and Inhelder 1968, Sacket 1971, Narayan Rao 1976, Bevli 1983). The concrete stage of cognitive development has received a very little empirical attention in India as there are very few studies related to the cognitive development of Indian children (Durgsnsnd Sinha and Tantreshwar Jha1989; De. B, 1983; Dasen 1974).

Review of related literature showed that, various research workers working within the framework of Piagetian theory of cognitive development have investigated the performance of the children on the various tasks framed by Piaget. Conservation tasks of number, area, length, mass, weight, volume have been used by them to study the attainment of concrete operational level of the child. But not many studies have been conducted on classification, seriation and numeration operation of children with Indian subjects specifically with children of Assam. Keeping this in view, the present investigation was made on classification, seriation and numeration operation with different age group and also with both boys and girls students in order to adjudge their relative abilities. This research investigation was also designed to study the cognitive development of young children in relation to their socio economic status.

### **Operational Definition of the Terms used in the Present Study**

Before dealing with the methodology of the present study, it would be essential to give the operational definitions of the various variables included in the study. They are being stated here under-

#### **Cognitive Development**

Cognitive development is the development process by which an infant becomes intelligent person, acquired knowledge with growth and improving his or her ability to think, learn, reason and abstract. But in the present study, the term cognitive development has been adopted from Piaget. Here, the development occurs in concrete operational stage is regarded as cognitive development of children.

## **Classification**

According to Oxford Advanced Learner's Dictionary of Current English (1974): Classification means arranging in classes or groups and put into a class. The Little Oxford Dictionary stated: classifying means arrange in classes, class. By Classification, the present investigator in the study meant the ability that children gain in concrete operational stage. It refers to the ability to structure the objects hierarchically.

## **Seriation**

Seriation is another new ability gained during this stage and refers to the child's ability to order objects with respects to a common property. It is the ability to sort objects in an order according to size, shape, or any other characteristic. For example, if given different-shaded objects they may make a colour gradient.

## **Numeration**

An important new ability which develops from the interplay of both seriation and classification is that of numeration. It is the ability that allows the child to apply mathematical operations in counting the objects presented before them.

## **Primary school children**

Primary education is the foundation of the entire superstructure of educational system of a country. It is the first beginning of formal system of education. Thus primary school children are children between the age group of 7 to 11 years. In the present study primary school comprising the class from class I to V of the age group of 7 to 11 years.

## **Age**

In the study, age referred to the chronological age that is actual age of the individual from birth in terms of years, as per school record.

## **Socio economic Status**

Socio economic status referred to the position than an individual or a family occupation with reference to the prevailing average standards of cultural possessions, effective income, material possessions and participation in group activity of the community. Socio economic status (SES) is strongly associated with cognitive ability and achievement during childhood and beyond. So this is regarded as inevitable for the present study.

## **Objectives**

On the basis of the afore-stated specification of the problem of this research and the issue involved therein, the following objectives were set up for the present study

1. To study the influence of age on cognitive development of primary school children.
2. To study the influence of gender on cognitive development of primary school children.

3. To study the relationship between socio-economic status of the parents and the development of cognitive abilities in primary school children.

### **Hypotheses**

The hypotheses formulated for investigation in the light of the above objectives were as follows

1. There exists no influence of age on the development of classification, seriation and numeration abilities in primary school children.
2. There would be no influence of gender on cognitive development of children
3. Socio economic status of the parents has no influence on development of cognitive abilities in primary school children.

### **Sample**

The sample of the present study involved individual testing of 100 rural Assamese speaking students of age group of 7 to 11 years studied in five different primary Govt. schools. The sample was mainly divided as gender wise. Half of the children were girls and the other half were boys. Thus

there were 50 girls and 50 boys selected randomly out of 180 girls and 220 boys in all. Further there were equal numbers of children from each of the age and grade groups of 6-7 grade I, 7-8 grade II, 8-9 Grade III, 9-10 Grade IV, 10-11 Grade V. The significant factors on which this sample differed from the sample of other developed countries like the USA, Sweden and the UK etc may be such as poverty, cultural value and environmental factors.

### **Piagetian Tasks**

Various Piagetian tasks (Inhelder & Piaget, 1958) and modified form of these tasks are used to identify the stages of cognitive development. The tasks selected for the present research study were constructed by the investigator herself. The present investigator developed five Piagetian type tasks with little variation in them. They are- Simple classification tasks, multiple classification task, simple seriation task, multiple seriation task and numeration task.

Task description, materials required, procedure of administration, procedures of scoring, classification in the different levels of cognitive development and reliability of each task are mentioned below.

### **Test Material and scoring**

1. For classification operation, two task-simple classification and multiple classification tasks were developed. For simple classification task, 55 beads: 40 of red, 10 of white and 5 of golden were used and for multiple classification task, 40 card blocks of different shape, size and colour were utilised. For Seriation operation again two task- simple Seriation and multiple serration tasks were developed. For simple seriation task, 8 two dimensional sticks varying in length and



for multiple Seriation task, 49 drawing of leaves cut out of cardboard increasing in size and according to increasing in colour intensity were used. For numeration task, nine three dimensional wooden blocks having first 1” and remaining are increasing ½” were utilised by the investigator. Manipulating the test materials, different questions were asked. In the first question, whether or not the subject had identified the objects or materials was ascertained. The rest of the questions pertained to finding out subject's reasoning level, their understanding through counter suggestion question and explanation with regard to the task. In order to know the subject's reasoning level, children were asked to show their ability to give reasons of why and how they thinks to group one or more things/ objects that look alike. In counter suggestion, the subjects were provided more objects in a particular way and they were to say whether the objects would remaining the same or not or they constitute same group. In the Explanation, 'why' of their judgement were sought.

Thus for correct responses for each level the subject was awarded 6 (0+2+2+2=6) scores. If the responses given by the subject were not correct at all the stages, they were given no score, if their responses were partially correct in all the four levels; the subject was awarded below 6 on the basis of their responses. The details of the scoring pattern has been shown on Table no 1

2. Total = 6 Table no 1

Level	Simple classification	Multiple classification	Simple Seriation	Multiple Seriation	Numeration
Level-1 Identification (Pre operational child)	0	0	0	0	0
Level- 2 Request for Reasoning (Intuitive stage)	2	2	2	2	2

Level -3 Counter suggestion (Transitional stage)	2	2	2	2	2
Level- 4 Explanation (Operational Stage)	2	2	2	2	2

### Reliability of the Piagetian Tasks

In the sample of 100 children, the above five Piagetian tasks were again administered after an interval of one month time to 15 students selected randomly, 3 students from each grades. The test, re-test reliability was calculated using product moment correlation formula. The reliability of each task are mentioned in Table 2

**Table 2**

Tasks	Simple classification	Multiple Classification	Simple Seriation	Multiple seriation	Numeration
Reliability Coefficient	0.89	0.95	0.90	0.76	0.70

Thus the reliability of each Piagetian task is quite high. It shows that individual Piagetian tasks can be used with a satisfactory degree of reliability.

Objective wise analysis of the data are presented in the following tabular form

1. To study the influence of age on cognitive development of primary school children.

Table 3 shows percentages of operational children in three concepts classification, seriation and numeration of different age groups (7-11 years)

Age in years	Classification	Seriation	Numeration
6 -7	0	0	24.00%
7 -8	16.00%	6.00%	38.00%

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8-9	31.00%	40.00%	60.00%
9-10	32.00%	53.00%	60.00%
10-11	48.00%	54.00%	60.00%

Table no=3 represent the results of percentage of operational children in three concept namely classification, Seriation and numeration. It shows that for classification concept, the percentage of operational children at 6-7 years are found 0. at 7-8 years 16.00%, at 8-9 years 31.00%, at 9-10 years 32.00% and 10-11 years 48.00%. For Seriation concept, , the percentage of operational children at 6-7 years are found 0. at 7-8 years 6.00%, at 8-9 years 40.00%, at 9-10 years 53.00% and 10-11 years 54.00%. For Numeration concept, , the percentage of operational children at 6-7 years are found

24.00%, at 7-8 years 38.00% and at 8-9 years, 9-10 and 10-11 years the percentages of operational child are found 60.00%. Thus it shows that in the entire three concepts there is not so much clear difference regarding their performance. However children show better performance in Seriation task than classification task and in numeration task then classification and Seriation task.

2. To study the influence of sex (gender) on cognitive development of primary school children.

The performance of the boys and girls on each task and on their respective questions are described in Table no 4 and Table no 5

**Mean Score in percentage achieved by primary school children (7-11 years) in achieving the concept of classification seriation and numeration operation**

**Table no. 4**

Sex	Classification			Seriation			Numeration		
	Level-2	Level-3	Level-4	Level-2	Level-3	Level-4	Level-2	Level-3	Level-4
Boys	50%	52%	66%	62%	69%	75%	82%	98%	92%
Girls	56%	57%	78%	66%	76%	82%	90%	100%	100%

Table no 4 represent the results of mean scores in percentage achieved by tribal boys and girls in three concept namely classification, Seriation and numeration. It shows that for classification concept, the mean percentage of boys are 66% against 78% of girls. For Seriation concept, the mean percentage of boys are found 75% against 82% girls and for numeration concept boys mean percentage are 92% against 100% girls. Thus it shows that in the entire three concepts there is not so much clear difference between boys and girls regarding their performance in cognitive tasks.

However, both boys and girls show better performance in Seriation task than classification task and in numeration task then classification and Seriation task.

Composite mean SD (Pooled) and 't' ratios for the concept of classification Seriation and numeration for the age group of 7-11 years of non tribal children (Boys and Girls)

Table No. 5

Age in Years	Means		Pooled SD	't' ratio	Level of Significance (0.01 & 0.05)
	Total Children=100				
	Girls=10	Boys=10	df=18		
6-7	10.20	11.00	1.60	3.24	*Not Significant
7-8	17.00	16.40	4.46	2.26	**
8-9	25.80	25.40	4.03	2.26	**
9-10	28.40	28.80	1.72	2.30	*
10-11	27.60	28.00	3.36	2.30	*

(Not Significant at 0.01 \*, Not Significant at 0.05\*\*)

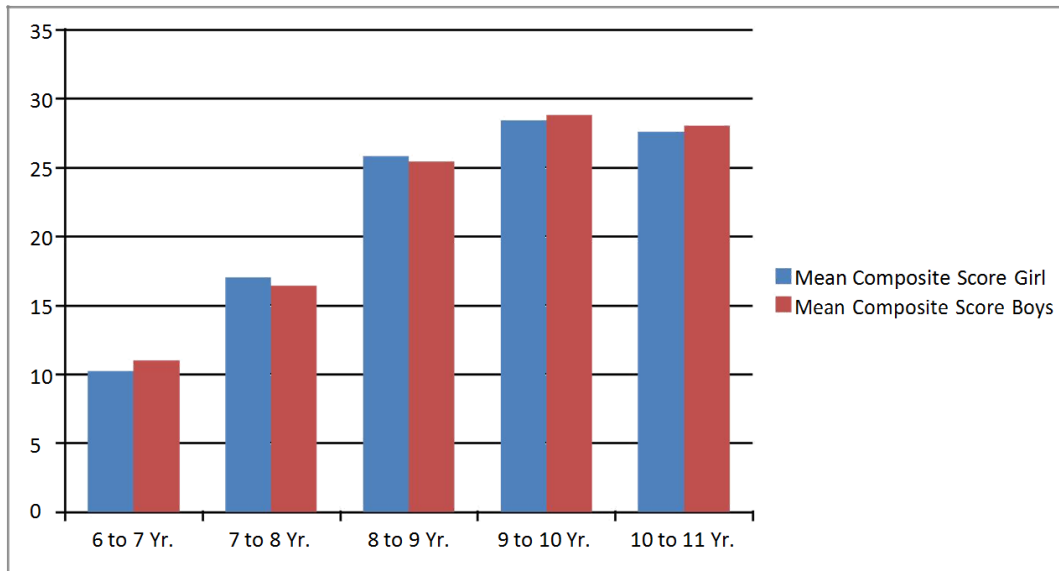
S = Significant

NS = Not Significant

This table presents the composite mean of boys and girls of different age groups (class) in three different concepts (classification, Seriation and numeration), along with pooled SDs and t ratios. At the age 6-7 years the composite mean scores of Girls are found to be 10.20 as against 11.00 of boys with pooled S.D. 1.60, at the age 7-8 years the mean scores of girls are found to be 17.00 as against 16.40 of boys with pooled SD 4.46, at 8-9 years the composite mean scores are found to be 25.80 as against 25.40 boys with pooled SD 4.03, at 9-10 years, composite mean score of girls are found as 28.40 against 28.80 girls with pooled SD 1.72 and at 10-11 years composite mean score of girls are found 27.60 against 28.00 boys with pooled SD 3.36.

Graphical Representation of the Composite mean cognitive scores for the concept of classification Seriation and numeration for the age group of 7-11 years of children (Boys and Girls)

Figure-1



The girls scores at the early age of 6-7 and 7-8 years seemed slightly exceed the boys scores. The mean score difference between boys and girls (0.80) at the age group 6-7 years and the respective t ratio (3.24), found to be significant. The respective mean score difference for boys and girls with the t values for the age groups 7-8 years 8-9 years, 9-10 years and 10-11 years are (0.60), (0.40), (0.40) and (0.40) with ( $t=2.26$ ), ( $t=2.26$ ), ( $t=2.30$ ) and ( $t=2.30$ ) found not significant. Thus there exists no significant difference between boys and girls scores in different age groups. The data for boys and girls were pooled for further comparisons.

Thus from the results found out from both the table, it can be concluded that, there exists no significant difference between boys and girls scores in different age groups. Hence the data are pooled for further comparison. However when we compare Table no. 1 & 2 we found that the growth rate of both boys and girls scores were found more (Mean) in case of non tribal children in compare to tribal children.

3. To study the relationship between socio-economic status of the parents and the development of cognitive abilities in primary school children.

Mean and SDs of Cognitive Scores of High and Low Socio Economic Status group of primary school children

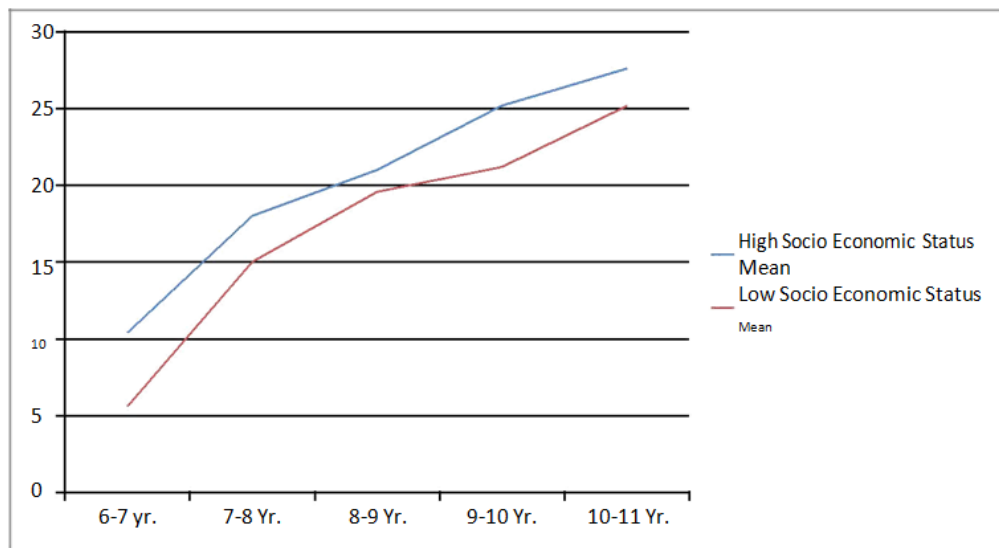


**Table No. 6**

Age in Years	High Socio Economic Status		Low Socio Economic Status	
	Mean	SD	Mean	SD
10-11 Yr.	N=10		N=10	
	28.53	2.45	27.20	3.69
9-10 Yr.	N=10		N=10	
	28.80	1.66	28.27	1.83
8-9 Yr.	N=10		N=10	
	26.13	4.24	24.80	4.26
7-8 Yr.	N=10		N=10	
	17.33	4.39	16.13	4.87
6-7 Yr.	N=10		N=10	
	10.93	1.49	10.13	1.60

This table represents the Means and SDs of the cognitive scores of non tribal children belonging to high and low socio-economic status groups. In HSES data according to table as age increased the mean were increased and there are slight changes seen in SD. In LSES data according to table as age increased the mean were increased and there are slight changes were seen in SD.

Graphical representation of the mean cognitive scores of high and low socio economic status groups children have been presented in figure no. 2-



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### Mean Differences and 't' Ratios of non tribal children (7 to 11 years) having two levels of socio economic status (High and Low)

Table No.7

Age in years	Mean difference		't' ratios	Level of significance at 0.05 level
6-7	High & Low SES	1.33	2.86	S
7-8	High & Low SES	0.54	1.61	NS
8-9	High & Low SES	1.33	2.86	S
9-10	High & Low SES	1.20	2.33	S
10-11	High & Low SES	0.80	2.52	S

This Table shows the results of t' test in the case of non tribal children. The respective 't' ratios are for 6-7 years for High & Low SES ( $t=2.86$ ), 7-8 years for ( $t=1.61$ ), 8-9 years for ( $t=2.86$ ), 9-10 Years for ( $t=2.33$ ) and for 10-11 years for ( $t=2.52$ ). In all the age group there was significant difference found in High & Low SES. Thus from the table it has been observed that the scores on cognitive development differed significantly between high and low socio-economic group children.

Results of Analysis of Variance (ANOVA) on Cognitive Scores of High and Low SES group of Parents of Non Tribal Primary School Children

Table No. 8

Age in Years	F Ratio	Level of Significance
6-7	2.5	S
7-8	1.81	(NS)
8-9	2.13	(NS)
9 10	1.55	(NS)
10 -11	3.28	(S)

This Table shows the results of one way ANOVA of the High and Low SES groups in case of Non Tribal Primary School Children for the age levels 6-7, 7-8, 8-9, 9-10 and 10-11 years. The F ratio for the age group 6-7 years, ( $F=2.5$ ) and 10-11 years age group ( $F=3.28$ ) were found significant. For 7-8 years ( $F=1.81$ ), 8-9 years ( $F=2.13$ ) and for 9-10 years ( $F=1.55$ ) found no significant at

0.05 level. Thus, no significant effect of socioeconomic Status on cognitive development has been noticed for the age group 7-8, 8-9 and 9-10 years.

## Results

1. Age of the child has direct influence on cognitive development (i.e. Classification, Seriation and numeration task). With the help of table no. III we can say that age of the child has direct influence on cognitive development .As age increases the cognitive development also increases. In other words, with increase in age, the frequency of operational child in all the three concept (classification, Seriation and numeration) tended to go up. Thus children of all the five age levels though differed from each other on three cognitive tasks, those of older groups being higher than those of lower groups. It is general in line with the Uzagiris, (1964) Sinha, D and Jha, T. (1989) Saha. K, (2001) etc.
2. From the table no IV, it has been found that, gender has no effect on cognitive performance of children. The influence of gender cannot be accepted as a major factor in development of cognitive ability. It is because, in all the cognitive tasks, among some age groups, though girls showed better performances than the boys whereas in some others, boys exhibit better performance than girls. But such difference was not significant. With the help of table no V it has been observed that the 't' ratios for all the five age groups were found not significant. Thus it can be concluded that, gender is not exerting major influence on cognitive development of the subjects.
3. On the basis of the findings it has been found that, so far as classification, Seriation and numeration is concerned, socio economic status of the parents plays an effective role on child's performance. SES of the family was associated with performance although its influence was negligible until the age of 6-7 years. Beyond it significant differences were observed between high and low socio economic groups which tended to get increased with age. Thus SES has great influence on cognitive development. This finding gets support from the earlier study by Peluffo 1962, 1967, Wei 1966, Delacy 1970a, 1970 b, Updesh Bevli 1970, 1978, Frank B. Murry, M puspa Jackuck and Mohanty A.K., Rao N.1977 etc. However the result contradicts with the result of Za'rouer where no positive relationship of SES with cognitive development was found. The results of the present study are also contradicted by previous study done by Pandey 1979. He argued that, socio economic status does not have any effect on the classificatory ability.

## Conclusion

At the end one point should be given importance that, as learning is not a passive process, the child should always be active in the learning situation. Learning will not take place unless the child is active. Piaget himself has written "My most central concern has always been to determine the contributions of the person's activities and the limiting aspects of the object in the process of acquiring knowledge". (Piaget, J. 1963) (Foreward to the Developmental Psychology of Jean

Piaget). The teacher's task thus is to create such an environment that, the child remains active so that his cognitive development can take place.

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