

COGNITIVE DEVELOPMENT TASK BATTERY FOR CLASS I PRIMARY SCHOOL CHILDREN

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In the context of a large research project aimed at improving primary school education in Pakistan by understanding cognitive development of Pakistani children, a battery of cognitive developmental tasks was evolved. The initial battery consisted of five tasks, namely, correspondence, seriation, conservation of length, conservation of liquid and classification. After a brief introduction to Piagetian theory and methodology sample and procedure for development of tasks and data collection is described. Data analytical method for assessing the performance of the task battery has been described in detail. Item facilities, item analysis and discrimination analysis are reported. The results indicate that the task battery is a respectable research tool for assessing cognitive developmental levels of class I primary school children of Pakistan. Description of tasks along with their scoring rules is included in Appendix.

A study of cognitive development of Pakistani children was planned with the assumption that understanding of the process of cognitive growth of children can raise pupils' level of educational achievement by providing them a curriculum matched with their cognitive structures. Many research projects of this nature, in various parts of the world, have been inspired by the contributions of Swiss psychologist Jean Piaget. Relevance of Piaget's work to educational practices have been discussed in detail by a number of authors (see, for instance, Athey, 1970; Beard, 1969; Furth, 1969; Schwebel & Raph, 1973).

Besides voluminous original work by Piaget and his associates, a large number of books have been written to understand, interpret and summarize Piaget's theory at various levels and from various angles. In the opinion of present authors, "The Essential Piaget" (Gruber, 1977) is the most important work in this direction.

Piagetian theory does not refer to educational practices as such. The fundamental question raised in this theory is how a person's way of knowing changes as he matures. Piaget has explored highly varied aspects of human knowledge. He has studied perception, child's understanding of space and time and child's conception of number and cause and effect, etc. He has explored the process of reasoning that the child goes through when faced

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with various kinds of problems or questions. With all this diverse subject matter, Piaget has been concerned to show how the process of acquiring knowledge of the child differs from that of adults (Child, 1973). He has shown that child's thinking in its various stages of development is qualitatively different from that of adults. Piagetian theory is better known for its conception of cognitive stages. Each stage is an organization or structure, the pattern of thought being characteristic of a particular stage, a point in the development. The process of knowing takes place within the context of these structures. A knowing cannot take place unless a particular structure is available to the 'knower' and availability of these structures is a function of developmental process. In an educational context it can be summarized that a particular segment of knowledge (let us say a particular concept or a lesson in a curriculum) cannot be assimilated by the pupil unless he has an appropriate cognitive structure available to him.

The main thrust of the present study was to map the cognitive structures in Pakistani children. It was hoped that this mapping will be helpful in understanding the pattern of cognitive development in primary school children and will be used to match the curriculum to the cognitive abilities of Pakistani children.

Thus the development of a cognitive task battery was a basic step in the study of cognitive development of primary school children.

Before describing the various steps involved in the development of cognitive task battery for class I children, it would be appropriate to consider the nature of Piagetian experimentation. One must be careful not to think of Piagetian experimentation in terms of the model of typical Anglo-Saxon psychological experiments which are the same as those used in the natural sciences. Piaget has devised a new method particularly suited to the evocation of psychological data. This entails experiments in which the subject participates at least as much as the observer, though in a different way.

In principle the method consists of an open-ended discussion with the child (for a detailed discussion on the Piagetian method see Schmid-Kitsikis, 1985). Although inspired by the traditional type of interview employed in psychiatry and psychopathology, it has the merit of going further than the analysis of purely individual cases in order to reach something that has general application. It depends essentially on interaction between the researcher and his subject, in the sense that he formulates every next question in the light of the answer that has just been given. Hence, the experimenter is able to go further than the method of pure observation and attains the main advantages of experimentation, without having recourse to tests and their attendant pitfalls. A clinical interview is conducted using as starting point a concrete situation contrived by the experimenter (CERI, 1977).

METHOD

Sample

The administration of cognitive tasks went through various phases in this study. In the first phase the objective was familiarization and informal training of the research staff to the Piagetian methodology. Therefore, the record of the number of children interviewed was not kept. Once the task battery was compiled, data were collected on 50 class I children from an average school in Islamabad (urban children). These children included boys and girls and were randomly selected from two class I sections of the school.

For the next phase of data collection, two villages near Rewat, namely, Jawa and Mera Mora, were selected. Boys' and Girls' schools were separate in these villages. Therefore, boys and girls were interviewed in their respective schools. In total, 50 rural children from class I were randomly selected for the rural sample.

Development of Tasks

In the very first phase of the development of battery, besides going through whatever printed material was available, Piagetian concepts were tried out by bringing children to the National Institute of Psychology and by going into village and interviewing children in highly unstructured situations. A village near Islamabad, Shah Allah Ditta, was selected for the purpose. This initial contact also included some interviewing of teachers and parents and looking into the actual educational practices. After this experience some rather irregular material was developed to interview children on various Piagetian concepts. For this purpose primary school children from Islamabad schools were brought to the Institute.

This phase not only gave basic understanding of interplay between the material of Tasks and child's thinking strategies, it was also the beginning of training of the technique where, one person's interview with the child was recorded on cassette and later on discussed in detail. By going through this process, basic tasks for class I were drawn up.

Tasks in the following areas were planned to be included in the task battery: one to one correspondence; seriation; conservation of length and classification. These tasks were of concrete operational thought, suitable for our sample age-range. It was also assumed that these areas cover the thinking strategies required for understanding the elementary school curriculum.

These tasks were again administered to children in order to lay down somewhat standardized procedures with full scope for recording child's original responses.

Initially the verbal activity during the testing process was tape-recorded but it was soon felt that by this method we were missing some significant details of the process because the child was interacting not only on verbal level but was also communicating through gestures. So, from then onwards, it was decided to record each and every response of the child on paper. Some general guidelines were also established, though adaptable to the individual testing situation.

Thus, the instructions for the administration of each task were formulated, and for the recording of responses of the children, it was decided to record each and every response.

Data Collection

With these instructions and administration procedures, data were collected on 50 urban children. These children were brought to the Institute in groups of 5 to 6 at a time. The battery consisted of the following Tasks:

1. One to one correspondence
2. Seriation
3. Conservation of length (with flexible sticks)
4. Classification

Before moving to the village, certain changes were made in the battery in the light of data collected on 50 urban children. After analysing data of these children it was found that the task on seriation requires more detailed inquiry. It was, therefore, broken down into three separate sets of administrations. Practically no child was able to achieve optimal level on the conservation of length (with flexible sticks). It was, therefore, decided to adopt a simpler version of conservation of length. It was also felt that conservation, being a key concept in the concrete operational stage, needs verification in some other areas. Conservation of liquid was, therefore, added into the battery.

At this stage it also became possible to make response categories of each task, in a sense somewhat structured, but flexible and open. These categories were laid down by looking into the data collected. The behavioral descriptions of each category were written in detail.

The next phase consisted of collecting data on 50 rural children. At this stage the cognitive task battery consisted of the following:

1. Correspondence
2. Seriation A, B and C
3. Conservation of length (B)

4. Conservation of liquid
5. Classification

Detailed description of the task battery has been included in Appendix 1.

RESULTS AND DISCUSSION

After administering the task battery to the sample of 50 urban and 50 rural children, it was put to a statistical analysis. At that time, the cognitive team had the services of a British consultant, Dr. Michael Shayer (University of London; Chelsea College), and this analysis was done under his supervision. This followed a strategy adopted by Shayer (1981) in his research programme. The purpose of this analysis was to check on the performance of the battery for the purpose for which it was designed, i.e., to estimate cognitive stages of development.

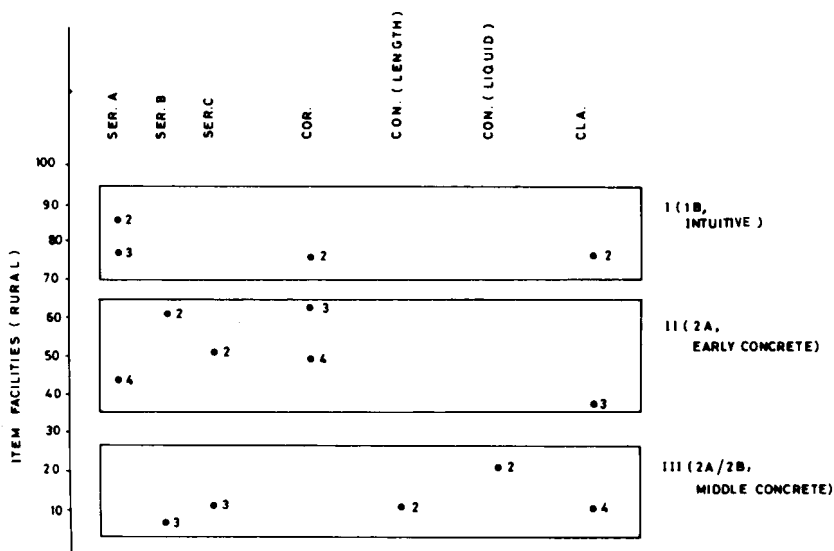


Figure 1. Scoring levels on tasks in the battery with imposed Piagetian stage levels.

Figure 1 gives the item facilities for the different levels at which the five tasks were assessed. These levels are given in Arabic numerals (2,3,4). For the purpose of investigating the item characteristics, and interpreting the battery data on an assumed single Piagetian developmental continuum, a scale ranging from Roman numerals I to III was imposed on the hypothesis that III = 2A/2B (middle concrete); II = 2A (early concrete); I = 1B (Intuitive), and that below this the performance was pre-operational. This decision was made in accordance with some of the behavioural descriptions which the team had used in assessing the highest levels on some of the tasks. The categorisation estimated the rural sample as 2A/2B = 15%; 2A = 44%; 1B = 26%; Pre-op = 15%.

Item analysis

The scores on the pupils' record sheet were transformed as follows:

<i>Tasks</i>	<i>Level on sheet *</i>	<i>Category given</i>
Correspondence	3 or 4	II
	2	I
Seriation	3 on either B or C	III
	Any 2 of A4, B2 or C2	II
	A2 or A3	I
Conservation (Length)	2	III
Conservation (Liquid)	2	III
Classification	4	III
	3	II
	2	I

* Please see Response Categories in Appendix I for description of these levels.

In addition, each pupil was given an overall task battery score of III if he scored III on any two tasks (or more); II if he scored II on any two tasks (or more), and I if he scored I on any two tasks (or more). These scoring rules follow from applying a two-thirds pass criterion to the situation where there were only 3 tasks on which the pupil could score III, and only three tasks where he could score I or II.

LEVELS ON TASKS

Overall battery level of children	Correspondence			Seriation			Conservation (Length)			Conservation (Liquid)			Classification										
	II	I	%	III	II	%	III	O	%	III	O	%	III	II	I								
2A/2B 3	9	2	82	100	2	6	1	0	89	100	5	0	100	8	0	100	5	3	1	0	56	89	100
2A 2	33	2	80	85	3	27	8	3	73	93	3	38	7	6	17	26	7	19	13	2	17	63	95
1B 1	15	21	38	92	0	8	23	8	20	79	0	41	0	1	14	7	0	2	26	12	0	5	63
1A 0	2	1	6	22	33	0	3	0	8	27	0	13	0	0	4	0	0	1	1	8	0	10	20

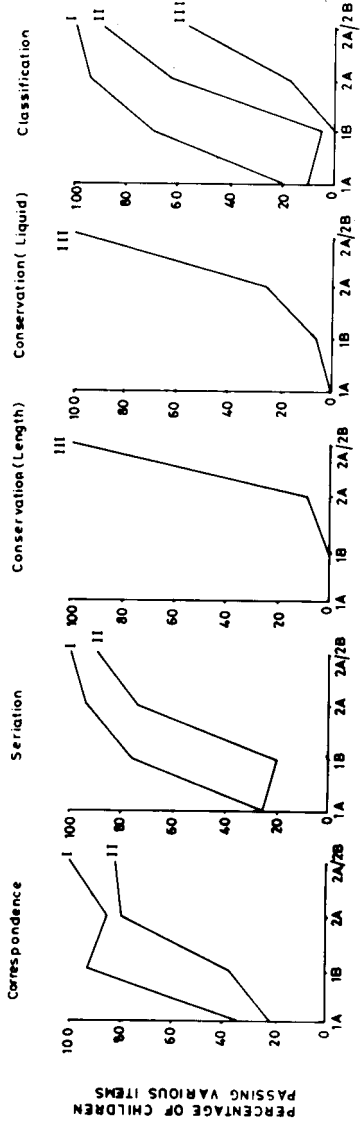


Figure 2. Relationship between overall task battery score of children (i.e., their overall cognitive level) with their levels on specific tasks.

In Figure 2 (table in the upper half) the spread of levels on each task is classified according to the overall task battery score, i.e., their overall cognitive level). For the children assessed at each overall level, starting at 3 the percentage of those who pass each item is calculated. An 'item' is regarded as any pass-fail decision. For example, for correspondence, the first 'item' is that produced by demanding that the pupil pass at level II. Nine out of eleven level 3 pupils, or 82% pass the item, and 33/41 or 80% of level 2 pupils pass it. The second 'item' is obtained by merely insisting on level I as a criterion. Eleven out of eleven or 100% of the level 3 children passed at level I (or II), and so on.

Subsequently, a discrimination diagram was plotted (lower half of Figure 2) showing percentage of children passing each item against their overall cognitive level (remember, 1B=I; 2A=II and 2A/2B=III). It can be seen that all the task items discriminate sharply. The purpose of this type of item analysis was to check on the performance of each task. Not only does each item function well, but the battery is also a well-balanced one, having three level-I items, three level-II items and four level-III items.

Figure 3 was derived from Figure 2 by finding the levels on each discrimination diagram at which 25%, 67% and 75% of the children pass the item. The width of the line (from 25% to 75%) estimates the precision with which the item discriminates, and 67% mark estimates the discrimination level of the item, on a two-thirds success criterion.

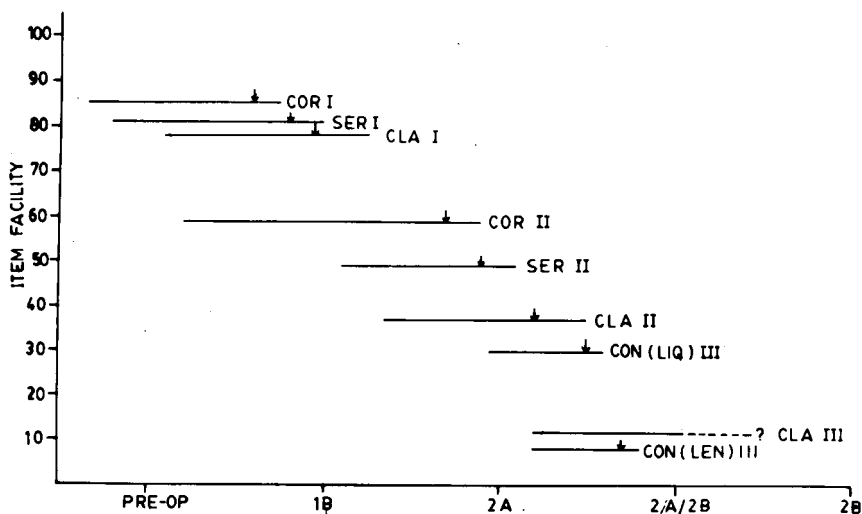


Figure 3. Discrimination, facility and level of the items in the task battery. The facility of the item was obtained from the table in the upper part of Figure 2. The item lines were derived from each discrimination diagram in the lower part of Figure 2. The width of lines were determined by reading off the 25% (beginning of line) 67% (arrow mark: 2/3 success criterion) and 75% (end of line) level.

In this Figure three parameters, i.e., facility, discrimination and item level are shown. A good test should show no large gaps between items and should have the items evenly distributed over the whole range over which it is desired to discriminate between subjects. This test battery appears to be satisfactory on this account.

In Table 1 the percentage of children classified on each task at the different levels, and on the task battery overall, are given.

Table 1

Percentage of children on each task at different levels
and on overall task battery.

Tasks	Levels			
	0 Pre-op	I 1B	II 2A	III 2A/2B
Correspondence	15	26	59	Not scored
Seriation	19	32	44	5
Conservation (Length)	92	—	—	8
Conservation (Liquid)	70	—	—	30
Classification	22	41	25	12
Overall task battery	12	39	40	9

Reliability of the Tasks

Reliability was calculated by analysis of variance, (Kerlinger, 1965). The reliability coefficients were:

$$rtt(\text{rural}) = 0.61$$

$$rtt(\text{urban}) = 0.58$$

Reliability score in the urban sample was little lower than rural. This may be a result of phasing in the data collection where urban data was collected earlier, when the cognitive team was less well trained to obtain optimal responses from the children. Moreover, administration and recording procedure was also slightly modified, for rural data collection.

Data derived through Piagetian methodology is generally not considered akin to statistical analysis. However, as can be seen above, statistical assessment of Piagetian data is possible. The battery of cognitive development tasks assembled for class I children can be used with a fair amount of scientific rigour for assessing cognitive developmental levels of this group of children. This is indeed an initial step. This battery will need further development and analysis before achieving the status of well-researched scientific tool.

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DESCRIPTION OF THE FINAL TASK BATTERY

1. Correspondence

Material:

Fifteen red and fifteen green wooden cubes.

Procedure:

After familiarizing the subject with material, the red and green cubes are put in two piles. He or she is asked to take one pile whichever he or she likes.

Nine cubes are taken up one by one by the experimenter from his pile and placed on the table in a line with a distance of half an inch between any two cubes.

The subject is asked to take as many cubes from his pile as the experimenter has taken and to put them on table so that there is an equal number in the two rows.

After asking questions about the initial equality of the rows and the reason, the experimenter piles up his row and the subject is asked the question about equality and the reasons for his answer.

Then the experimenter spreads out his cubes in a line and now the subject's cubes are piled up and again questions about the equality of two sets and the reasons are asked.

Response categories:

1. No correspondence: The child cannot establish even the initial equality of two sets.
2. Intuitive correspondence with no reasons: The child establishes the initial equality but cannot maintain the equivalence when one of the rows is piled up, i.e., when perceptual equivalence is destroyed.
3. Correspondence with no reasons: Maintains correspondence throughout the interviewing session but gives no reason for the equality.
4. Correspondence based on counting: The child maintains the

correspondence and when giving the reason refers to immediate counting at each step.

5. **Operational correspondence**: The child gives logical and operational reasons for correspondence, e.g., he says, "cubes in the two sets are equal because they were equal before and it is just their configuration which has been changed", or he gives numerical reason, i.e., "they are the same because they are nine or were nine and nothing has been added or subtracted", etc.

2. Seriation

Material :

10 wooden sticks differing in size ranging from 2 inches upto 6.5 inches, all blue coloured, and a base-line stick.

Procedure A :

The three largest sticks are seriated by the experimenter (with a base-line stick) as a model for the subject. The rest of the seven sticks are handed over to the child and he is asked to continue the seriation in such a way that going down with the next smaller stick, in the end there is the smallest one. The responses were categorized as follows:

1. No seriation at all: All the sticks are put at random with no care of size.
2. The child can put first three or four sticks in the right order but can't complete the seriation.
3. The child can put all the sticks in correct order but with trial and error.
4. The child completes seriation with no error. He selects and puts the correct stick and if picks some wrong stick does not leave it there, rather replaces it with the right one.

Procedure B :

If the subject is able to do seriation, with or without error, in the first step, then sticks No. 2,4,6,7 and 9 are taken out of the ten seriated sticks. The child is handed over these five sticks one by one in a pre-determined order and is asked to insert those sticks in their proper places.

Response categories :

1. Fails to insert the sticks in proper places.
2. Can insert the sticks but with trial and error.
3. Can do insertion perfectly without trial and error.

Procedure C :

In the third variation, all the ten sticks are held by the experimenter and he hands them over to the child one by one in a predetermined order. The task for the child is to reconstruct the seriation by predicting the place of each coming stick, putting it there and leaving proper spaces for the sticks that are yet to come in.

Response categories :

1. Puts the sticks in mixed order randomly and can't seriate.
2. Can put all the sticks in their proper places but with trial and error, i.e., he can't put the stick in its right place immediately but changes over the position of sticks on getting the subsequent sticks or puts the sticks close to each other without leaving room in between for the other sticks that have to come later.
3. Can predict the place of each stick by putting each one in its right place.

3. Conservation of Length*Material :*

Two blue sticks, each of 12 inches in length.

Procedure :

Both the sticks are placed on the table parallel to each other in exact alignment in front of the child. After establishing the equality of the two sticks, the top stick is moved forward (about 2 inches) and question about equality is asked. Whatever the response is, the displaced stick is brought back to the original position. Then again establishing the equality, the bottom stick is moved forward and question about equality is again asked. Reasons for the child's response are also inquired.

Response categories :

1. No conservation. After displacement, the child says that the one stick is longer than the other.
2. Conserves the length. In each step, the child says that the two sticks are of equal length whatever the spatial configuration may be.

4. Conservation of Liquid

Material :

Four beakers: A, B1, B2 and C; of 250 ml., 100 ml., and 50 ml., capacity, respectively.

Procedure :

Equal amount of water is poured in B1 & B2. After establishing the equality of water in the two containers, water from B1 is poured into A, that is, wider and bigger than B1 and B2. The child is asked the question of equality and the reason for his answer. Then water from A is poured back into B1 and again after establishing the equality, water from B1 is now poured into C, which is narrower and taller than B1 and B2. Same questions are again asked.

Response categories :

1. No conservation. After disturbing the perceptual equality of water in the two containers, the child says that there is more water in one beaker.
2. Conserves liquid in the two situations.

5. Classification

Material :

18 wooden chips of 2 sizes (large, small), 3 colours (red, green and blue), and 3 shapes (circle, square and triangle).

Procedure :

After familiarizing the subject with the material, he is asked to put together those which go together or which are alike. After the child has sorted those pieces in some way he is asked to explain or verbalize the criteria

on which his classification is based. Then all the chips are mixed again and the child is asked to classify them on some other criterion. If the child repeats the previous one, he is asked to classify on some dimension other than the previous one. When he switches over to the different criterion, he is asked now to bring forth the dimension different from the ones he has already done.

Response categories :

1. Figurative collection.
2. One criterion and no further progress.
3. Two dimensions in two steps.
4. Two dimensions in one step.
5. Three criteria but the child is able to bring forth these in two or three steps.
6. Can classify considering the three dimensions simultaneously in one step.