CHAPTER—V

ANALYSIS OF DATA
CHAPTER 5

ANALYSIS OF DATA

In an attempt to find out any difference in level of achievement in relation to arithmetic skills between the Sighted and the CVH, a comparative analysis of arithmetic achievement between the CVH and the Sighted children at lower primary level – V Graders, on Arithmetic Diagnostic Test is presented under:

5.1: comparative analysis of arithmetic achievement between CVH and the Sighted

• Analysis of overall arithmetic achievement - comparison between the CVH and the Sighted
• Analysis of overall arithmetic achievement – comparison based on nominal groups
• Analysis of overall arithmetic achievement – gender differences
• Analysis of arithmetic achievement – Main area-wise and task-wise

In order to probe the percentage of success and failure in each of the arithmetic competency selected for the study a diagnostic analysis of performance of CVH and the Sighted is discussed.

5.2: Diagnostic analysis of performance of children with visual handicap on arithmetic diagnostic test

• Error Analysis – Area: Number
• Error Analysis – Area: Place Value
• Error Analysis – Area: Addition
• Error Analysis – Area: Subtraction
• Error Analysis – Area: Multiplication
• Error Analysis – Area: Division

In order to determine the types of errors committed by the CVH in their performance on ADT an attempt is made to probe into the percentage of failure in each of the arithmetic competency selected for the study and thereby categorise the types of errors.

5.3: Categorisation of errors in arithmetic skills among children with visual handicap
An inquiry into the achievement of cognitive capabilities (classification, seriation, conservation of number and conservation of quantity by Piaget) among CVH, through their performance on CCT is interpreted qualitatively.

5.4: Analysis on cognitive capabilities of Children with Visual Handicap

- Performance on cognitive capabilities test – Whole test
- Performance on cognitive capabilities test – Task-wise (Classification; Seriation)
- Performance on cognitive capabilities test – Conservation task
- Attainment of Concrete Operational Stage

Teaching-learning factors influencing the efficacy of prescribed curriculum for CVH at lower primary level is discussed using qualitative approach.

5.5: Appraisal of arithmetic curriculum with respect to CVH

- Descriptive analysis of classroom observations
- Descriptive analysis of responses collected through the structured and semi-structured interviews
5.1 COMPARATIVE ANALYSIS OF ARITHMETIC ACHIEVEMENT BETWEEN CVH AND THE SIGHTED

The research question laid out for the study under Objective-I (vide Section 3.2.1 Supra) warranted a comparative analysis of Arithmetic Achievement on ADT to study the development of arithmetic skills among the Sighted and the CVH – V graders. It was decided to compare the overall performance as well as task-wise performance on ADT between the CVH and the Sighted. All the answered test booklets were scored with respect to both Sighted (N = 260) and the CVH (N = 30) V graders for a maximum score of 50. Mean percent and SD values were computed separately. The following sections give the details.

5.1.1 Analysis of Overall Arithmetic Achievement

— *Comparison between the CVH and the Sighted*

Table 26 gives the mean, mean % and SD values for the CVH and the Sighted groups with respect to ADT.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean Max. Score: 50</th>
<th>Mean %</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVH</td>
<td>30</td>
<td>28.36</td>
<td>56.72</td>
<td>10.23</td>
</tr>
<tr>
<td>Sighted</td>
<td>260</td>
<td>36.90</td>
<td>73.80</td>
<td>6.77</td>
</tr>
</tbody>
</table>

It could be observed from the Table 26 that
• The Children with Visual Handicap have exhibited a considerably lower performance with a mean percentage of 56.72 as against the Sighted children with a mean percentage of 73.80.

• The overall performance on ADT being very low (56.72%), the CVH lag behind in the development of basic arithmetic skills.

• Even among the Sighted children, the mastery level is below 80%, which is usually considered as the ‘index of mastery’ revealing that their Arithmetic Achievement has also not reached the expected level.

• The SD value of Sighted children (10.23) reveals a better degree of homogeneity than that of CVH with high SD value of 10.23. This was expected as the size of the groups varies drastically; the CVH group (N = 30) vary in their background too with respect to the degree and on set of their blindness.

Further, it was decided to compute the Critical Ratio (CR) for analyzing the significance of difference between the two groups – Sighted and the CVH to test the null Hypothesis 1.

**H1:** There is no significant difference between the V grade Sighted students and the CVH with respect to their overall Arithmetic Achievement

The following Table 27 gives the values of CR.
Table 27

Results of critical ratio test for mean differences on ADT scores between Sighted and the CVH

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>CR</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVH</td>
<td>30</td>
<td>28.36</td>
<td>10.23</td>
<td>6.188</td>
<td>288</td>
<td>0.001</td>
</tr>
<tr>
<td>Sighted</td>
<td>260</td>
<td>36.90</td>
<td>6.77</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 27 reveals that the critical ratio value of mean differences is significant at 0.001 level. It means that Sighted children (M = 36.90) have significantly higher mean score of CVH (M = 28.36). Thus it is evident that the Sighted children have performed significantly better than the CVH. Hence, the null hypothesis 1 is rejected at 0.001 level of significance.

Therefore, it could be concluded that

- The V grade CVH lag behind in their overall Arithmetic Achievement in comparison to that of Sighted children of V grade.
- The performance of CVH is found to be considerably low with a mean percentage of 56.72, just above 50 percent of mastery in the basic arithmetic skills.
- The overall performance of Sighted also does not reach the mastery level of 80 per cent of achievement in arithmetic, their mean value being 73.80 per cent.

As ADT is focused on basic arithmetic skills, it was expected that at least few of the V graders would achieve mastery, but there was not a single student
scoring 100% on the test in both the Sighted and the CVH group. These findings warrant serious consideration for diagnosis of arithmetic errors and subsequent remedial programmes in regular as well as special schools.

5.1.2 Analysis of Overall Arithmetic Achievement

— *Comparison based on Nominal Groups*

It was also decided to compare the performance of CVH and the Sighted by classifying them into three nominal groups on High, Moderate and Low, following the criterion of ‘Mean ± |σ|’ distances as the cut off points in the whole group, i.e. combined group of Sighted and the CVH. This was thought necessary to understand the spread of the scores on the ADT to compare the relative performances of both the CVH and the Sighted. For this purpose the mean and SD values for the combined group were computed (N = 290) and sample were classified into nominal groups with respect to both the CVH and the Sighted. Further, the percentage of children falling into High, Moderate and Low groups were also calculated for comparison. This provided an index for comparison between the CVH and the Sighted Table 28 gives the details of percentages of children falling into High, Moderate and Low groups.
Table 28

Classification into Nominal Groups for the Combined Groups
(N = 290)

N = 290; Mean = 32.63; SD = 850

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nominal Groups</th>
<th>Criteria</th>
<th>Cut off Marks</th>
<th>Children Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High group</td>
<td>(M+</td>
<td>σ) and above</td>
<td>≥ 41</td>
<td>57</td>
</tr>
<tr>
<td>2</td>
<td>Moderate group</td>
<td>(M-</td>
<td>σ) to (M+</td>
<td>σ)</td>
<td>24 to 40</td>
</tr>
<tr>
<td>3</td>
<td>Low group</td>
<td>(M-</td>
<td>σ) and below</td>
<td>≤ 23</td>
<td>72</td>
</tr>
</tbody>
</table>

Note: The cut off score is rounded off to the nearest number.

It could be observed from Table 28 that

- The spread of scores on the combined group has indicated the presence of both High and Low groups at 20% and 25% respectively.
- The percentage of children (55.51%) at moderate level indicates the clustering of sizeable group of the sample at the middle point.

This clearly indicated that the items of the ADT could discriminate between the high and low performers. However, relative performance of CVH and the Sighted could be seen in the following Table 29 with respect to their High, Moderate and Low performance.
Table 29

Percentage of Children in High, Moderate and Low groups - Comparison between CVH and Sighted

<table>
<thead>
<tr>
<th>Nominal Groups</th>
<th>Number of children</th>
<th>Percentage of children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CVH</td>
<td>Sighted</td>
</tr>
<tr>
<td>High group</td>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>Moderate group</td>
<td>13</td>
<td>148</td>
</tr>
<tr>
<td>Low group</td>
<td>11</td>
<td>61</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>260</td>
</tr>
</tbody>
</table>

It could be seen from Table 29 that

- The percentage of children (20%) at High level is equal to both CVH and the Sighted indicating that there are high achievers in CVH group too par with the Sighted group.

- The percentage at the Low group is considerably more in case of CVH (36%) than the Sighted group (24%).

- Similarly, the percentage at the middle level is considerably lower for CVH than the Sighted (44% against 57%).

Thus, it could be concluded that there are high achievers among CVH also as it is found among the Sighted group to an extent of 20%. However the percentage at moderate and low levels indicate that the Sighted have performed better than the CVH, 56% falling at moderate level and only 24% at the low level.
5.1.3 Analysis of Overall Arithmetic Achievement

– Gender Differences

With an intention to analyse the significance of mean difference between the CVH and Sighted with respect to their gender following null hypothesis were formulated (vide Section 3.3 Supra). The hypotheses 2 and 3 are restated below.

H2: There is no significant difference between boys and girls in the CVH group with respect to their Arithmetic Achievement on ADT.

H3: There is no significant difference between boys and girls in the Sighted group with respect to their Arithmetic Achievement on ADT.

Table 30
Results of ‘t’ test on ADT scores – Gender-wise on CVH group

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>df</th>
<th>‘t’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>14</td>
<td>27.35</td>
<td>9.78</td>
<td>28</td>
<td>0.5026NS</td>
</tr>
<tr>
<td>Girls</td>
<td>16</td>
<td>29.25</td>
<td>10.79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table entry of ‘t’ value to be significant at 0.05 level is 2.05. So, the obtained ‘t’ value was found to be not significant. Hence, hypothesis 2 was accepted.

Thus, it was concluded that boys and girls in the CVH group did not differ significantly in their performance on ADT.
The Critical Ratio value obtained on the Sighted group was very low i.e. 0.43 as against 1.96 to reach at least significance level at 0.05 level. Hence, the mean differences between boys and girls with respect to ADT were not significant. Hence, the H3 was accepted. Thus, it could be concluded that boys and girls in the Sighted group did not differ significantly in their performance on ADT.

This result is similar to that of CVH with respect to gender differences. Hence, it could be concluded that boys and girls with or without sight do not differ significantly in their development of Arithmetic skills.

### 5.1.4 Analysis of Arithmetic Achievement – Main areas and Task wise

The overall performance comparison between the CVH and the Sighted has been analysed in the previous sections (vide 5.1.1. and 5.1.2 Supra). Analysis based on main areas and task-wise comparison is considered in this section. Table 32 and 33 provide the breakup of mean percentages – main areas as well as on different tasks separately. Percentages are graphically depicted in Graph 1 and Graph 2.
A. Analysis of arithmetic competencies – main areas

There were six main areas of arithmetic skills considered for ADT – I. Number, II. Place Value, III. Addition, IV. Subtraction, V. Multiplication and VI. Division. The mean scores for each area were computed for both the CVH and the Sighted separately. The following table gives the mean score as well as mean percentage scores for both the CVH and Sighted children.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Max. Score</th>
<th>CVH Mean Score</th>
<th>CVH %</th>
<th>Sighted Mean Score</th>
<th>Sighted %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Number</td>
<td>14</td>
<td>10.55</td>
<td>37.20</td>
<td>11.14</td>
<td>30.18</td>
</tr>
<tr>
<td>II. Place Value</td>
<td>16</td>
<td>8.66</td>
<td>30.53</td>
<td>11.42</td>
<td>30.94</td>
</tr>
<tr>
<td>III. Addition</td>
<td>6</td>
<td>4.11</td>
<td>14.49</td>
<td>5.60</td>
<td>15.17</td>
</tr>
<tr>
<td>IV. Subtraction</td>
<td>6</td>
<td>3.26</td>
<td>11.49</td>
<td>4.50</td>
<td>12.19</td>
</tr>
<tr>
<td>V. Multiplication</td>
<td>4</td>
<td>1.48</td>
<td>5.21</td>
<td>2.74</td>
<td>7.46</td>
</tr>
<tr>
<td>VI. Division</td>
<td>4</td>
<td>0.30</td>
<td>1.07</td>
<td>1.50</td>
<td>4.06</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>28.36</td>
<td>100.00</td>
<td>36.90</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Note: Percentages have been calculated for a total of 100.
It could be observed from Table 32 and Graph 1 that

- The CVH have outscored the Sighted in the first area Number and Numeration scoring 37.20% out of 100 as against 30.18% score obtained by the Sighted. Thus, it could be said that the level of mastery attained by the CVH on these tasks is comparatively better than the mastery attained by the Sighted.

- In all the remaining five areas, the Sighted have performed better than that of CVH.

- The lowest performance for both the groups is indicated in the Area – Division, Sighted performing slightly better than the CVH – thus Division is definitely the most difficult operation for both the groups.

- The arithmetic tasks on Addition, Subtraction, Multiplication and Division appear to be very difficult for both the groups, the difficulty level in the increasing order with respect to Addition → Subtraction → Multiplication → Division.

Thus, it could be concluded that though the overall performance of CVH, on ADT is comparatively less than the Sighted, CVH have performed better than the Sighted in the Area – Number and Numeration. Further, it could also be concluded that both the Sighted and the CVH in solving arithmetic tasks in the areas – Addition, Subtraction, Multiplication and Division, the degree of their performance vary, CVH being at a lower level than the Sighted. It could also be concluded that the order of difficulty has been revealed from Addition to
Subtraction to Multiplication to Division (in that order) for both Sighted and the CVH.

**B. Analysis of arithmetic competencies – task-wise**

Under each of the six main areas, a series of sub-tasks were presented in the ADT for both the CVH and the Sighted. It is noteworthy to compare the performance of these sub-tasks between the Sighted and the CVH. Following Table 32 and Graph 2 gives the details.
Table 33

Mean percentage scores of Arithmetic Achievement on ADT — Task-wise

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Max. Score</th>
<th>CVH</th>
<th>Sighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Score</td>
<td>%</td>
<td>Mean Score</td>
</tr>
<tr>
<td>I. Number</td>
<td>CVH</td>
<td>Sighted</td>
<td></td>
</tr>
<tr>
<td>1. Counting</td>
<td>4</td>
<td>3.60</td>
<td>90.00</td>
</tr>
<tr>
<td>2. Odd-Even</td>
<td>6</td>
<td>4.90</td>
<td>81.66</td>
</tr>
<tr>
<td>3. Completion of series</td>
<td>2</td>
<td>1.50</td>
<td>75.00</td>
</tr>
<tr>
<td>4. Ascending-Descending order</td>
<td>2</td>
<td>0.55</td>
<td>27.5</td>
</tr>
<tr>
<td>II. Place Value</td>
<td>CVH</td>
<td>Sighted</td>
<td></td>
</tr>
<tr>
<td>5. Number Naming</td>
<td>4</td>
<td>2.33</td>
<td>58.25</td>
</tr>
<tr>
<td>6. Number Expansion</td>
<td>4</td>
<td>2.25</td>
<td>56.25</td>
</tr>
<tr>
<td>7. Place Value Identification</td>
<td>4</td>
<td>2.73</td>
<td>68.25</td>
</tr>
<tr>
<td>8. Number formation</td>
<td>4</td>
<td>1.35</td>
<td>33.75</td>
</tr>
<tr>
<td>III.9. Addition</td>
<td>6</td>
<td>4.11</td>
<td>68.50</td>
</tr>
<tr>
<td>IV.10. Subtraction</td>
<td>6</td>
<td>3.26</td>
<td>54.33</td>
</tr>
<tr>
<td>V. 11. Multiplication</td>
<td>4</td>
<td>1.48</td>
<td>37.00</td>
</tr>
<tr>
<td>VI.12. Division</td>
<td>4</td>
<td>0.30</td>
<td>7.50</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>28.36</td>
<td>36.90</td>
</tr>
<tr>
<td>Mean %</td>
<td>100</td>
<td>56.72</td>
<td>73.80</td>
</tr>
</tbody>
</table>

Graph 2

Mean percentage scores of Arithmetic Achievement on ADT — Taskwise

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From the task-wise breakup Table 33 and Graph 2, it could be observed that

- Sighted children are found to be better than the CVH in all the items of ADT except in item 1 Counting Numbers; the overall mean % score of Sighted is significantly better than that of CVH as has already been proved in the previous section.

- Sighted children have scored above 80% in three items under area ‘Number’ and area ‘Addition’ as against CVH who have scored above 80% only in two items on area Number – Counting and Odd-Even numbers.

- The differences between the Sighted and the CVH under area Place Value, CVH have scored less than the Sighted in all the four sub-tasks on place value indicating their difficulties in the development of place-value principles. The mean score on item ‘Formation of Numbers’ is as low as 33.75% as against 68.75% of the Sighted group.

- With reference to the tasks on four arithmetic computational skills – Addition, Subtraction, Multiplication, Division, Sighted children are better than the CVH in all 20 tasks; Sighted have scored 93.33% in Addition, the highest among all the items of the test, whereas CVH have scored 68.50% in Addition (average score of 6 items).

- The mean scores on Addition, Subtraction, Multiplication and Division are in the decreasing order for both the Sighted group and CVH indicating their increasing difficulty level over the computational skills in that order.
• With respect to Multiplication, the mean percentage of CVH (37.00%) is very low against the mean percentage of the Sighted (68.50%); it is very clear that multiplication skill has not been developed by many among the CVH.

• Among all the tasks of the ADT, skills on Division is the most difficult one for the CVH with a mean percentage as low as 7.50% as against 37.50% scored by the Sighted.

In general, it was observed that the Sighted children were better in their Arithmetic Achievement with respect to all the tasks except on Number Tasks of Counting and Odd and Even numbers. But in all the other tasks, Sighted children have outscored the CVH.

Sighted children have an edge over CVH in the acquisition Arithmetic skills through experience (Raychoudhari, 1992). The visual perception, which provides an enormous amount of information in just a glimpse enables the Sighted children to have rich experiences in a 'natural way', in which they experience as a 'whole', but the experiences of CVH are always 'fragmented' (or in parts), the Sighted having 'Natural Learning' and the CVH having 'Mediated Learning' warrant for different approaches in the curriculum of CVH.

Curriculum approach to Arithmetic differs to a great extent for the CVH in special schools to those in IED or inclusive set up in regular schools. As the present study focussed on CVH in special schools, it was observed that the compulsory use of Taylor Frame for solving Arithmetic Tasks at grade V was the main difference between the modalities of the two groups. While Sighted were
comfortable in using the ADT as paper-pencil test, CVH had to use the Taylor Frame for solving each task. This point has been discussed in detail the appraisal of curriculum in special schools in the last part of the analysis chapter (vide Section 5.5.2 Infra).

Another factor is the pace of learning mathematics by CVH. The fact that teaching of mathematics to the CVH is begun later than that of the Sighted and also that the modalities for learning the various concepts differs, CVH lag behind in their development of Arithmetic skills as compared to the Sighted group. Teachers in an attempt to familiarize the student with various modalities may focus more on the training of skills required to learn the usage of modality than the content strand of mathematics. It is also evident by the present study that provides a major clue to the aspect of slower pace of teaching and learning than that of the Sighted children. In this regard Mukhopadhyya et al. (1987) reiterates that the pace of learning is slower for CVH than that of the Sighted. This is due to his limitations in organizing ideas, methods and devices that the student uses to solve mathematical problems and interpret results (p. 204).

The "Source Book for Teachers of Visually Impaired" developed by a team of special education experts Mukhopadhyay, Jangira, Mani and Raychowdhary (1987) has clearly provided the important aspects to be considered while teaching Mathematics for CVH in comparison to the teaching of Sighted children. In their own words "a good learner of mathematics will be able to "organise" ideas. When the organisation is good, the learner will be able to place the ideas
in sequence. Good sequence will be useful for the attainment of results. When the correct results are arrived at, the interpretation will be good. Even though the end product is the same for both visually impaired children and Sighted children, the means are different. Teaching of mathematics to the normal children is mostly done through Black Board work supplemented by oral instruction. Normal children grasp the ideas of “Organising” and “Sequencing” mostly by the manner in which the material is presented on the blackboard. Owing to the limitation of visual impairment the child loses this very important information in learning. Thus, visually impaired children have great difficulty in the remaining processes, the results and interpretation. Hence, a good completion is the result only of a good start. Every mathematics teacher and resource teacher of visually impaired children should bear this in mind while planning the programmes for teaching mathematics” (pp. 203-204).

Not withstanding the other factors i.e. delay in beginning the instruction of arithmetic to CVH in comparison to the Sighted, based on the discussion presented above, two points emerge to answer the Research Question 1 (comparison between the Sighted group and the CVH with respect to their development of Arithmetic Skills at the lower primary level) of the present study. The first being the difference in their organisational set up (Normal Schools vs. Special Schools) and the second – the difference in the modalities they use in solving the tasks on ADT (Paper-Pencil Testing Mode vs. Taylor Frame Mode).
Hence, it could be concluded that the Sighted children are found to be better than the CVH in Arithmetic Achievement with respect to the sample selected for the present study; but more research is needed for generalization of this finding with a larger sample covering CVH in different types of organizations such as integrated and inclusive education set up so that the teaching-learning factors are comparable.

However, a diagnostic evaluation of the data on the same test was taken up which was limited to CVH, but extended to VI and VII graders in the same special schools to throw light on their learning deficiencies, mastery level of each competency leading to the classification of errors, which are explained in sufficient details in section 5.2 and 5.3 Infra.

5.2 DIAGNOSTIC ANALYSIS OF PERFORMANCE OF CHILDREN WITH VISUAL HANDICAP ON ARITHMETIC DIAGNOSTIC TEST

The first section of the data analysis (vide Section 5.1 Supra) was quantitative in nature, using the Arithmetic Diagnostic Test to measure the individual performance of each child with a norm-referenced approach and the hypotheses of the study were also statistically tested with the quantitative data.

Analysis in this section (5.2), in the pursuit of Objective II had to be qualitative in nature in terms of diagnosing the errors and categorising them for further interpretations. Diagnostic analysis was based on the individual performance of each CVH on ADT, by evaluating their answer sheet and also taking into account the field notes taken by the investigator during the collection
of data. Analysis was considered for all three grades V, VI and VII from the perspective of inquiring into the existence of cumulative deficiencies (if any), and hence the analysis was carried out for the total group N = 50.

As already has been explained in chapter IV the ADT was also meant for analysing the arithmetic competencies acquired by CVH. An attempt has been made in this section to present an ‘error analysis’ of the performance of CVH with respect to these competencies.

For the purpose of error analysis, the following steps were followed:

**Step 1:** The answered test booklets for each child was thoroughly scrutinized and a master sheet for marking the right (✓) and wrong (X) responses for each item for each subject was prepared, “not answered” items by the children were also marked as not attempted (NA).

**Step 2:** Each of the competencies under sub items was assessed and marked on the master sheet for each child by the symbols ✓, X or NA.

**Step 3:** For each item, total number of correct, wrong and NA responses were computed for boys and girls separately and also for the total group.

**Step 4:** Based on the total number of items, average number and percentages for each competency was further computed for the whole group.

**Step 5:** Based on the averages of competencies, average for the Main Areas of Arithmetic was computed.
Thus, the wrong answers for each item marked in the master sheet provided the basis for error analysis. The wrong answers thus identified were again scrutinized in the answered test booklets to categorise different types of errors. However, the first two areas – Number and Place Value provided for general scrutiny for errors but the four Arithmetic computations – Addition, Subtraction, Multiplication and Division yielded types of errors made by the CVH selected for the study. The following sections provide the details.

5.2.1 Error Analysis – Area: Number

There are four competencies under the Area – Number as follows.

<table>
<thead>
<tr>
<th>Competency and Description</th>
<th>Number of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Counting</td>
<td>4</td>
</tr>
<tr>
<td>2. Odd-Even</td>
<td>6</td>
</tr>
<tr>
<td>3. Completion of Series</td>
<td>2</td>
</tr>
<tr>
<td>4. Ascending and Descending Order</td>
<td>2</td>
</tr>
</tbody>
</table>

5.2.1.1 Error Analysis on Number – Counting

Competency 1

Count and write the total number of dots in each row in the box.

1) Row 1 = ● ● ● ● ● ●

2) Row 2 = ● ● ● ● ● ● ●

3) Row 3 = ● ● ● ● ● ● ●

4) Row 4 = ● ● ● ● ● ● ●
It could be seen from Table 34 that

- All the girls have mastered counting with correct answers in all the four items with cent percent.
- Few boys have wrongly answered in all the four items, but the incidence is quite low.
- All subjects have attempted all the four items.
- For the total group, the occurrence of errors is 4% in counting and 96% of children have mastered the competency – counting.

Errors Observed

- Out of 4% of children, three boys have wrongly counted both the numbers 8 and 9, and one boy has counted wrong numbers 6 and 7.
• A single subject has committed errors in all the items, two others have wrongly answered second and fourth items.

• Wrong answers: 10 instead of 9

7 instead of 6

• A child who could not count any item, counted as 1, 2, 3, 4, 5, 7, 9, 10.

• There are gaps in knowledge about consecutive numbers.

Though, it could be concluded that 96% children have mastered the competency counting and the presentation mode of the task (Bindi Card – a card with raised dots) that was adapted for the test could have been one of the factor for lower performance of 4% of children who could not count correctly. As the study did not attempt to modify the item, hence, a modification of this item may be considered for testing the mastery level of counting among the CVH.

5.2.1.2 Error Analysis on Number – Odd and Even Numbers

Competency 2

Identify 'odd' and 'even' numbers and group them separately.

<table>
<thead>
<tr>
<th>Odd Number</th>
<th>Even Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>5) 931</td>
<td>6) 642</td>
</tr>
<tr>
<td>7) 7906</td>
<td>8) 8640</td>
</tr>
<tr>
<td>9) 1735</td>
<td>10) 4683</td>
</tr>
</tbody>
</table>

356
Table 35

Item-wise Error Analysis – Odd-Even Numbers

Modality: Presentation = Oral
Response = Oral
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>G</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>21</td>
<td>15</td>
</tr>
</tbody>
</table>

It could be seen from Table 35 that

- Mean percentage of children who have mastered this competency is 72%, unsuccessful – 20% and not attempted – 8%.
- The 21 boys out of 25 have mastered as against 15 girls out of 25, showing better performance.
- All the boys have attempted all the items, but an average of 4 girls could not attempt the items.

The item-wise percentages reveal that 80% of CVH have mastered the first two tasks, and the percentage of success ranges between 62 to 76 in the remaining items.
Errors Observed

- Numbers containing zero, i.e. 7906 and 8640 were identified as odd numbers.
- Maximum number of errors were found in items 8 and 10 (26%) i.e. 8640 and 4683.
- Few children could not read the number correctly hence the mistake.
- Few children have identified the numbers by reading the first digit from the left side i.e. in item 4 683, 4 is considered to identify whether it is odd or even.

This was observed through observation while the child attempted the task.

Thus, it warrants serious consideration for focusing on such errors in remedial programmes.

5.2.1.3 Error Analysis on Number – Completion of Series

Competency 3

III Complete the series with filling up the missing numbers.

11) 4848, ________, ________, 4851, ________
12) ________, 9120, ________, ________, 9123
It could be observed from Table 36 that

- 79% (N = 50) of the group have mastered this skill.
- 20% of the group committed errors.
- But except 1% all have attempted both the items.
- Boys with 42% correct responses have performed better than girls with 37% of correct responses.

Thus, it could be concluded that this competency has been attained by majority (79%) of the group (N = 50).

Errors Observed

- Most common occurrence of error was the confusions in filling up the numbers around 4850 and 9120, both ending with zero.
### 5.2.1.4 Error Analysis on Number – Ascending and Descending Order

#### Competency 4

**IV** Write the numbers in ‘Ascending’ and Descending’ order.

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1057</td>
<td>56,841</td>
<td>11,113</td>
<td>85,305</td>
<td>76,044</td>
<td>10,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13) **Ascending Order**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14) **Descending Order**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 37

**Item-wise Error Analysis – Ascending and Descending Order**

**Modality:** Presentation = Taylor Frame

Response = Taylor Frame

Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>B G X NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N %</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>8 13</td>
<td>5 7</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>7 14</td>
<td>5 3</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td>7.5 13.5</td>
<td>6.5 5</td>
</tr>
</tbody>
</table>
It could be observed from Table 37 that,

- Only 42% of the whole group has mastered the competency.
- 38% have committed errors.
- 20% have not attempted this item.
- Girls have performed better.

It could be concluded that the concept of ascending and descending order of numbers has not been understood properly. Even though better performance is observed in 'completion of series' which involves ascending and descending order of numbers, the item in the form of fill in the blank provided the clue for the 'middle', 'before' or 'after' numbers, hence the better performance than in this competency.

Errors Observed

Lot of confusions prevailed in this competency for CVH. For arranging the numbers in the ascending and descending orders, identification of 'biggest' and 'smallest' in the given set of numbers becomes the prerequisite. Then the identification of next bigger/smaller number is considered and the sequence continues. So a series of mental operation of comparing "bigger and smaller numbers" are involved. This mental arithmetic processes appear to be difficult for CVH because they cannot perceive the items as a 'whole set of numbers'. Sequential perception of numbers (by touching the pegs placed in a particular direction) on Taylor Frame makes it a challenging task to choose the biggest or
smallest number. Lot of memorizing is involved in the process. Students have to perceive the number and memorize them according to their place value, and then perceive the next number and so on. Thus, the modality of learning the skill plays a crucial role in the performance of CVH in relation to arithmetic skills.

5.2.1.5 Summary on Responses – Number

Table 38

Summary Table on Errors – Competencies 1 to 4

<table>
<thead>
<tr>
<th>Competencies</th>
<th>Items</th>
<th>Percentage of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>1. Counting</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>2. Odd-Even</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>3. Number Series</td>
<td>2</td>
<td>39.5</td>
</tr>
<tr>
<td>4. Ascending-Descending Order</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Main Area—Number</td>
<td>14 items</td>
<td>36.12</td>
</tr>
</tbody>
</table>

Graph 3
Summary graph on responses – Number

[Bar graph showing responses]
The summary Table 38 and Graph 3 on area – Number reveals a number of points which are noteworthy.

- Counting is the easiest among all the four competencies, 96% have attained the mastery; there are few cases who cannot count above 5 through bindi-card which is tactile in nature.

- There are confusions represented through errors on odd-even number with 72% of success, falling short of 80% mastery index.

- Numbers with zero ending are perceived as odd number. The first digit from the left side of the given number is considered for identifying odd/even numbers, indicating that they do not read the whole number first (four digit numbers starting with thousand) but search for the single digit at the end of number; instead of unit place they identify the thousandth place.

- ‘Completion of Series’ and ‘Ascending and Descending Order’ competencies require the knowledge of biggest and smallest numbers as well as ‘before’, ‘after’ and ‘middle’ position of the numbers. Surprisingly CVH have mastered the competency in completing the series upto 79%, but not in Ascending and Descending order (42%). This indicates insufficient experiences in Ascending and Descending order for CVH, which appears to be challenging for them in mental processing all the given numbers to identify them in Ascending and Descending order before answering through Taylor Frame. The knowledge of ‘ordinality’ of numbers should be meaningfully taught to CVH.
• Thus in the Area – Number itself, the most basic to all other higher order competencies, there are variations in attaining the mastery for CVH, unless the number competencies are mastered thoroughly, they cannot be expected to solve the higher order competencies. Moreover, there are CVH who have committed errors in VI and VII grade too. It is needless to say that remedial programmes have to be planned individually correcting their mistakes.

5.2.2 Error Analysis – Area: Place Value

There are four competencies in the Area Place Value with sixteen items in the ADT.

1. Naming Numbers – 4 items
2. Expansion of Numbers – 4 items
3. Identification of Place Value in four digit numbers – 4 items
4. Formation of four digit numbers from given three numbers – 4 items
5.2.2.1 Error Analysis on Place Value – Naming Numbers

Competency 5

Match the number names given in column ‘A’ by drawing a circle around the number in column ‘B’ (as shown in example).

\[ \begin{align*}
\text{Example:} & \quad \text{Two thousand nine hundred eighty eight.} \\
\text{Column A:} & \quad 2899 \\
\text{Column B:} & \quad 2988 \\
\end{align*} \]

15) Six Thousand Seven Hundred and Twenty Five
16) Thirty Three Thousand Six Hundred and Ninety
17) Ninety Thousand Three
18) Ten Thousand

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1</td>
<td>B: 16, G: 14, X: 9, NA: 0, N: 30</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>B: 15, G: 15, X: 10, NA: 0, N: 30</td>
</tr>
<tr>
<td>17</td>
<td>3</td>
<td>B: 13, G: 14, X: 12, NA: 0, N: 27</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>B: 12, G: 13, X: 12, NA: 0, N: 25</td>
</tr>
<tr>
<td>Average</td>
<td>14</td>
<td>B: 14, G: 14, X: 11, NA: 0, N: 28</td>
</tr>
</tbody>
</table>

Table 39

Item-wise Error Analysis – Naming Numbers

Modality: Presentation = Taylor Frame
Response = Taylor Frame + Oral
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>G</td>
<td>X</td>
<td>NA</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>17</td>
<td>3</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Average</td>
<td>14</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

365
It could be observed from Table 39, that

- 56% of children have mastered this competency.
- Boys and girls have performed equally well.
- All the students have attempted all the items.
- The error percentage of 44% is quite noteworthy.
- There are errors found in all the four items with at least 40%.
- The last item is most difficult as there are only 50% of CVH with correct answers (i.e. to identify 10,000).

**Errors Observed**

Naming numbers is presented through a multiple-choice question with three distracters for each item. There are both four and five digit answers to choose from.

<table>
<thead>
<tr>
<th>Item</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 15— 24% of error found in choosing the correct place value of 100; 6 is common for all the items at thousandth place.</td>
<td></td>
</tr>
<tr>
<td>6,725</td>
<td></td>
</tr>
<tr>
<td>Item 16— 16% error found in choosing tenth place value. The same children with errors in the first item have committed the similar mistakes in the second item too. Confusions prevail in identifying the hundredth place value.</td>
<td></td>
</tr>
<tr>
<td>33,690</td>
<td></td>
</tr>
<tr>
<td>Item 17— Many could not name the number correctly with clear understanding. Guess work was observed in choosing the correct answer. 46% have errored, in naming the thousandth, hundredth and tenth place as zero. Many choose 9003 as the correct answer. Zero in different positions of place value is very difficult for CVH to understand.</td>
<td></td>
</tr>
<tr>
<td>90,003</td>
<td></td>
</tr>
<tr>
<td>Item 18— Errors found similar to that of 90,003, confirming the lack of understanding ‘zero’ at different positions in five digit numbers.</td>
<td></td>
</tr>
<tr>
<td>10,000</td>
<td></td>
</tr>
</tbody>
</table>
5.2.2.2 Error Analysis on Place Value – Expansion of Numbers

Competency 6

Expand the given numbers as shown in the example

<table>
<thead>
<tr>
<th>Thousands</th>
<th>Hundred</th>
<th>Tens</th>
<th>Ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 7213 =</td>
<td>7000</td>
<td>200</td>
<td>10</td>
</tr>
</tbody>
</table>

19) 8437 =

20) 5062 =

21) 1910 =

22) 4903 =

Table 40

Item-wise Error Analysis – Expansion of Numbers

Modality: Presentation = Taylor Frame
Response = Taylor Frame + Oral
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>21</td>
<td>3</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>17.25</td>
<td>17.25</td>
</tr>
</tbody>
</table>
It could be observed from Table 40, that

- 70% of CVH have mastered this competency
- Boys and girls have performed equally.
- 14% of children have not attempted.
- 17% of children have answered wrongly.
- There are errors found in all the four items but the last item 4903 has 24% as wrong and the first item 8437 has the least 4%. The middle two items are with 20% and 18% respectively.

**Errors Observed**

- The first item of the task has been attempted successfully by 84% with only 4% as unsuccessful.
- The remaining items were found to be difficult for CVH.
- The last three items involving zero in unit, tenth and hundredth place value have been misunderstood by many CVH.

Presentation of the test item was mainly Taylor Frame with oral modality for probing the response. Though an example is given to demonstrate the expansion of numbers, but the perception challenges posed by Taylor Frame may lower the performance of the CVH (e.g. only 88% of students who attempted the first item, only 4% were unsuccessful). Further, it could be
concluded that the zero concept, its position at different place values – Unit, Tens and Hundreds is yet to be mastered by many of the CVH in the study.

5.2.2.3 Error Analysis on Place Value – Identification of Numbers

Competency 7

Read the numerals carefully and answer the given questions

<table>
<thead>
<tr>
<th></th>
<th>23) 6 8 4 2</th>
<th>24) 3 2 6 8</th>
<th>25) 9 7 0 2</th>
<th>26) 9 9 5 0</th>
</tr>
</thead>
</table>
a) Which numeral has 8 at units (ones) place?
| 23) 6 8 4 2 | 24) 3 2 6 8 | 25) 9 7 0 2 | 26) 9 9 5 0 |
|   |           |             |             |             |
b) Which numeral has 0 at Tens place?
| 23) 6 8 4 2 | 24) 3 2 6 8 | 25) 9 7 0 2 | 26) 9 9 5 0 |
|   |           |             |             |             |
c) Which numeral has 9 at hundred place?
| 23) 6 8 4 2 | 24) 3 2 6 8 | 25) 9 7 0 2 | 26) 9 9 5 0 |
|   |           |             |             |             |
d) Which numeral has 6 at Thousand place?
| 23) 6 8 4 2 | 24) 3 2 6 8 | 25) 9 7 0 2 | 26) 9 9 5 0 |
|   |           |             |             |             |

Table 41

Item-wise Error Analysis – Identification of Numbers

Modality: Presentation = Taylor Frame
Response = Oral
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B G</td>
<td>B G</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>26</td>
<td>4</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It could be observed from Table 41, that

- 62% of children have mastered this concept.
- Boys and girls are similar in their performance with not considerable differences.
- 9% of the whole group have not answered on average.
- There are errors found in all the four items ranging from 26% to 36% indicating the confusions/misconceptions about this competency.
- The last item is the most difficult with mistakes as large as 36%.

Errors Observed

- The last two numbers have zeros at hundredth and tenth place which are found to be most confusing for CVH.
- The writing of answers pose another form of difficulty – many children have just written ‘zero’ as the answer instead of writing their place value as 100, or 10, indicating that CVH need systematically planned remedial programmes to overcome these learning difficulties in Arithmetic.
5.2.2.4 Error Analysis on Place Value – Formation of Numbers

Competency 8

VIII

Form any four 4 Digit number from the given digits (only one digit can be used twice in the number as shown in the example) and write the number names.

Example: Numbers 1 8 3

<table>
<thead>
<tr>
<th>Digits</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 1183</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2) 1836

Numbers

Digits

6 7 4

27) [Blank]
28) [Blank]
29) [Blank]
30) [Blank]

Table 42

Item-wise Error Analysis – Formation of Numbers

Modality: Presentation = Taylor Frame
Response = Taylor Frame
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl. No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students — Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>✓ B G X B G NA B G</td>
<td>✓ N % X N % NA N %</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>15 14 8 7 2 4</td>
<td>29 58 15 30 6 12</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>13 12 9 4 3 9</td>
<td>25 50 13 26 12 24</td>
</tr>
<tr>
<td>29</td>
<td>3</td>
<td>11 12 8 8 6 5</td>
<td>23 48 16 32 11 22</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
<td>6 7 2 3 17 15</td>
<td>13 26 5 10 32 64</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>22.5 45 12.25 24.50 15.25 30.50</td>
</tr>
</tbody>
</table>
It could be observed from the Table 42, that

- Only 45% of CVH have mastered this competency.
- 25% of them have erred.
- 30% of them have not attempted at all.
- Boys and girls are similar in their performance.
- As the students lack the knowledge forming new numbers with given numbers many have not tried to answer these subitems.
- The item provides for lot of imagination to form four digit numbers, but the CVH might not have attempted due to the absence of previous experience.

Errors Observed

- 6, 7, 4 are the given numbers, with a condition to use any one of them to be used twice to form four digit numbers.
- This condition has not been followed by many CVH.
- Typical errors  – 6677, 7744
  -- 666, 777, 444, 674

- It could be concluded that the comprehension of any Arithmetic Task is very crucial to solve that task using correct thinking strategies following the given conditions.
• It is also evident that Arithmetic Tasks involving originality in thinking such as formation of numbers, would also require sufficient practice in executing suitable thinking strategies.

Thus, the CVH in particular, operating through Taylor Frame, have a specific difficulty in solving such problems; they get frustrated to try out new strategies mostly because the Taylor Frame is quite complicated; solving of Arithmetic Tasks depends upon their efficiency in operating Taylor Frame.

5.2.2.5 Summary on Responses – Place Value

Summary Table 43 and Graph 4 on Place Value not only indicates the variations in performance among the CVH of the study but also their problems in comprehending different kinds of Arithmetic tasks. Though all the four competencies aimed at assessing the knowledge and skills of Place Value, which paves the way for learning higher order competencies, the percentage of responses varies drastically from one competency to another. As a good characteristic of any criterion referenced test, each competency on Place Value was tested on four items. So, it was possible to analyse the errors on individual items too.
Table 43

Summary Table on Errors – Competencies 5 to 8

<table>
<thead>
<tr>
<th>Competencies</th>
<th>Items</th>
<th>✔</th>
<th>%</th>
<th>✗</th>
<th>%</th>
<th>NA</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Naming Numbers</td>
<td>4</td>
<td>28</td>
<td>56</td>
<td>20</td>
<td>44</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Expansion of Numbers</td>
<td>4</td>
<td>35</td>
<td>70</td>
<td>8</td>
<td>16</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>7. Identification of Numbers</td>
<td>4</td>
<td>31</td>
<td>62</td>
<td>15</td>
<td>30</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>8. Formation of Numbers</td>
<td>4</td>
<td>23</td>
<td>46</td>
<td>12</td>
<td>24</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Total = 4</td>
<td>16</td>
<td>30</td>
<td>60</td>
<td>14</td>
<td>28</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Graph 4

Summary graph on responses – Place Value

- Correct
- Wrong
- Not attempted

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Here are some indicators on errors to be taken care of, in providing for remedial programme on place value for primary children irrespective of their grades. Children from different grades have erred in these competencies on Place Value. These could be notified as cumulative deficiencies as they should be masters in basic number concepts and skills to understand the place value. The following points are noteworthy:

- The place value of ‘zero’ is the most difficult concept to understand for CVH. Owing to lack of concrete manipulatives to teach the concept of zero and in absence of any other strategies for the teacher of the CVH (Teacher, personal communication, November 28, 1998) to teach the place value of ‘Zero’, teachers resort to making oral statements that ‘Zero has no place value by itself’. Such statements are not understood well by the CVH. It is only when the children start doing arithmetic operations involving regrouping that children identify that zero has place value assigned to it based on the preceding number or the succeeding number. For example: in numbers 5044, 9806 and 2130, the position of zero takes different place value. Thus, these children need different kinds of concrete experiences to understand the concept of ‘Zero’ and assignment of place value to it.

- Competency – Formation of Numbers, provided a unique experience to CVH of this study. Such exercises motivate children to learn Arithmetic with a positive approach. Most of the CVH interviewed were of the opinion that they are happy if they didn’t have to use the Taylor Frame. But all the Arithmetic Tasks cannot be solved by mental arithmetic only. Hence Taylor Frame
becomes inevitable for CVH. It is left to the teachers of CVH to combine both mental arithmetic and Taylor Frame so as to provide a meaningful learning experience for CVH.

5.2.3 Error Analysis – Addition

Addition is a skill with counting capabilities. The understanding of addition with bigger numbers depends upon the understanding of place-value. Addition in which the sum of the ones, tens and hundreds are less than 10 can be easily done either in horizontal or vertical form.

(for example: 321 + 475 = 796 or 321)
\[ \begin{array}{c}
321 \\
+ 475 \\
\hline
796 
\end{array} \]

But when the sum of ones, tens and hundreds is 10 or more, 'regrouping' or 'carry over' needs to be done for which vertical form of addition is necessary. Vertical form provides for the addition of two or more rows with bigger numbers of any size with 'carry over' systematically.

For the present study, ADT comprised 6 competencies on Addition selected and graded carefully. Performance of CVH on each competency was analysed to detect different types of errors. The following table provides the details.
### Table 44

**Item-wise Error Analysis – Competencies on Addition**

**Modality:** Presentation = Taylor Frame  
**Response** = Taylor Frame  
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl. No. on ADT</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>[N, %]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>G</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>20 18 5 7 0 0</td>
<td>38 76 12 24 0 0</td>
</tr>
<tr>
<td>32</td>
<td>2</td>
<td>10 12 8 6 5 4</td>
<td>35 70 15 30 0 0</td>
</tr>
<tr>
<td>33</td>
<td>3</td>
<td>10 12 9 7 11 12</td>
<td>22 44 18 36 10 20</td>
</tr>
<tr>
<td>34</td>
<td>4</td>
<td>2 8 8 8 15 9</td>
<td>11 22 21 42 18 36</td>
</tr>
<tr>
<td>35</td>
<td>5</td>
<td>2 4 7 19 14 6</td>
<td>10 20 16 32 24 48</td>
</tr>
<tr>
<td>36</td>
<td>6</td>
<td>2 4 7 19 14 6</td>
<td>20 40 16 32 14 28</td>
</tr>
</tbody>
</table>

**Responses**

It could be observed from Table 44, that

- Competency 1: Four digit addition in two rows, without carryover,  
  **Column sum < 10**  
  Ans: 5879

- 76% of children have attained this simple addition competency.
- 24% have committed errors.
- All the students have attempted this task.
- Boys and girls have performed more or less similar to each other.

- Competency 2: Four digit addition in two rows, without carryover,  
  Column sum > 10 and < 20  
  Ans: 15778

- This competency has been mastered by 70% of CVH.
- Errors account for 30%
- All the CVH have attempted the item.
• Boys and girls have performed equally well.

<table>
<thead>
<tr>
<th>Competency 3: Four digit addition in two rows, with</th>
<th>111</th>
</tr>
</thead>
<tbody>
<tr>
<td>carryover (regrouping)</td>
<td>7257</td>
</tr>
<tr>
<td>Last digit</td>
<td>9856</td>
</tr>
<tr>
<td>Column sum &gt; 10 and &lt; 20</td>
<td>Ans: 17113</td>
</tr>
</tbody>
</table>

• The percentage of mastery is 44.

• Errors account for 36%.

• Not attempted by 20%.

• Girls have performed slightly better than boys.

• 30% of errors indicate the high difficulty level of the Arithmetic Task.

<table>
<thead>
<tr>
<th>Competency 4: Four digit addition in three rows</th>
<th>4021</th>
</tr>
</thead>
<tbody>
<tr>
<td>without carryover,</td>
<td>2107</td>
</tr>
<tr>
<td>Numerals with zero in unit, tens and</td>
<td>7850</td>
</tr>
<tr>
<td>hundreds place value and</td>
<td>Ans: 13978</td>
</tr>
<tr>
<td>column sum &lt; 20</td>
<td></td>
</tr>
</tbody>
</table>

• The item is difficult for majority of CVH as the mastery of the competency is found only in 22% of CVH.

• Errors account for 42%.

• Not attempted by 36%, which indicates that children have not understood the addition with zero in different place values.

• Girls have performed better than boys.
• 44% of children have mastered the item.

• 12% of children committed mistakes while solving.

• 44% of children did not attempt the item.

• Girls have better performed.

The not attempted items account for 44% of children indicated that CVH do not attempt the item.

This is the most difficult competency for CVH in Addition as the percentage of children who have not attempted being 66% and with a meager 12% of children mastering this competency. The wrong responses account for 22%.

Considering the overall performance of CVH on the six graded competencies of Addition it could be concluded that majority of them have not mastered the higher order Addition Tasks. This is clear from their performance on the first two items 'without carryover' in which 70% and above children have mastered the simple addition problems. The sudden drop in the success rate
from the third item ‘with carryover’ (70% to 44%) and further decrease in the percentage up to the sixth competency provides ample evidence that CVH are yet to master the Addition with carry over. The Addition with zero was also found to be difficult and the errors occurred in items with zero need to be analysed in detail for diagnosing their difficulties in understanding zero with addition.

Thus, the six competencies identified in the area – Addition of ADT have provided a lot of scope for understanding what CVH ‘can’ or ‘cannot’ do in solving different types of Addition Tasks. A detailed error patterning in Addition should provide for meaningful clues for developing suitable remedial programmes for CVH.

5.2.4 Error Analysis – Subtraction

Just as by addition we mean combining of objects of different collections together and counting the objects of this combined collection, by subtraction we mean ‘taking away’ some of the objects (or all the objects) from a collection and counting the remaining objects of the collection. Children need to understand subtraction as taking away and comparison. The relationship between addition and subtraction is also to be reinforced. Thus the competencies of subtraction also, as in addition, were considered sequentially with increasing difficulty in ADT. There are six items representing different competencies of subtraction – with or without regrouping, with or without zero, all with four digit numerals. Table 41 provides the number and percentages of children who have/have not successfully mastered these competencies.
Table 45

Item-wise Error Analysis – Competencies on Subtraction

Modality: Presentation = Taylor Frame
Response = Taylor Frame
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>37</td>
<td>1</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>38</td>
<td>2</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>39</td>
<td>3</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>40</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>41</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>42</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>9</td>
<td>11</td>
</tr>
</tbody>
</table>

1. Four digit subtraction without borrowing – minuend less than subtrahend
   - 7468
   - 5134
   - 2334

2. Four digit subtraction without borrowing – remainder to be zero with same digit as minuend and subtrahend
   - 4637
   - 4215
   - 422

3. Four digit subtraction without borrowing
   -- with zero in subtrahend and minuend
   (e.g. 0)
   - 5206
   - 3001
   -- with zero in minuend only
   (e.g. 2)
   - 2205

4. Four digit subtraction with borrowing
   - 8657
   - 4968
   - 3689

5. Four digit subtraction with borrowing
   -- with resulting zero in subtrahend after borrowing
   - 7516
   -- remainder to be zero with same digit as subtrahend and minuend after borrowing
   - 6789
   - 727

6. Four digit subtraction with borrowing
   -- with zero in subtrahend for first three digits
   - 9000
   -- remainder to be zero with same digit as subtrahend and minuend after borrowing
   - 2951
   - 6049

The results of Table 45 reveals that,
• The results are similar to that of addition.

• The first two competencies without borrowing are mastered by 74% and 68% respectively and then a steady decrease in the percentage of performance can be observed from the items 3 to 6.

• Not attempted children are not found in the first two tasks whereas there a gradual increase in this over the subsequent items reaching 64% for the sixth item which is to be noted seriously. This indicates lack of knowledge in performing subtraction tasks.

• The errors account for an average of 28% ranging from 24% to 36% which provides lot of scope for identifying the causes for their errors in subtraction.

• Zero concept poses a serious threat in solving subtraction problems as well.

• Comparison of numbers – big vs. small, was also found to be a serious cause for errors.

Thus, a detailed error analysis in subtraction becomes necessary for providing the classroom teachers with effective means of diagnosing difficulties of CVH in subtraction.

5.2.5 Error Analysis – Multiplication

The concept of multiplication as repeated addition of a number with itself should be a basic understanding for all children in the very beginning of Arithmetic learning. Using this concept, the knowledge of multiplication tables becomes an essential factor for learning further process of multiplication. The
four competencies of multiplication were graded suitably in the ADT for assessing the performance of CVH. The following Table provides the number and percentage of students with success/failure/not attempted.

Table 46

Item-wise Error Analysis – Competencies on Multiplication

Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B G</td>
<td>N %</td>
</tr>
<tr>
<td></td>
<td>N %</td>
<td>N %</td>
</tr>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

It could be observed from Table 46 that,

- The overall performance on Multiplication tasks is very low, with 20% of CVH having successfully performed; 32% of them not attended.
- Errors account for 48% children.
• Item-wise comparison shows that the first task with single digit multiplication 48% have correctly done the task.

• Subsequent tasks 2, 3 and 4 with two-digit multiplication are found to be difficult with success rate of 18%, 8% and 8% respectively.

Thus, a detailed error analysis in multiplication becomes necessary for providing the classroom teachers with effective means of diagnosing difficulties of CVH in multiplication.

5.2.6 Error Analysis – Division

Division is a complex Arithmetic Skill, which serves as basic understanding for higher order concepts fraction and decimals. The simple division process involves ‘Equal Sharing’ and ‘Grouping’ situations. In ‘equal sharing’ we need to find out how much each portion contains when a given quantity is shared out into a number of equal portions. In ‘grouping’ we need to find out the number of portions of a given size which can be obtained from a given quantity.

To make children understand division involving divisor, dividend, quotient and remainder, plenty of examples should be provided in the beginning to understand division as the ‘reverse process of multiplication’ and also ‘repeated subtraction’.
There were five items on Division in ADT with graded difficulty and the results of performance on these competencies are given in Table 46 with the task details.

Table 47

Item-wise Error Analysis – Competencies on Division

Modality: Presentation = Taylor Frame
Response = Taylor Frame
Boys = 25, Girls = 25, Total Group = 50

<table>
<thead>
<tr>
<th>Responses</th>
<th>Number of students</th>
<th>Percentage of students—Total Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on ADT</td>
<td>B</td>
</tr>
<tr>
<td>47</td>
<td>Item</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>Four digit division without remainder</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Four digit division with remainder</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Four digit division with remainder</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Four digit division with remainder</td>
<td>16</td>
</tr>
<tr>
<td>Average</td>
<td>18</td>
<td>8</td>
</tr>
</tbody>
</table>

It could be seen from Table 47 that,
• The average percentages of the four items reveals that only 16% CVH have marked this competency with 17% of CVH who have committed errors and the remaining 67% have not at all attempted the Division items.

• From item 1 to 4, there is a steady decrease in the percentage of successful children from 20% to 12% and there is a steady increase in the percentage of 'not attempted' from 60% to 72%.

• The errors account for 20% for the first item, all the remaining items with 16%.

• Girls have performed better than boys.

Thus, it could be concluded that the Division as a complex skill involving both Multiplication and Subtraction, appears to be the most difficulty competency for CVH. Unless children are skilled in Multiplication and Subtraction, they cannot be expected to perform at a high level in division.

5.2.7 Summary on Computational Skills

It can be observed from the below summary Table 48, and Graph 5, that majority of the CVH have not mastered higher order tasks on four computational skills, however a simple task on Addition, Subtraction and Multiplication were mastered but not in Division. Children need to have a firm understanding of place-value ideas before they can work effectively with the algorithms. Linking place-value ideas directly with renaming/regrouping/ carryover/borrow ideas is a necessary step as the algorithms for each computational operation – Addition, Subtraction, Multiplication and Division to be developed.
### Table 48
Summary Table on Errors – Arithmetic Operations

<table>
<thead>
<tr>
<th>Competencies</th>
<th>Percentage of Responses</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>X</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Addition</td>
<td>22</td>
<td>44</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>Subtraction</td>
<td>20</td>
<td>40</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Multiplication</td>
<td>10</td>
<td>20</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Division</td>
<td>8</td>
<td>16</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>30</td>
<td>16</td>
<td>32</td>
</tr>
</tbody>
</table>

#### Graph 5
Summary graph on responses — Computational Skills

- **Division**
  - Correct: 16
  - Wrong: 18
  - Not attempted: 66

- **Multiplication**
  - Correct: 20
  - Wrong: 48
  - Not attempted: 32

- **Subtraction**
  - Correct: 40
  - Wrong: 32
  - Not attempted: 28

- **Addition**
  - Correct: 44
  - Wrong: 28
  - Not attempted: 28
According to Wills (1971), developing the algorithms that work with multi
digit numbers has to evolve from students' understanding of place value, which
involves building connections between key ideas of place value – such as
quantifying sets of objects by grouping by ten and treating the groups as units –
and using the structure of the written notation to capture this information about
groupings.

The above statement highlighting the role and importance of place value is
equally applicable for CVH in their development of Arithmetic skills. In the
absence of visual perception, concrete materials through tactile perception which
are manipulative in nature are crucial for their Arithmetic learning. The results of
the study on computational skills – Addition, Subtraction, Multiplication and
Division subscribe to this view and the types of errors they commit in solving
computational problems are to be carefully analysed for developing suitable
remedial programmes. The errors that we identify among CVH could be
compared with that of Sighted children which further indicates the differences if
any, between the nature and type of errors they commit. Even though it was
beyond the scope of this study to make a comparison of errors between the CVH
and the Sighted within the sample of the study, an attempt has been made to
refer the identified error categories among CVH to the available literature on the
Sighted. This has been presented in section 5.3 Infra.

The low level of performance of CVH in this study with various kinds of
errors in solving Arithmetic tasks warrants suitable remedial measures so that
cumulative deficiencies could be taken care of for upper primary children. It is very disappointing to note that majority of CVH from V, VI and VII grades of this study have not mastered multiplication and division skills; each subject has revealed his/her inadequate knowledge of zero concept at different situations and lack of knowledge on several aspects of place value.

5.3 CATEGORISATION OF ERRORS IN ARITHMETIC SKILLS AMONG CHILDREN WITH VISUAL HANDICAP

In section 5.2 an attempt was made to analyse the errors committed by CVH with respect to different competencies of ADT focusing on the percentage of children with correct (✓) and (X) responses and also who did not attempt (NA) the task at all. It provided for comparison between the competencies and also yield at results on the difficulties in solving different kinds of Arithmetic Tasks all in percentages. An earnest attempt has been made in this section to categorise/classify the errors. Following sections provide details on categories of errors in the pursuit of Objective II – Research Question 3

What kind of errors the primary school Children with Visual Handicap commit in solving different kinds of arithmetic tasks pertaining to basic arithmetic concepts and operations?

Diagnosis in arithmetic is a broad field which encompasses the study of difficulties in computation in relation to the objectives of arithmetic, pedagogical factors, student abilities and the method of evaluation. Julian and Julie (1997) – find reference in this regard remarks - The identification and characterisation of
the way children understand mathematics presented to them in the curriculum has long been the focus of research in the psychology of mathematics education and continues to be a source of empirical and theoretical investigation (e.g. Vinner, 1998). While much of this work was and is still conducted within a ‘misconceptions’ or ‘alternative frameworks’ paradigm, there is continuing development of theoretical perspectives on children’s mathematical thinking which elaborate on contextual, social and socio-cultural factors, (Forman & van Oers, 1998; Kirschner & Whitson, 1998).

Delimiting the scope of error analysis, following sections present error analysis from the perspective of analysing the arithmetic operational process errors and categorise the committed by CVH on the ADT. Rivera and Bryant (1992) note the importance of conducting a process assessment to determine the strategies that students use to determine answers. Specially, they suggest using passive and active process assessments. Passive process assessments involve examining a student’s work to determine error patterns and procedural strategies. Active process assessments involve a form of flexible student interviewing in which the student “thinks aloud” while solving an equation or word problem. For the purpose of this study, error analysis was carried out using the passive process. Student work samples by recording the details worked out by them for each task on paper from the Taylor Frame (modality used by the children to solve problems on ADT) has been used.
Ginsburg (1987) notes that student error patterns tend to fall into three categories: number facts, slips, and bugs. Number facts error occurs when the student has not mastered the basic facts. Slips consist of deficiencies in the execution of a readily available procedure (e.g., forgetting to add a regrouped number). Bugs are systematic procedural errors (e.g. always subtracting the smaller number from the larger number) that are made repeatedly during problem solving. To develop effective remedial programs, these error patterns must be recognised.

Many models have been proposed for error analysis with categories of errors for each operation of arithmetic task – addition, subtraction, multiplication and division (Ainsworth, 1991; Buswell, 1925; Cox, 1975; Reismann 1982). Most of these models and error categories are for the Sighted children. Categorisation of mathematical errors though can be seen for mathematically disabled children in special education has not been dealt in-depth especially for CVH.

Thus, an attempt is made here to categorise the errors committed by CVH on ADT. As the sample of the study was microgenetic, hence, generalisation of error categories is not attempted. Further, while analysing the errors committed by CVH it should be noted that the besides the absence of vision combined with multiple modalities presented to them for the purpose of recording, reproducing and solving the problems may offer possible cause for some of the errors. In this

---

6 Dense observations of behaviour are followed by intense analysis of both qualitative and quantitative aspects of change. This allows the generation of differentiated descriptions of particular changes, and makes microgenetic methods highly pertinent as a source of information about how change occurs (Siegler, 1996)
study, error analysis was only limited to the analysis of the work samples collected on ADT. Probing into the depth of various other factors influencing the occurrence of errors – modalities, pedagogy etc. was not considered.

Some forms of individualized, component-based techniques of assessing and remediating mathematical difficulties have been in existence at least since the 1920s (Buswell & John, 1925; Brownell, 1929; C. Williams & Whitaker, 1937; Tilton, 1947). Some researchers and educators have emphasized the importance of investigating the strategies that individual children use in arithmetic: especially those faulty arithmetical procedures that lead to errors (Buswell & John, 1925; Brownell, 1929; Van Lehn 1990). Buswell and John (1925) have carefully studied the arithmetic procedural errors and categorized them based on the different arithmetic operation. Buswell and John (1925) categories of errors have been considered for this study, as the categories of errors grouped by them yielded for an informal diagnostic evaluation of errors committed by CVH selected for this study. Further, as the sample size (N= 50) of the study was very small, grouping the errors committed by them based on Buswell and John (1925) categories of errors was considered meaningful. Any additional errors other than that of Buswell and John (1925) categories of errors have been reported separately as ‘New Errors’. A complete checklist of Buswell categories has been reproduced in the following pages.
5.3.1 Error Categories in Addition

Table 49 gives the types of errors committed by CVH with respect to addition problems on ADT.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Error Category</th>
<th>Error Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>a2</td>
<td>Counting</td>
<td>[ \begin{array}{c} 2 \ 4 \ 6 \ 7 \ + \ 3 \ 4 \ 1 \ 2 \ \hline \ 5 \ 7 \ 7 \ 9 \end{array} ]</td>
<td>Counting 4,5,6,7 = 7 (counted 4 numbers)</td>
</tr>
<tr>
<td>a4</td>
<td>Forgot to add carried number</td>
<td>[ \begin{array}{c} 7 \ 2 \ 5 \ 7 \ + \ 9 \ 8 \ 5 \ 6 \ \hline \ 16 \ 1 \ 1 \ 3 \end{array} ]</td>
<td>Forgets to add carried over at tens, hundreds and thousands place.</td>
</tr>
<tr>
<td>a6</td>
<td>Added carried number irregularly</td>
<td>[ \begin{array}{c} 7 \ 2 \ 5 \ 7 \ + \ 9 \ 8 \ 5 \ 6 \ \hline \ 17 \ 0 \ 0 \ 3 \end{array} ]</td>
<td>Remembers to add the carried number only for the last column. Forgets to add carried over at tens and adds carried over twice at hundreds.</td>
</tr>
<tr>
<td>a12</td>
<td>Used wrong fundamental operation</td>
<td>[ \begin{array}{c} 2 \ 4 \ 6 \ 7 \ + \ 3 \ 4 \ 1 \ 2 \ \hline \ 1 \ 8 \ 7 \ 9 \end{array} ]</td>
<td>Starts with addition at units, tens and hundreds place, however moves to subtraction at thousands place.</td>
</tr>
<tr>
<td>S.No.</td>
<td>Error Category</td>
<td>Error Analysis</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>a13</td>
<td>Lost place in column</td>
<td><img src="" alt="Addition Example" /></td>
<td>Perceptual errors in column. Unknown</td>
</tr>
<tr>
<td>a16</td>
<td>Omitted one or more digit</td>
<td><img src="" alt="Subtraction Example" /></td>
<td>Remembers to add the carried number but misses the digit 6 in third row while adding</td>
</tr>
<tr>
<td>a19</td>
<td>Derived unknown combination from familiar one</td>
<td><img src="" alt="Multiplication Example" /></td>
<td>Reversal of number 9 and 6. In the thousand place the child combines 7+9 as 7+6</td>
</tr>
<tr>
<td>a23</td>
<td>Carrying when there was nothing to carry.</td>
<td><img src="" alt="Carrying Example" /></td>
<td>Carried over to hundreds when not necessary.</td>
</tr>
<tr>
<td>New</td>
<td>Subtracting carried number from the addend before addition.</td>
<td><img src="" alt="Subtraction Example" /></td>
<td>Subtracts carried 1 from the addend 7 at thousands place and then adds 9 + 6 = 15. Other error response was in counting – 9,10,11,12,13,14,15 = 7 numbers added (a2)</td>
</tr>
</tbody>
</table>

Nine major categories of errors (Buswell & John, 1925 Categories – 8; New Category – 1) have been identified from the work samples of CVH on ADT.
Analysis of these errors reveals both slips and bugs (Ginsburg, 1987) in problem solving of tasks in Addition.

All the subjects with have attempted the first item of the task. Very few have committed errors and among the errors committed, two major types of errors can be seen – a2 (Counting), a4 (Forget to add carried number) and a12 (Used wrong process).

With category a2, it can be seen that the child exhibits slip in counting: \(4+4 = 4,5,6,7\) instead of \(4+4 = 5,6,7,8\)

Other very common mistake that was observed in the error analysis belonged to the type a4 – Forget to add carried number. This error was observed in the instance of item number 3 (4 digit addition with carryover in two rows and item 5 (4 digit addition in three rows with carryover and zero).

Two types of errors were observed in case of forgetting to add carried over. Forgetting to add the carried over at tens place (Item 35(a)) was commonly observed not only in this item but also in other items where regrouping with carry over was mandated. Irregularity in adding the carried number can also be seen.
In item 35(b) it can be seen that the child adds the carried number with respect to other columns except for the hundredth column. Repeated error in case of Item 35(b) and specifically at hundredth place, though categorises it under a4, availability of zero in the topmost row at the hundredth place may have posed the confusion to child, as the child might have not mastered the fact \((1+0 = 1)\) instead considering \((1+0 = 0)\) proceeds with the item and adds the remaining two digits in the column. Buswell (26.03%) and Cox (1.72%) have reported that child forgets to add carried over with respect to category a4.

The second type of mistake that was observed was proceeding the problem solving with addition, the child moves on to use Subtraction (a12) eg:

\[
\begin{array}{c}
+ \\
\hline
2 & 4 & 6 & 7 \\
3 & 4 & 1 & 2 \\
\hline
1 & 8 & 7 & 9
\end{array}
\]

Though this type of error can be seen as a slip in this particular task, it was observed in the later analysis, children tend to use the wrong fundamental process in case of subtraction (use addition) and multiplication (multiply as addition). Thus, this particular error may build up cumulative deficiency in the child in later stages for all major computational operations. Cox (1975) reports 9.48% for the error category a12 – Used wrong fundamental operation i.e subtraction.

Few repeated errors were also seen in case of category a13 – Lost place in column specifically with respect to items 34 and 36.
Though this error can be categorised as a bug, and the performance of CVH on item 36 revealing it as the most difficult item (12% on achievement score), in both the instances, specifically in case of item 36 possible errors might have crept in because of the modality. Task analysis of the item reveals that (item on Taylor Frame shown in the Picture 3) the child has to

- Perceive the ‘types in rows’
- Perceive the symbol
- Perceive the ‘types’ in column from unit end
- Solve the item at unit end and carryover one to tens column
- Regroup the tens column to add the carried number, perceive the numbers in column and solve the item at tens place

Similarly continue with the next place value hundreds and thousands place value and arrive at the solution as shown in the Picture.
However, when the child comes to the thousands place, perception of types pose problem to the child, as the thousands place value is empty in the third row and similarly the space is empty for ten thousand place value in the second row. Thus, common mistake of missing a column in between or adding numbers from adjacent column may appear. Perception plays an important role for problem solving complex arithmetic tasks with multiple columns in multiple rows for CVH on specifically on Taylor Frame.

A bug in relation to the reversal of numbers was also observed in some instances. This bug was carried over to other computational items as well.
specifically in Subtraction thus indicating the cumulative deficiency of this particular error. The numbers that were often confused are 6 and 9 and were reversed for conducting the computational operation eg:

\[
\begin{array}{c}
7 \\
9 \\
13 \\
\hline
2 \ 5 \\
8 \ 5 \\
0 \ 0 \\
\hline
7 \ 6 \\
13 \ 3
\end{array}
\]

Here, the child adds 7+9 as 7+6. Therefore the total 13. As is evident this error appears in combination with the other error of forgetting to add the carried number.

The categories a23 and New were not commonly observed but appearance of such errors indicated the slips that may occur in performing the computational task. Cox has reported 1.72% frequency for the error category a23 – Added carried number irregularly; wherein the child carries over 1 to tens when not necessary.

Proper instruction and remediation of bugs is warranted to address the errors and help the child in avoiding building up of cumulative deficiencies.

5.3.2 Error Categories in Subtraction

Table 50 gives the types of errors committed by CVH with respect to Subtraction problems on ADT.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Error Category</th>
<th>Error Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>s4</td>
<td>Errors due to zero in minuend</td>
<td><img src="image" alt="Minuend Example" /></td>
<td>Does not borrow when zero in minuend.</td>
</tr>
<tr>
<td>s6</td>
<td>Subtracted minuend from subtrahend</td>
<td><img src="image" alt="Subtracting Example" /></td>
<td>Subtracts from a bigger number irrespective of its position minuend or subtrahend.</td>
</tr>
<tr>
<td>s8</td>
<td>Added instead of subtracted</td>
<td><img src="image" alt="Adding Example" /></td>
<td>Begins subtraction process from units, continues till tens however reverts to addition at hundreds.</td>
</tr>
<tr>
<td>s10</td>
<td>Used same digit in two columns</td>
<td><img src="image" alt="Same Digit Example" /></td>
<td>Considers the digit at thousands place for the hundreds and the thousands place for subtraction.</td>
</tr>
<tr>
<td>s11</td>
<td>Derived unknown from known combination</td>
<td><img src="image" alt="Unknown Answer Example" /></td>
<td>Subtraction of minuend from subtrahend and for the unit column derives an unknown answer (possibly 15 of which 1 is retained and for thousands column answer could be 13 of which 3 is retained – addition process)</td>
</tr>
<tr>
<td>S.No.</td>
<td>Error Category</td>
<td>Error Analysis</td>
<td>Comments</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>s23</td>
<td>Increased minuend digit after borrowing</td>
<td>8 6 5 7 - 4 9 6 8 = 4 7 9 9</td>
<td>Does not reduce the number by one after borrowing. Though the number is not increased but retains, as is despite of borrowing.</td>
</tr>
<tr>
<td></td>
<td>Adds borrowed number to the minued before subtraction</td>
<td>8 6 15 17 - 4 9 6 8 = 4 0 0 0</td>
<td>Adds borrowed number to the minued number eg: 1+7 = 8; 8-8=0. At hundreds place reads the number in reverse 6 as 9</td>
</tr>
</tbody>
</table>

Error categories in subtraction reveal that CVH have not mastered some basic facts specifically including zero. Majority of the errors that appeared in Subtraction was in relation to the presence of zero either in minuend or subtrahend. Some common errors that were observed are:

Below examples have been taken from the work sample of CVH. Number of digits used here highlights the specific error committed within the 4-digit subtraction in two rows with and without borrowing; with and without zero in subtrahend and minuend. – show examples in 4 digits

\[
\begin{array}{c}
4 6 3 7 \\
\hline
4 2 1 5 \\
\hline
4 8 2 2 \\
\end{array}
\]

The child does not comprehend the fact when subtraction takes place between two similar numbers nothing remains.

\[
\begin{array}{c}
8 6 15 7 \\
\hline
4 9 6 8 \\
\hline
4 0 0 0 \\
\end{array}
\]

The child does not know borrowing. As the minuend is lesser than the subtrahend, rule applied by the child is: a greater number cannot be
subtracted from a smaller number therefore, the remainder is zero.

In this case, the child uses the rule that nothing can be removed from zero therefore the remainder will be zero. Also, displays that the concept of borrowing is probably not known to the child.

In this case, the child applies the rule that a bigger number cannot be subtracted from zero therefore the remainder will be the bigger number irrespective of its position in the subtrahend or minuend.

Here, the child is using reverse subtraction and when the child realises that bigger number cannot be subtracted from the smaller number 6, therefore borrows one from the next number in the subtrahend and performs the task (error category (s6)).

Here the child know to borrow from the tens place, but regroups the number as nine and subtracts the subtrahend.

Again the child uses the reverse subtraction (error category s6) but as the number in the hundredth column of minuend is greater than the subtrahend,
hence subtracts digit in the subtrahend from the minuend.

In this case, the child borrows number from the Hundredth place to the Tens and Unit place and assumes that as he borrowed the number from the Hundredth place hence, nothing remains in that place therefore the remainder will be zero.

Mercer (1998) has listed some error categories for pupils with learning problems and the identified errors are similar to what has been observed by Buswell (1925) and among CVH in this study viz – The upper number (minuend) is subtracted from the lower number (subtrahend) (category – s6); when regrouping is required more than one, the appropriate amount is not subtracted from the column borrowed in the second regrouping (category – s23); Reversal of number 6 and 9; using wrong fundamental process (addition instead of subtraction) is also observed in this task.

Thus, it is seen that errors committed by CVH are not entirely new and conforms to the error categories identified by other researchers.

5.3.3 Error Categories in Multiplication and Division

From the results of the performance of CVH on ADT in relation to multiplication and Division, it is observed that very few CVH have attempted to work on Division problems and the attempted item showed partial responses; hence, enumeration of errors was not possible. Lack of skill to work on Division
problems indicates poor development of the basic arithmetic skills of place value, addition, subtraction and multiplication as all of these skills will be involved in performing on a task of Division. Therefore, the below account is limited to highlight the categories of errors in Multiplication skill only. Table 51 gives the types of errors committed by CVH with respect to Multiplication problems on ADT.
Table 51

<table>
<thead>
<tr>
<th>Error Category</th>
<th>Error Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>m10 Used wrong process</td>
<td>6423 x 20</td>
<td>Adds the numbers for multiplicand with that of multiplier from left</td>
</tr>
<tr>
<td></td>
<td>8650</td>
<td>6+2 = 8, 4+2 = 6, 3+2 = 5, 0 + - = 0</td>
</tr>
<tr>
<td>m12 Omitted digit in</td>
<td>3 9 6 5 x 49</td>
<td>Multiplied only by 5.</td>
</tr>
<tr>
<td>multiplier</td>
<td>3 5 6 8 5</td>
<td></td>
</tr>
<tr>
<td>m21 Multiplied by</td>
<td>9070 x 65</td>
<td>Adds the numbers irregularly</td>
</tr>
<tr>
<td>added</td>
<td>1 8 1 8 6 5</td>
<td>65 + 0 = 65, 7+6+5 = 18, 9 + 6+5 = 18</td>
</tr>
<tr>
<td>m26 Errors in writing</td>
<td>6 4 2 3 x 20</td>
<td>Did not carry the tens, wrote the product of each multiplication</td>
</tr>
<tr>
<td>product</td>
<td>1 2 8 0 4 0 6 0</td>
<td>except for 6 at thousands place   i.e 20x3 = 60; 20x2 = 40; 20x4 = 80 ; 20x6 = 12</td>
</tr>
<tr>
<td>m28 Illegible figures</td>
<td>6 4 2 3 x 20</td>
<td>The product cannot be understood.</td>
</tr>
<tr>
<td></td>
<td>0 6 3 2 8</td>
<td></td>
</tr>
<tr>
<td>New Repeat multiplication while adding partial products</td>
<td>3 9 6 5 x 49</td>
<td>Partial products are correct, while adding, addition is correctly carried out till hundreds place, after that the child starts multiplying the digits in the partial products: 8x5=40 (carries 4) 5x3=15 +4(carried number) Adds the carried number to the end place, as there is no digit available to multiply.</td>
</tr>
<tr>
<td></td>
<td>3 5 6 8 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 5 8 6 0 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 9 0 2 8 5</td>
<td></td>
</tr>
</tbody>
</table>

Performance of CVH on the task of multiplication has been observed to be very poor with an average performance of 10% for all the items. Most of the errors that children have committed in this task relate to the availability of zero in the multiplicand. CVH have mastered the multiplication process using single digit
multiplier (as most of them have mastered multiplication tables upto ten) but when a number higher than ten is given as multiplier the child does not know how to multiply. In some instances children multiplied the 4 digit multiplicand with two digit multiplier however, problem was found to be difficult as they did not know how to carryover. As such, multiplication products for each number were written as answer. Eg:

\[
\begin{array}{c}
6423 \\
\times \quad 20 \\
\hline
120804060
\end{array}
\]

Further, errors with respect to carryover at zero place value and using addition process instead of multiplying was also observed. In one typical case the child added all the numbers in the multiplicand and the multiplier end and further added the multiplier digit and the multiplicand digit which aligned below each other eg:

\[
\begin{array}{c}
6423 \\
\times \quad 20 \\
\hline
17240
\end{array}
\]

As can be seen the child has added all the numbers 6+4+2+3+2 = 17 and then 2 (multiplicand) +2 (multiplier) = 4 as they align beneath each other.

Some of the other errors that were observed for this task are:
N \times N = N \quad \text{The child does not know multiplication.}

64 \times 2 = 64

0 \times 3 = 3 \quad \text{Basic facts in relation to zero not known.}

N \times N = N + N \quad \text{Except for the multiplication at the tenth place,}
\quad \text{the child adds the multiplier digit to all the}
\quad \text{numbers in the multiplicand to derive the answer.}

212 \times 4 = 646

Ainsworth (1991) has reported 1.32% frequency for the occurrence of
error category – m10 i.e. Adds instead of multiply. Buswell (1925) has found .2% frequency of error category – m12 i.e. Adds using multiplication. Though the last category is considered as new in relation to Buswell system of errors however, Ainsworth has found similar error and he reports 2.63% frequency for the occurrence of such errors. Buswell (10.16%), Ainsworth (2.63%) have reported the frequency of error for the occurrence of instance where in the child quits multiplication after the first multiplier is used (m12). Also, with respect to addition of multiplicand and multiplier from left Buswell highlights 0.2 frequency of occurrence of that error type.

Cox (1975) conducted a study of error patterns across skill and ability level among students with and without learning problems. In a comparison with students without learning problems, she found that the average percentages of systematic errors in multiplication and division were much higher for the special
education students. The majority of the errors for all students occurred because of a failure to understand the concept of multiplication and division. Moreover, Cox (1975) found that without intervention many of these youngsters persisted in making the same systematic errors for a long period of time.

Miller and Milam (1987) found similar results in a study on 213 students of multiplication and division errors. They found that the majority of the errors were caused by a lack of pre-requisite skills; Multiplication errors primarily resulted from a lack of knowledge of multiplication facts and inadequate addition skills. Division errors included many subtraction and multiplication errors.

Below a case study gives details of an individual student on ADT specifically on the computational operations. Individual map of a CVH showing pattern of errors on ADT with respect computational skills may be helpful to the teacher in designing suitable remedial program.

<table>
<thead>
<tr>
<th>Name: Smriti*</th>
<th>Sex : Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade: VI</td>
<td>Age : 12 Years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Error Category (Buswell Categories)</th>
<th>Area</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>a4, a13, a23</td>
<td>Addition</td>
<td>✔</td>
</tr>
<tr>
<td>s10, s4, s6, s11</td>
<td>Subtraction</td>
<td>✔</td>
</tr>
<tr>
<td>m21</td>
<td>Multiplication</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Division</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Name has been changed in lieu of confidentiality.
It is evident from the above table that, Smriti has performed well with respect to the task of addition and with the increasing difficulty of the operations her performance deteriorates. Even with respect to addition her achievement is 50% of total number of items for the task. This is in consonance with the achievement results of CVH wherein the performance is found highest (44%) for the first item of the task and lowest for the task of division (16%).

It is also clear that Smriti has successfully attempted the first item in all the three operations successfully, indicating that she has mastered the basic arithmetic skills. However with the increasing difficulty of operation in the order of subtraction, multiplication and division Smriti exhibits following deficiencies:

Addition

Regarding the wrong responses for the task of addition it has been observed that she fails to add the carried number and is inconsistent in exhibiting the error for eg:

\[
\begin{array}{c}
7 & 2 & 5 & 7 \\
+ & 9 & 8 & 5 & 6 \\
\hline
15 & 0 & 1 & 3
\end{array}
\]

In this case, Smriti remembers to regroup the tens to add the carried number from the units place, however fails to add the carried number at hundredth place and also at thousands place. Further with in relation to item 34 similar carryover problem exists, which indicates that it is a bug and requires remediation in order to help her to understand the concept of carryover and provide her with strategies for remembering to add the carried number.
Subtraction

Smriti has got only two items right in this task. The items that she got wrong were related to the competencies wherein she was being assessed for knowing the process of subtraction involving zero in subtrahend or in minuend; with or without borrowing for eg:

\[
\begin{array}{c}
4637 \\
-4215 \\
\hline
0222
\end{array}
\]

ADT Item 38

\[
\begin{array}{c}
8657 \\
-4968 \\
\hline
4691
\end{array}
\]

ADT Item 40

\[
\begin{array}{c}
9000 \\
-2951 \\
\hline
0049
\end{array}
\]

ADT Item 42

The error category for the item 2, 3 and 6 are s6, s10, s4, and s11. She has considered the same digit for subtraction in two columns in case of item 38. And with respect to item 40, she is using the reverse subtraction i.e subtracting minuend from subtrahend as minuend is smaller than subtrahend and further she derives a unknown combination from the known one in this item at hundredth place (16 - 9 = 6; 8 + 8 = 16 therefore 16-9 = 6). Regarding the last item 42 she borrows from the thousands place but assumes that number becomes equivalent to the number at thousand place in the subtrahend and hence derive 0 as the remainder for that column.

Multiplication

She has attempted only two items for this task of which one is correct and the other is wrong. Wrong response of the second item is attributed to the confusion in the process of addition and multiplication. Also, the error could have
been generated because of the two digit multiplier. As the response for the first
items is correct which involves multiplying four digit item with single digit, hence,
when confronted with an item wherein there is two digit multiplier, she in order to
attempt the item uses trial and error method of addition in multiplication style.
Example shown below:

\[
\begin{array}{c}
6423 \\
\times 20 \\
\hline
1740
\end{array}
\]

Here, adding all the numbers in the multiplicand and the multiplier she
derives the solution \((6+4+2+3+2 = 17)\) and then adds multiplier and multiplicand
aligned in the manner of addition \((2+2 = 4; 3+0 = 0)\). Thus, it is seen that Smriti
not only has problems in multiplying using two digits further, shows slip in
addition \((3+0 = 0)\) as well.

**Division**

Smriti has not attempted any of the Division items, which implies the
highest difficulty level of the operation. This is confirmed by the group results as
well achievement level being 16% for the whole group.

The determination of a specific error is important because the type of error
influences the corrective intervention (whether the student receives place value
instruction or algorithm instruction). Individual map (as done for Smriti) for a child
is helpful in planning the remedial programme for the child. The program should
focus on the specific difficulties faced by the child and should involve child in identifying the best-liked method/strategy for providing instruction.

As seen from the above account it is clear that CVH requires remediation and improved instruction for concepts of Place Value, Addition, Subtraction, Multiplication and Division. Though, the categories identified in this study does not necessarily highlight the algorithmic or computational errors, instructions in both would enable the child to understand the concept better and help in the transfer of learning to higher computational operations for eg: fractions.

5.4 ANALYSIS ON COGNITIVE CAPABILITIES OF CHILDREN WITH VISUAL HANDICAP

In pursuit of objective III (vide Section 3.2 Supra) a set of four Piagetian tasks suitably adapted for CVH with respect to Classification, Seriation, Conservation of Number and Conservation of Quantity were administered individually on fifty CVH. Interviews on each task were recorded, analysed and classified according to the stage criteria as prescribed in the original version of MCCT (vide Supra 4.2.3).

The percentages of CVH falling into different substages for each task were analysed for the whole group and with respect to gender – Boys and Girls, with a view to study developmental trends among CVH focusing on the implication of attainment of concrete operational stage. Owing to heterogeneous nature of the sample of CVH information on each child was very important. An attempt has been made to indicate the developmental trend based on grade rather than age.
as CVH selected for the study were all studying in residential schools; the influence of their home background could be considered least in their cognitive development. Moreover, in the absence of visual perception the chances of incidental learning (Mukhopadhyay et al., 1987) being minimum, their school learning experiences specifically focused on curriculum content would be a major factor in fostering their cognitive development. Moreover, the size of the sample being small, considerable age variations within one grade was not convenient for grouping them into either grade wise or age wise groups; the late admission to special schools bring in large age variations within a grade. It is common feature to have a CVH of 10 years age in I grade in special schools. Children studying in V, VI and VII grades were all found to be in the age range of 13 to 15 years. It was decided to analyse classification task grade wise with clear-cut differences in their responses. However, for the remaining three tasks the whole group was considered with gender differences.

Data analysis and interpretations with respect to the objective III is given below.

5.4.1 Performance on Cognitive Capabilities Test – Whole Test

Mean percentages were computed for the whole test to compare the performances of CVH – boys and girls, and further with respect to grade. Table 52 gives the details of the performance.
Table 52
Percentage of Mean Score on Cognitive Capabilities Test – CVH

<table>
<thead>
<tr>
<th>Grades</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 13 to 15 years</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>VII</td>
<td>5</td>
<td>73.52</td>
<td>4</td>
</tr>
<tr>
<td>VI</td>
<td>6</td>
<td>63.10</td>
<td>5</td>
</tr>
<tr>
<td>V</td>
<td>14</td>
<td>49.20</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>62.11</td>
<td>25</td>
</tr>
</tbody>
</table>

Regarding the performance of three different grades on the total test performance it could be observed that:

- There is a clear gradation with respect to the Mean values of total test performance in all the grades. The maximum has reached 72% at VII grade and the least at 48% at V grade.

- It is evident that even at the age range of VII grade, the overall cognitive capabilities did not reach beyond 72% indicating that CVH sample selected for the study develop certain concepts and operations very slowly and gradually.

- Overall mean score of 61% for the whole group irrespective of the grades indicate that CVH show a definite lag in the attainment of cognitive capabilities.

- Further, boys show a higher rate of attainment of cognitive capabilities with highest 74% and 49% in comparison to girls with highest 71% and 47%.

- Overall performance of boys also shows slightly higher attainment of cognitive capabilities with 62% in comparison to girls with 60%.
A considerable difference of attainment of overall cognitive capabilities can be seen between boys and girls of V, VI and VII grades indicating that boys perform certain cognitive capabilities better than girls.

Relating the above findings to the theory, the stage of concrete operations is observed in children of approximately the ages of seven to eleven. Children in this stage can think much more systematically and quantitatively. The child's reasoning processes become logical and they acquire operations; "systems of internal mental actions that underlie logical thinking" (Flavell, Miller & Miller, 1993). The children can now conserve and classify, they are no longer bound by egocentrism or perceptual centration and can follow the successive movements of a transformation. The concrete operational child can conserve in all forms, number, area and liquid. Multiple classification is mastered by children in the concrete operational stage. This is when children have the ability to classify objects on more than one dimension such as colour and size. Class inclusion is also another classification system that is understood by children in this stage. Understanding transformations is a development, which takes place in the concrete operations stage. The child can now produce replications of the transitions between initial and final states of things such as a stick falling over. They can also order objects in hierarchical structures called seriation. The child can rank objects in terms of dimensions such as height. This helps them to deal with numbers and mathematical problems (Le Francois, 2000).
However, the sample (N = 50) selected for the study whose age range varied from 13 to 15 years on the CCT performed at 60.94%, indicating that even at the highest age range of 15 years, CVH selected for the study has not fully attained the concept of classification, seriation and conservation.

Thus, it is evident that there is a definite developmental lag among CVH with respect to overall attainment of cognitive capabilities selected for the study. This is further clarified from the analysis of performance of CVH on individual task of Cognitive Capabilities Test – CVH.

5.4.2 Performance on Cognitive Capabilities Test – CVH – Taskwise

As the concrete operational stage is marked by various sub-stages, below texts give details on the performance of CVH on the four selected tasks for the study.

5.4.2.1 Performance on Classification Task

Classification forms the basis for further complex mental operations determining cognitive capabilities. Classification skills are considered prerequisite to any meaningful number work, (Robert et.al., 1998). Class inclusion with ‘singular class’ and ‘complimentary class’ as well as ‘null class’ is considered as pre requisite to meaningful counting and operations involving numbers. Hence, this particular task that gauges the attainment of notion of singular class and complimentary class at the concrete operational stage was selected. Aim of the classification tasks was to determine whether CVH across the ordered
development of classification as described by Piaget and Inhelder (1964) for Sighted children. Graphic and non-graphic collections, class inclusion and hierarchical classification, complementary and multiplicative classification, singular and null class are the various aspects of classification that were studied by Piaget and Inhelder and the details of their analyses is available in their publication - “Early growth of Logic in the Child” (1964). Though a number of tasks are available to test the attainment of classification, after a careful review of the original tasks only one task – ‘Identification of Odd thing in a Group’ was considered relevant with the focus of the study and hence, selected.

Piaget (1964a) has reported a study on the development of the notion of a 'complementary class'. A complementary class is one which may be combined with a given class. This links up, according to Piaget, with the specific problem such as that of the 'singular class', and the 'null class' etc. The notion of a 'unique specimen' is structured by operations of classification. It therefore takes the character of singular class because of the systematic compliment involved, (p.124). This is indicated by expressions such as the 'others' or 'different'; 'not of the same colour/use' (both positive and negative kinds are possible) in classification. Piaget (op cit) studied the development of notion of 'singular class' among the Sighted using a set of geometrical shapes among which the child has to find 'the one that is different'. This problem is often referred to as 'the oddity problem'.
Description of the task

To study the development of notions of ‘singular class’ in CVH, the task ‘Identification of Odd Thing in a Group’ was adapted for CVH from the MCCT by the investigator. MCCT was developed by Padmini (1983). The task consisted of four items and was presented verbally to the child. Two main reasons for making the test item purely verbal were: (i) to avoid the unnecessary confusions that may arise in the tactile classification for CVH, (ii) to analyse different modes of reasoning in classification – perceptual, functional and nominal modes.

Perceptual (P) – classification on the basis of immediate phenomenal qualities such as size, shape; or on the basis of positions in time or space.

Functional (F) – classification on the basis of function of the items considering either what they do or can be done to them.

Nominal (N) – classification based on the name of kind of the items that exists in the language used.

Each child had to identify the item in the group which is different from others. In other words, the task consisted of grouping three items out of four based on a criterion and indicate/justify the reason for remaining particular item. The four items are given below:

i). Parts of the body vs. spectacles (eyes, ears, nose and spectacles)
ii). Writing materials vs a pair of scissors (pen, pencil, piece of chalk, and a pair of scissors)

iii). Class-room furniture vs teacher (Table, chair, bench and teacher)

iv). Clothes vs detergent (shirt, sari, towel and soap).

Items were presented to the child by mixing the options (e.g. eyes, ears, nose and spectacles) in an item ensuring that the odd thing was not very obvious (e.g. eye, ear, spectacles and nose). After presenting each item following questions were asked – “How are these alike? Is there any item that does not belong to the group? How is it different from the group?” etc. The interviews were scored on the basis of the qualitative judgments of the children for identifying the ‘odd thing out’ (e.g. ear – through eyes, we see, we use spectacles for seeing and nose is required when we wear the spectacles, whereas with ears we listen)

Description of stages

Stage I: No Answer (NA) – Children were unable to respond to the task. They were unwilling, withdrawn and felt shy to respond. Some of them were not able to point out the odd thing and did not respond. On the whole these children were not able to perform the task.

Stage II: Illogical Answer (IA) – Children could identify an element as ‘different’ (whether right or wrong), in the group, but could not justify the criterion with sound logic.
Stage III: Logical Answer (LA) – Children could justify their response with sound logic, reasoning was observed in their response. Further, children of this group were classified based on their modes of reasoning – perceptual, functional and nominal.

Percentage Analysis

From Table 53, it is revealed that

- development of the notion ‘singular class’ is not gradual with the grade levels.
- in all four items the result is not consistent in terms of grade with most of inconsistencies are observed at the grade level VI.
- except for in item 4 there is a gradual decrease in the illogical answers given by CVH. Interestingly, the highest illogical answer for item 4 is observed in the upper grade level of VII.
### Table 53

**Performance of CVH on Identification of odd things in a group**

**Percentages of Children in stages and sub-stages**

<table>
<thead>
<tr>
<th>Grade Age Range</th>
<th>Item 1</th>
<th>Item 2</th>
<th>Item 3</th>
<th>Item 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 to 15 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VII N=10</td>
<td>- 10</td>
<td>60 30</td>
<td>- 10</td>
<td>60 10</td>
</tr>
<tr>
<td></td>
<td>(90)</td>
<td>(90)</td>
<td>(90)</td>
<td>(90)</td>
</tr>
<tr>
<td>VI N=10</td>
<td>8 -</td>
<td>60 25</td>
<td>8 -</td>
<td>60 25</td>
</tr>
<tr>
<td></td>
<td>(85)</td>
<td>(85)</td>
<td>(80)</td>
<td>(80)</td>
</tr>
<tr>
<td>V N=30</td>
<td>- 7</td>
<td>33 61</td>
<td>- 20</td>
<td>33 29</td>
</tr>
<tr>
<td></td>
<td>(98)</td>
<td>(98)</td>
<td>(80)</td>
<td>(73)</td>
</tr>
</tbody>
</table>

N= 50 * The figures in brackets are the totals of stage III
### Table 54

Performance of CVH (Boys) on Cognitive Capabilities Test – Classification Task

<table>
<thead>
<tr>
<th>Grade Age Range</th>
<th>Item 1</th>
<th>Item 2</th>
<th>Item 3</th>
<th>Item 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
<td>Stage III</td>
<td>Stage I</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>IA</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>VII</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>N=5</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VI</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>N=5</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>V</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>N=15</td>
<td>14</td>
<td>11</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total N</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>%</td>
<td>4</td>
<td>4</td>
<td>92</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 55

Performance of CVH (Girls) on Cognitive Capabilities Test – Classification Task

<table>
<thead>
<tr>
<th>Grade Age Range</th>
<th>Item 1</th>
<th>Item 2</th>
<th>Item 3</th>
<th>Item 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
<td>Stage III</td>
<td>Stage I</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>IA</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>VII</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>N=5</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VI</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>N=5</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>V</td>
<td>-</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>N=15</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Total N</td>
<td>-</td>
<td>2</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>%</td>
<td>8</td>
<td>8</td>
<td>92</td>
<td>8</td>
</tr>
</tbody>
</table>
the three modes of thinking – P, F, N are neither uniform nor dominant in their occurrences in four different items, implying that CVH reason out the singular class differently in different situations

- highest 80% functional mode of thinking is observed for item 2 and with a least 10% for item 3. CVH in the lower grade have shown a higher functional mode of thinking with respect to item three when compared to the CVH of upper grade level.

- perceptible mode of thinking is clearly dominant for classifying in the items 1 and 3.

- nominal mode of thinking is completely absent for item 2 and is highest for item 3

- overall, there is a gradual increase in the attainment of stage III for each item among all the grade levels.

Further, from Table 54 and Table 55, that shows the comparative performance of CVH boys and girls on the classification tasks reveals that:

- girls have performed on all the classification tasks where as there is a gradual decrease in NA among boys with respect to grade thus indicating absence of stage I among girls.

- boys show highest number of illogical answers for most of the items with a maximum of 40% for item 3 in comparison to girls who show highest of 40% for item 3.
• girls have performed better on item 2 and item 4 whereas boys have performed better on item 3. Boys and girls show attainment of stage III at an equal level with highest of 92% for item 1. For the remaining items attainment of stage III is not consistent indicating that boys and girls think differently in different situations

• girls show a dominance of functional mode of thinking in comparison to boys with majority showing perceptible mode of thinking for all the items

• interestingly, girls and boys both show a gradual decrease in the attainment of stage III with respect to age.

**Qualitative observations**

As all the four items differ from each other in terms of the different types of elements used in the classification, responses show a great variation in the type of thinking mode applied for classifying the items.

a). It is observed that more of perceptible mode of thinking is applied in classifying the elements for item 1 – ‘The parts of the body and spectacles’ in comparison to functional mode of thinking. Most of the answers could be categorised as - Ear, Eyes and Nose are the parts of the body and spectacle is an object. Some unique answers such as - Spectacles is a solid object and Ear, Eyes and Nose are parts of the body and answers like spectacles are used by few people whereas Ear, Eyes and Nose is present in everyone, though helped in correct classification
of the items but the reasoning was more based on the generic use of the terms and properties of the items. Certain illogical answers such as spectacles is made of glass and shiny and eyes are small, nose is long and ear is round helped the child to classify the items correctly however without sound logic for classification. Further, it is observed that boys (4%) have given lesser illogical answers in comparison to girls (8%). Both boys and girls show a dominance of perceptible mode of thinking for classifying and girls show a slightly higher rate of functional thinking capability in comparison to boys with this item.

b). Item 2 shows a reverse mode of thinking from item 1 with functional mode of classification applied for classifying elements of item 2 – ‘Writing materials and a pair of scissors’. The most prevalent answer was – Chalk, Paper and Pencil are used for writing whereas scissors is used for cutting. Girls (92%) show a higher rate of functional mode of thinking in comparison to boys (64%) I attainment of stage III with respect to this item. There is a gradual increase in Stage III with respect to Grade. Though a slight decline is observed in Grade VI, it is picked up in Grade VII. Further, most illogical answers were elicited at Grade VI. Illogical answers were mostly based on the material property of the items e.g.: Scissors is made of iron and others are not. Scissors is not used for reading whereas all other items are used for reading; Scissors is a solid object whereas other items are not; Paper is thin and others are not etc. Boys (32%) have given more illogical answers in comparison to girls.
(8%). Also, boys (16%) show higher rate of perceptible mode of thinking in comparison to girls (4%). Similar observations were noted by Mandarvalli (1990) with respect to the above two items – ‘The parts of the body and spectacles’ has elicited a greater use of perceptible and a lesser use of functional attributes as the basis of the grouping. But it is reversed in the item 2 – ‘writing materials and a pair of scissors’. The steady increase in the percentage of VH with their age is clear in both the tasks.

c). Relative use of perceptible, functional and nominal mode of thinking is clearly seen in the performance of CVH on item 3 – furniture vs teacher. With perceptible mode of thinking being dominant, the item has also elicited illogical answers. There is a clear gradation in stage II with a decrease in illogical answers with respect to Grade. Further, there is a clear increase in the attainment of stage III with respect to Grade. There is a decline in the attainment of stage III at Grade VI with a predominant perceptible mode of thinking for classifying the elements. However, an increase in the attainment of stage III with increase in functional mode of thinking is also observed. Boys (84%) show a higher rate of attaining stage III in comparison to girls (64%). Girls (40%) show a higher number of illogical answers in comparison to boys (12%). Also, boys (60%) predominantly show perceptible mode of thinking for this item. Nominal mode of classification is quite evident for this item. Classification is mainly based on the conventional name rather than the functions of the teacher...
or the furniture in the room. Most of the answers received belonged to the group – teacher is a human being and others are not and also, teacher teaches and other objects are made of wood. Nominal mode of classification is comparatively higher among boys (24%) than girls (8%). Classification based on the premise – Teacher talks and chair is small, table is round and bench is square; teacher is hard and other objects are also hard but teacher is different from the other objects; teacher moves and other objects remain there; teacher sits on chair and all other objects are made of wood; teacher teaches and other objects do not, though helped the child to classify the elements correctly was not reinforced by meaningful logic.

d). In item 4 – 'clothes vs. detergent', functional mode of classification is predominant. Interestingly, stage II – illogical answers seem to be quite apparent for this item. This could be because of the linguistic labels used in the elements – shirt, towel, soap and sari. For boys, sari seems to be the element that did not belong to the group as boys used all other items whereas girls used sari. There is a gradual increase in the perceptible mode of thinking and illogical answers with increase in Grade. Soap is for washing/bathing and others are to wear was the most common answer. However, answers like girls wear sari and all other items are used by everyone was also quite common. Also, answers based on size of the elements were also observed wherein sari was the odd thing out on the basis that it was too long. Girls (80%) have performed better than boys.
(52%) and also, girls (76%) have used more of functional mode of classification in comparison to boys (52%) whose predominant thinking mode seems to be nominal (8%) and perceptible (8%).

e). It is quite clear that for CVH the linguistic labels guide how things will be classified. The growth of different modes of thinking can be quite independent of each other, depending on the experiences with the materials/items CVH have. In other words as Mandarvalli (1990) remarks, CVH could be clearly using all the three modes of classification within the limits of their own experiences in their daily life.

Thus, the differences in styles of thinking are remarkably inconsistent throughout the four items of the Classification task. CVH have resorted to perceptible, functional and/or nominal mode of thinking based on the elements presented to them in the item. It is very difficult to infer whether the concept formation (in terms of complementary class vs. singular class) in CVH proceeds by differences more than by similarities or vice versa. In order to classify an element in terms of what it is not, CVH were aware of the common criteria attributes among all the other items to form a group, hence, it appears that the development of notions of ‘singular class’ and ‘complementary class’ are parallel achievements among the CVH.

**Interpretations**

Overall, it can be said that the attainment of notion of ‘singular class’ is highest among the lower grade level with a dominance of functional mode of
thinking. With the increase in grade a trend of reverting to more of perceptible mode of thinking and classification without sound reasoning is observed. The observation is not consistent with the results noted by other researchers. Mandarvalli (1990) administered three classification tasks – classification of shapes, classification of models and odd thing in a group on 190 CVH children. Major findings of the study clearly indicated that in all the three tasks selected for the study the sub stages found among CVH to attain operational level of thinking (Stage III) corroborated with the sub-stages of Piagetian theory for the development of classificatory abilities; but with a clear developmental lag with respect to their grade. Further, it was also observed that, the transitory stage was markedly low in all the three tasks compared to stage I and stage II.

The findings of the above studies confirm that children pass through the main stages of developing the concept of ‘Singular Class’ as described by Piaget, but they also indicate the variations in the attainment of classificatory abilities. In some studies by (Hooper & De Frain., 1974) it was concluded that stage II does not exist separately or stage II merges with stage I at least for some children.

As reported by Piaget, the results of the oddity problem as identified by giving the triangles and diamonds for classification were summarized as: Three stages were observed. In the first, corresponding to stages I and II and ages 5-7, there was a 50% level of success, but either no understanding of the system, or only partial understanding. These successes were entirely due to sensor-
motor learning. At stage IIIA, corresponding to ages 7-9, there was a 75% level of success, combined with understanding of the system. At stage IIIB, corresponding to ages of 10-12, the percentage of success fell to 33% because of a tendency to introduce imaginary complications. Emphasising the relation of complementarity with that of inclusion states that first of all, a pre-operational form of "otherness" exists before inclusion is established. At the pre-operational level, when "classes" are only foreshadowed by intuitive, pre-conceptual "collections", the notion of a singular class cannot be grasped, because it contradicts the very idea of a "collection". A child of 5-7 years may, of course, solve the practical problem of singling out "the one that is different" in the course of a series of presentations in which its relationship with other elements is varied. But there is no intensive classification involved and it is only at 7-8 years, i.e. at the stage of operational complementarity, that a singular class is treated in the same way as other classes.

The overall picture that emerged in the present study shows an adoption of different modes of thinking in different situations of classification. With respect to identify the perceptual differences, preferences for functional attributes, and using linguistic labels to classify the items, CVH are in sharp contrast to the Sighted. CVH exhibit functional mode of thinking even at an earlier age marked by abstract reasoning rather than linking perceptual attributes of an object. CVH are more likely to refer to function in terms of their personal interaction with the items.
Mandarvalli (1990) summarising the 'oddity problem' concludes that – a Sighted child starts by dealing with objects in terms of their perceptible and concrete characteristics. He then considers them in the light of what he can do with them. In time, he is led to more abstract formulations as to how things are, how they are alike and different. Unlike the Sighted child, the CVH, due to lack of vision, does not experience the uniqueness of events, objects and people in terms of their functions (uses) as they come normally to his sphere of experiences. CVH has no alternative experiences to choose from. Most of his experience being purposive, the influence of incidental learning through visual channel is absent in his development. Hence, it can be inferred that they unavoidably concentrate on the functional attributes of the objects/events; if functional thinking is to be considered a higher order 'epistemic process' than perceptual thinking, then the Children with Visual Handicap has an inherent strength to develop functionalism among CVH at an early age itself.

Thus, from the above analyses it could broadly be concluded that the main sub-stages – No Answer, Illogical Answer and Logical Answer are found among CVH in the development of notion of 'singular class' as Piaget has described, with a developmental lag in their age. The use of three classification-thinking modes – perceptual, functional and nominal among the CVH depends on the nature of the items and experiences of the items presented but not hierarchical from perceptual to functional.
5.4.2.2 Performance on Seriation Task

The aim of Seriation tasks was to determine whether the same stages are demonstrated in the development of Seriation among CVH as Piaget (1952) has reported on Sighted children in his books the ‘The Child’s Conception of Number’ and ‘The Growth of Logic in Children’ (1964). Implicit in Piaget’s experiments on number is his assumption that conceptualising ability derives from the internalisation of the child’s classification, ordering/seriating and counting/numeration actions – actions that give rise to class, relations and arithmetic operations (coordinating cardinal and ordinal number). Piaget has worked on length, area, volume and multiple seriation to enumerate the attainment of seriating abilities among the Sighted children. As the objective of the study was to inquire into the development of arithmetic skills among CVH, mental operations that were relevant for the purpose was chosen hence, only Length Seriation was considered for this study.

Task Description

The task consisted of two situations presented one after another, asking the CVH to arrange the materials in a row (the differences in sizes being fairly clear), from the shortest to the longest or vice versa. The materials used in each situation is detailed below:

Doll Seriation: Seven dolls graded in height and size

Stick Seriation: Seven sticks graded in length + 3 sticks for insertion
Description of stages

The stage classification of I, II and III were given to the subjects for the two situations of the task as follows:

Stage I: Failure in Seriation – Children could not seriate at least three items in the set

Stage II: Success by trial-error – Children could seriate three to four items correctly but, on trial and error could complete the whole series

Stage III: Systematic Operational Seriation – an operational Seriation was observed in children, without any doubt/error.

Doll Seriation

In this situation, the child was presented with seven dolls of graded height and was asked to arrange them in an order of biggest to smallest or vice versa. Classroom bench top was considered as the base reference for this item. As such, the child had to distinguish the height from the top of the given elements and organise them in an order. Further, the child was asked to pick the biggest and smallest doll from the arranged series. Table 56 gives the details of CVH performance on this situation.
Table 56

<table>
<thead>
<tr>
<th>Performance on Items</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>All incorrect</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>1 item correct</td>
<td>11</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>2 items correct</td>
<td>9</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

From Table 55 it can be observed that -

- Stage I is absent among girls and boys show a 20% failure in seriating the item.
- Girls show a higher performance in stage II of success by trial and error in comparison to boys.
- Again, girls (52) show attainment of operational Seriation at a higher rate in comparison to boys (44%).

Overall performance of 42% at stage III indicate that the item is not easy for both boys and girls and that there is a lag in the attainment of this mental operation of seriating the doll in a given order.

**Stick Seriation**

In this situation, the child was presented with seven sticks of graded length and was asked to arrange them in an order of longest to smallest or vice versa. There was no base reference for this item. As such, the child had to distinguish the length first by forming a base reference and then gauging the variation of the length of each element and organise them in an order. Three
more sticks were given for insertion, and the child was asked to insert the sticks in the previously arranged series so that the order from shortest to longest or vice versa is maintained. The child was also asked to confirm the series in the order of shortest to longest or vice versa and further the child was asked to pick the shortest stick and the longest stick. Table 57 gives the details on performance of CVH on this situation.

Table 57

<table>
<thead>
<tr>
<th>Seriation – Sticks</th>
<th>Performance on Items</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>0 performance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 item correct</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2 items correct</td>
<td>6</td>
<td>24</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>3 items correct</td>
<td>8</td>
<td>32</td>
<td>13</td>
<td>52</td>
</tr>
<tr>
<td>4 items correct</td>
<td>11</td>
<td>44</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

From Table 56 it is revealed that -

- Absence of stage I among both boys and girls indicate that CVH at grade V are prepared to seriate the given items operationally.

- Overall attainment of stage II (66%) in comparison to stage III (34%) indicate that even though CVH at grade V are prepared to seriate operationally cannot do so fully and still try by trial and error.

- Boys (44%) show a higher rate of attainment of stage III in comparison to girls (24%) indicating that operational level of thinking is better among boys than girls.
Overall score of 34% on the length Seriation at operational level indicate that not all children among CVH who have reached the grade V and beyond as prescribed by Piaget have attained operational level of thinking in terms of Seriation.

**Qualitative Observations**

In spite of considerable individual differences, results on two situations of length Seriation are coherent. The qualitative observations on the performance of these two situations revealed that –

- CVH (20%), at stage I could not arrange the dolls in an order in spite of the presence of base reference implying that they lacked the direction and exactness.

- At stage II CVH showed coherent performance in both the situations - doll Seriation and stick Seriation. Largest number of CVH was found in this stage for both the items. It was observed that initially CVH tries ordering the dolls from biggest to smallest by comparing the size and then when question to pick the biggest and smallest was asked, got confused and reordered the whole series including the two elements given for insertion, however, the final result was correct and could explain the arrangement of series and picked the biggest and smallest doll. Similar observations were made for stick Seriation, wherein they tried by keeping the table top as the base reference and then holding all the sticks in one hand and through comparison arranged the sticks in an order. Insertion was done similar to doll
Seriation by regrouping the sticks and reordering them by repeated comparison. Finally, through trial and error Seriation of stick was achieved.

- At stage III operational serration was clearly observed by the method adopted by CVH in order to seriate the given sticks including insertion. In both the items CVH started with the longest element and then through repeated comparison of one element at a time with the longest item started arranging the sticks on the table. They continued the action by keeping base as the reference to find the next longest/tallest element and then placing them on the table very tactfully. It was interesting to note that they did not bother about the base line of the series of sticks while laying on the table and were sure that the organisation was right. Upon probing – “how do you know the arrangement is correct?”, they answered the question by feeling the base of the sticks and reassured that the ordering was right. Similarly for dolls they felt the top of the element and by feeling and keeping in mind the tall range assured that the ordering was right. For insertion of elements (sticks), the given element was compared to each individual element already placed on the table and was inserted properly. After inserting all the elements verified the series for for sticks first by organising the baseline and then feeling the heads of the sticks. Even, for answering the questions – which is the longest stick? Which is the smallest stick? CVH used the comparison method and first pointed the longest stick and then the shortest stick. Thus, there was a clear indication of operational Seriation in this stage.
Interpretations

Inhelder and Piaget (1959) studied the development of length seriation in 88 Sighted children of age between 4 and 9 years. The results are given in the following Table 58.

Table 58

<table>
<thead>
<tr>
<th>Stage</th>
<th>Age (N)</th>
<th>4 (19)</th>
<th>5 (33)</th>
<th>6 (19)</th>
<th>7 (10)</th>
<th>8-9 (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>-</td>
<td>84</td>
<td>54</td>
<td>42</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>-</td>
<td>16</td>
<td>40</td>
<td>36</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>III</td>
<td>-</td>
<td>0</td>
<td>6</td>
<td>22</td>
<td>80</td>
<td>86</td>
</tr>
</tbody>
</table>

Further, Inhelder and Piaget (op cit) have reported the findings on tactile Seriation, and its anticipation in drawings on Sighted children in which most of the tactile results lagged behind the visual Seriation. According to them, operational schema of Seriation is necessarily anticipatory. The subject knows in advance that by choosing the smallest element among those that remain, he will eventually build a series in which each term is larger than the preceding ones, which is why he is able to avoid any errors or inconsistencies. With maturation, operationality of ordering the series by choosing the longest first and the again the longest among the remaining ones begin and this marks the emergence of stage III.

The present study also shows similar results wherein the attainment of stage II - seriating by trail and error is prevalent among CVH in VII grade and the emergence of stage III at VII grade however, with a definite developmental lag of
around 6-7 years of age. This finding cannot be generalised as the sample of the study is small and the observation of performance of each child is important. Mandarvalli (1990) in her study on 190 CVH children observed that CVH too encounter similar sub-stages in the acquisition of Seriation with a developmental lag in their age. Though her study found that there was 100% percent attainment of length Seriation (operational Seriation) in thirteen and fifteen years, the present study shows that only 34% could attain stage III in stick Seriation and 42% could attain stage III in doll Seriation.

Piaget drawing conclusion on parallelism in development of Classification as a whole and Seriation as a whole states that Seriation correspond closely to a highly acceptable “good” perceptual form, unlike classifications which do not, conversely, classificatory structures are constantly being reinforced by the syntactical structure of the language. The development of Classification and Seriation is marked by similar turning points, at ages, which are roughly parallel. In both the cases stage I where the establishment of relations is successive, a stage II where the problem may be solved, but the method is pre-operational, and a stage III, where the ascending method and descending method are co-ordinated.

Observations from the current study confirm that the CVH attain the stages and sub-stage of Classification and Seriation as described by Piaget however, with a definite developmental lag in their age.
5.4.3 Performance on Cognitive Capabilities Test – CVH - Conservation Tasks

Piaget considers Conservation as a necessary condition for any rational activity. Arithmetic thought is no exception to this rule. A set of collection is only conceivable if it remains unchanged irrespective of the changes occurring in the relationship between the elements. A number is intelligible if it remains identical with itself, whatever the distribution of the units of which it is composed. A continuous quantity such as a length or a volume can only be used in reasoning if it is a permanent whole, irrespective of the possible arrangements of its continuous parts. In other words, whether it be a matter of continuous or discontinuous qualities, of quantitative relations perceived in the sensible universe, or of sets and numbers conceived by thought, whether it be a matter of the child's earliest contacts with number, in or of the most refined axiomatizations of any intuitive system, in each and every case the conservation of something is postulated as a necessary condition for any mathematical understanding.

According to Flavell's (1977) definition – “Conservation is the cognition that certain properties (length, number, quantity etc) remain invariant (are conserved) in the face of certain transformations (displacing objects or object parts in space, sectioning an object into places, changing shape etc)”.

On the basis of extensive studies Piaget has identified three stages of development of Conservation as follows:
Stage I: Non-Conservation (NC) – Children are not aware of the invariant aspects of properties of objects in the face of transformation.

Stage II: Transitory Conservation (TC) – Children are aware of invariance of properties of objects in the face of transformation partially. Gradually they tend to give non-conservation responses due to the dominance of perceptual appearances of the objects in the transformation.

Stage III: Complete-Conservation (CC) – Children are totally aware of the invariance of the properties of objects in the face of transformation. Operational thinking is established.

To assess the attainment of Conservation among CVH, two Conservations tasks from five Conservation tasks of MCCT was selected for the study. They are: Conservation of Number and Quantity.

5.4.3.1 Performance on Conservation of Number

"The child’s concept of number" by Piaget (1952), is a theoretical treatise with supporting empirical results describing in detail the sequence of the development of the Number concept. According to Piaget two ideas that are basic to an operational understanding of Number are “one-one-correspondence” and “conservation”. Various levels of correspondence has been explained by Piaget – a child progressing from intuitive global perception through intuitive qualitative correspondence achieves logical coordination of relationships into numerical correspondence. Psychologically, to make a correspondence is
merely to systematize judgments of resemblances and difference. Emphasizing on the mathematical correspondence, Piaget states that—whether it be the elements as such or the relations that are being considered, in order that there shall be the transition from qualitative to numerical correspondence, a process of reasoning that goes beyond mere qualitative logic is necessary. It is the construction of units, which are at the same time equal to one another and susceptible of Seriation, and this construction takes place through the equating of differences. Then, a class is in fact, a union of terms seen as equivalent irrespective of their differences. Therefore, the construction of number consists in the equating of differences, i.e. in uniting in a single operation the class and the asymmetrical relationship. The elements in question are then both equivalent to one another, thus participating of the class, and different from one another by their position in the enumeration, thus, participating of the asymmetrical relationships.

**Description of the Task**

Task from the Original MCCT (vide Supra 4.2.3) was adopted for the current study and was presented to the CVH with a slight modification in number of tumblers (original – 8, study – 10) and number of situations (original – 4, study – 3). Premise for increasing the number of tumblers from 8 to 10 was based on the arithmetic skill of counting (1 to 10). As finalized ADT (Vide Section 4.2.1.4) had an item on counting the dots in a range of 1 to 9, and further the arithmetic operations consisted of working on ‘tens’, hence, it was thought useful to test the
one-to-one correspondence of items 1-10. The task consisted of presenting ten tumblers and ten spoons. Initially the child was asked to establish "one-one-correspondence" by keeping one spoon in each of the tumblers kept in a row (where the child found it cumbersome to manage the number of elements, the child was asked to count the number of tumblers and then the number of spoons and the question was asked to state whether the number of spoons and tumblers were equal). Further, two situations were presented by taking out the spoon from the tumblers and arranging them 1. in a line horizontally in front of the tumbler, 2. like a flower. All ten tumblers were retained in their original position in a line for comparison; the child was asked conservatory questions in each situation with respect to number of spoons and number of tumblers as Piaget did in his experiment.

**Description of the stages**

Table 59 gives the details of three main stages observed in CVH based on their qualitative judgments and explanations during the administration of the task. Further, under stage III, two modes of thinking - Identity and Equality were observed, the typical responses are also presented in the below Table.
Table 59

Description of Stages in "Conservation of Number"

<table>
<thead>
<tr>
<th>Stage</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>No Answer (NA)</td>
<td>Those who were reluctant to reply; I don't Know' answers; who could not establish even one-to-one correspondence.</td>
</tr>
<tr>
<td>Stage I (NC)</td>
<td>Non-Conservation</td>
<td>Answers dominated by fantasy, imagination or verbalism; logic is totally absent. For ex: &quot;I can understand as you 'see' it&quot; concentrates on perceptual attributes of elements.</td>
</tr>
<tr>
<td></td>
<td>(i) Romancing Answer (RA)</td>
<td>Intends to interpret the situations marked by illogical answers. (For ex: &quot;They are not same because tumblers are big and spoons are thin&quot;, &quot;because spoons go inside the tumblers&quot;, etc.)</td>
</tr>
<tr>
<td></td>
<td>(ii) Wrong Answer (WA)</td>
<td>Conservatory answers for one or two situations; but wrong answers for the subsequent situations.</td>
</tr>
<tr>
<td>Stage II (TC)</td>
<td>Transitory Conservation</td>
<td>Operational thinking in judging the invariance of number.</td>
</tr>
<tr>
<td></td>
<td>(i) Identity Thinking</td>
<td>The 'sameness' of number is ascertained; they are same as nothing is added or removed from the 'original set' 'Arrangements may be different, but they are same because they were same earlier'.</td>
</tr>
<tr>
<td></td>
<td>(ii) Equality Thinking</td>
<td>The 'equal number' in both the sets is ascertained 'one tumbler has one spoon so both are equal'; 'there are eight tumblers and eight spoons, so they are equal'.</td>
</tr>
</tbody>
</table>

Percentage Analysis

Table 60

Performance on Task – Conservation of Number

<table>
<thead>
<tr>
<th>Stages</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>No response</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-conservers (NC)</td>
<td>3</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Transition conservers (TC)</td>
<td>7</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>Complete conservers (CC)</td>
<td>15</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

444
Table 60 gives the details of percentages of CVH at each stage of development with respect to their grade. Considering the three main stages of conservation – NC, TC and CC following inferences could be drawn from the Table 58:

- There are none in the category of NA implying that none of the participant showed reluctance in involving him or herself in the task.
- There is a steady increase in the percentage of CVH in stage III and a steady decrease in stage I among CVH implying a gradual development of Conservation of Number.
- The number of CVH in TC is half of the total sample considered for study. Of the total conservers, boys (60%) show a higher performance when compared to girls (40%).
- Boys (28%) are lesser in stage II in comparison to girls (52%). Overall, 40% TC imply that though intuitive qualitative correspondence is set in but fails to progress to numerical correspondence.

Qualitative Observations and Interpretations

- Non-Conservatory Answers

CVH who were unable to give the correct number of tumblers and spoons within the situations presented to them fell into this category. Though non-conservatory answers were observed for the situations wherein the arrangement of spoons varied, correct answer for one-to-one correspondence was observed,
implying attainment of intuitive qualitative correspondence however failing to progress to numerical correspondence by logical co-ordination of relationships as stated by Piaget.

Most of the answers were based on either the properties of the elements or the shape of the arrangement viz. - spoons are arranged in a long shape; spoons are arranged in round shape; height of the tumblers is more than the spoons. Similar observations were made by Mandarvalli (1990) in her study - CVH who did not show number conservation fell into two categories - Romancing and Wrong answers. Several CVH relate their answers to their previous experiences without considering the situations of the task (for eg: there were lot of spoons and tumblers in the kitchen) Further, though answers were incorrect, there existed some logic for eg: the spoons are more because they are taller than the tumblers; or tumblers are more because the spoons can go inside the tumbler etc.). The dependent variable here is perceptual arrangement rather than the number of elements in the task.

Piaget (1952) describes stage I as level of intuitive global perception without lasting equivalence of corresponding sets. According to him, although the method of global comparison allows for a rough comparison between two sets of the same form, becomes inadequate as soon as the properties of the sets differ substantially. Two sets, which the child has stated to be identical by global comparison, are no longer considered equivalent when the elements of one set are spaced out. He cannot understand that when there is a change in
the shape, and therefore in the distribution of the parts, something remains invariant, namely the number of elements. The reason is that he has not yet acquired the notion of number, but only perceptual wholes. Therefore, the notion of conservation of the set is lacking because the elementary relationships inherent in the global perceptions are merely juxtaposed instead of being coordinated.

It can be seen that initial one-to-one correspondence is lost when the arrangements of spoons is changed and only perceptual qualitative factors are considered by CVH for answering the conservatory answers for this item.

**Transitory Answers**

Most of the answers elicited for the situations in which the arrangement of spoons varied were — spoons are more as the length (of arrangement) is more; more spoons are used for making the shape of a flower; tumblers are more (when spoons were arranged in the shape of a flower); cups/ spoons when spread out take more space hence are more.

Piaget (1952) did experimented with bottles and glasses and found similar results (glasses are more (when bottles were grouped); bottles are more (when glasses were grouped). He described intuitive qualitative correspondence as the characteristic of this stage. A slight progress in the precision of thought can be seen in this stage. Intuitive correspondence without lasting equivalence makes the child think that number of elements change with a change in
configuration and ceases to believe in the constancy or correspondence of the sets.

Observations from the current study conform to the characteristics of Stage II as stated by Piaget.

**Conservatory Answers**

Performance of CVH showed the dominance of operational correspondence of elements involved in the task. Answers were based on counting the number of spoons and number of tumblers irrespective of the changes in the arrangement. Some of the CVH rearranged the number of spoons for counting. "No matter what ever shapes you arrange the spoons, number of tumblers and spoons will remain the same" was the most common explanation provided for the equal count of spoons and tumblers.

Mandarvallii (1990) reported similar observations – “no matter whatever arrangements you make with spoons, they are ‘eight’ and there are ‘eight’ tumblers; so both are equal. She observed two types of explorations – Identity and Equality among CVH regarding this task with CVH concentrating more on the equality of sets than the identity of the elements. She argues that the absence of visual channel (to take note of different perceptual arrangements of the task) leads CVH to ascertain the equality of two sets without confusion as it is commonly observed in Sighted children.
Piaget (1965) reasoning the development of stage III states that – this stage represents a definite progress: correspondence leads to necessary and lasting equivalence. The sets are now assumed to be equivalent, whatever the configuration or the distribution of the elements. Fundamental factor of this development is the complete reversibility of the action involved in the child’s procedure. The operation he performs is no longer immediately absorbed in the intuitive result obtained. It frees itself, as it were, and becomes capable of moving in reverse. Each transformation can be compensated by its inverse, so that any arrangement may give rise to any other, and conversely. Thus, instead of relying on perceptual attributes of an element, the child proceeds exclusively by reference to the one-one correspondences, and thereby succeeds for the first time in decomposing the wholes and co-ordinating the relationships. This system serves as the principle of generalization of qualitative correspondences or logical-co-ordination of relationships into numerical correspondence, in which each element irrespective of its qualities, is considered as a unit equal to the others and differing from them only by its temporary position in the series.

An adapted study of original number task by Good (1973), and replication studies by Elkind (1961) and Dodwell (1960) on Sighted have supported Piaget’s findings. A conservation study on CVH in India by V. Sharma (1988) parallels the findings of the present study supporting not only the developmental stages but also the developmental lag with respect to age of CVH.
Thus, it can be concluded that CVH follow the same sequences of developmental stages as ascertained by Piaget for normal children in attaining the conservation of number however, with a developmental lag with respect to their age.

5.4.3.2 Performance on Conservation of Quantity

Piaget (1965) in his work (originally published in 1941) on 'The Concept of Numbers' studied conservation of continuous and discontinuous quantities states that the development of notion Conservation of Quantity progresses through the stages of initial perception, through co-ordination of relations marked by the realisation of 'intensive quantities' to the development of 'extensive quantities' through logical co-ordination. He describes these stages as non-conservatory, transition and conservation. In Piaget's view, a child's thinking is largely dependent on perception from 4-7 years of age. During this period thinking tends to be determined by the child 'centering' on one aspect ignoring the other dimensions of the substance presented. But from 7-8 years of age, the child is able to apply logical thought to concrete situations. Piaget maintains that the concepts that figure in logical thought result from the co-ordination of 'actions' in which the child combines, dissociates, orders and sets up correspondences. Child gradually acquires reversible operations in the mind without depending upon perception Piaget (1965).
Description of the Task

The well-known Piaget and Szeminska (1952) 'Sausage experiment' adopted in the original MCCT by Padmini (1983) in her study among Sighted was used for the study with necessary modification to suit CVH. Two identical balls of modelling clay were shown to the child. After the child established initial equivalence of quantity of two balls, one of the balls was then shaped to look like a sausage and the conservatory questions were asked. In subsequent situations, the sausage was turned into shape of a cylinder, and in the last situation the clay was divided into four small balls and then he was asked conservatory questions. The stage classification I, II and III were assigned on the basis of their judgments and explanations. Qualitative analysis of reasoning was also done.

Description of Stages

Stages for this task is similar to as identified for Conservation of Number (i) No answer, (ii) Transitory and (iii) Conservation. Further exploratory stages of Romancing Answer, Identity and reversibility operations are also similar to other conservation tasks as ascertained by Piaget.
Percentage Analysis

Table 61

Performance on Task – Conservation of Quantity

<table>
<thead>
<tr>
<th>Stages</th>
<th>Boys</th>
<th></th>
<th>Girls</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>No response</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Non-conservers</td>
<td>9</td>
<td>36</td>
<td>11</td>
<td>44</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Transition conservers</td>
<td>11</td>
<td>44</td>
<td>6</td>
<td>24</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>Complete conservers</td>
<td>5</td>
<td>20</td>
<td>3</td>
<td>12</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
<td>25</td>
<td>100</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 61 gives the details of percentage of CVH under each stage genderwise.

- There is a gradual decrease in CVH with respect to no answer. Boys have shown inclination to attempt the item and hence, there are none in the no answer group. Girls (10%) have not attempted the item implying that though numerical correspondence might have begun among CVH, still the thinking process cannot relate to the equivalence correspondence with respect to mass.

- A gradual decrease in the number of CVH at stage III shows that there are more number of non-conservers and transitory conservers implying the prevalence of qualitative correspondence of mass and unavailability of the reversibility operation.
• Number of complete conservers is very low (16%) in the total sample of which boys (20%) show attainment of CC better than girls (12%).

• Girls (44%) exhibit non-conservation higher than boys (36%) whereas it is reversed in case of achieving transition stage among boys (44%) when compared to girls (24%).

Qualitative Observations and Interpretations Non-Conservatory Answers

Most of the CVH in this category could comprehend the problem but elicited wrong answers. Wrong answers were dominated by the perceptual attributes of the elements given in the task e.g.: Sausage is flat and hence will need less clay; there are four balls, it will require more clay to make four balls hence, the four balls have more clay; shape of the cylinder is long, and it requires more clay to make long shape, hence cylinder has more clay.

Similar answers were observed by Mandarvalli (1990), wherein the CVH resorted to romancing answer and wrong answer, with wrong answers dominating the stage for e.g.: “This is like a dosa (pancake) which I ate today”; sausage is flat, so it has less clay; snake is longer so it has more clay and so on.

Transitory Answers

A comparatively smaller percentage of CVH could be observed in this stage. Interestingly, the items that were answered correctly was for the initial situation wherein they were required to establish the equivalence of the balls and then further for the situation wherein the balls were divided into four small
balls. In both the situations, amount of clay is the same was the answer. However, for the other two situations wherein the ball was pressed into a sausage shape and cylindrical shape, the answer was based on shape, therefore ascertained that the sausage required less clay and the cylinder required more clay. Hypothetical Reversibility operation could be observed in certain cases wherein the answers were – there is more in clay in the sausage shape, cylindrical shape and the four balls because if you change the shape into the form of a ball the size of the ball will be more as more clay is required to make the shape of a sausage, cylinder and four balls. In some instances, the answers were based on weight – weight of the sausage shape is less hence, it has less clay and weight of the cylindrical shape is more, therefore, the amount of clay is more. Thus, it was observed that there was a clear thinking in explaining the equivalence of quantity in some situations however did not last long and resort to non-conservation answers when the shape of the clay is modified.

Conservatory Answers

Sameness of quantity was established in Stage III by CVH. Piaget's subjects could attest the sameness of the quantity in spite of the variations in shape of clay. They were aware that change of shape did not alter the amount of mass. Two types of reasoning were observed in CVH – identity and reversibility. In both the modes of reasoning an operational thinking about the quantity was clearly indicated. Majority of them justified the 'sameness' of the quantity of clay
in each situation – clearly an identity operation. They were very clear in their answer stating "no matter what shape you make out of the ball, the amount remain same'. When presented with varied shapes, even before the conservatory question was asked, CVH would say that the shape has changed but the amount of clay remains the same. Very few CVH could apply the reversibility reasoning specifically in sausage shape and cylindrical shape situations. Majority of reversibility answers were observed in case of item 4, wherein the answer was – if you combine all the four balls it will make the ball of the same size as that of the other thus, implying the equivalence of mass. This particular observation has been reported by Madarvalli (1990) as well – "I can put all these together to make a ball as it was before and amount of clay will be the same." Thus, it appears that the possibility of ‘inverse action’ depends upon the nature of the situation presented.

It can be concluded that identity reasoning is the basic operation for attaining the notion of clay conservation. Findings by Madarvalli (1990) also support the finding of this study. According to her self-activity of transformation of clay into different shapes facilitates the development of conservation – the identity operation in particular, as the ‘effect of centration’ (the most common error/block in grasping the conversation) is minimised in this, further it appears that lack of visual channel enables the CVH to avoid the errors of centrations and conservation without causing conflicts in their conservation judgments (a characteristic of stage II) leading them from non-conservation stage to conservation stage directly.
5.4.3.3 *Comparison between conservation of number and conservation of quantity*

Percentage of CVH for comparison of Conservation of Number and Conservation of Quantity among CVH were calculated. Results are given in the below table.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Conservation of number</th>
<th>Conservation of quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>No response</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-conservers</td>
<td>12</td>
<td>52</td>
</tr>
<tr>
<td>Transition conservers</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>Complete conservers</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

It is evident from Table 62, that:

- Total CVH CCs with respect to conservation of number (50%) is significantly higher than that of total number of CVH CCs with respect conservation of quantity (16%) implying CVH are better conservers in numbers against conservation of quantity. Even with respect to gender boys (60%) show higher rate of conservation of number in comparison to their (20%) rate of conservation of quantity; girls (40%) also show a higher rate of conservation of number in comparison to their (12%) rate of conservation of quantity.

- There are more number of transition conservers with respect to conservation of number (44%) in comparison to conservation of quantity (34%).
• CVH have shown their inclination to attempt the tasks on conservation of number whereas with respect to conservation of quantity, specifically girls (10%) have not attempted the task.

• Total number of non-conservers with respect to conservation of number is significantly lower than that of conservation of quantity implying that numerical correspondence is achieved quicker than lasting equivalence of quantity. Further, girls (44%) show highest number of non-conservers for conservation of quantity when compared to boys (36%).

Interpretations

Piaget (1964a) in the 'The Early Growth of Logic' infers that conservation of number depends on the adherence to a criterion of number based on the enumeration of objects by taking each once and once only, thereby setting up a one-one-correspondence between the numbered collection and all other collections having the same cardinal value. Similarly, the Conservation of weight argues a criterion based (initially) on the use of a balance. According to him each of these criteria involves an appeal to actions carried out by the subject, and the selection of such a criterion is attributable to the fact that such actions can be anticipated. Thus, attainment of various sub-stages with respect to a task of Conservation infers the development of concepts and actions that are attributable to other concepts of conservation to be achieved at the same stage, however there could be a hierarchy in the attainment of different concepts at the same level for different stages. As is evident from the current study, though
Conservation of Number and Conservation of Quantity shows similar stages of attainment of Conservation, still vary in terms of attaining the attributable actions, which are achieved quicker for Conservation of Number in comparison to Conservation of Quantity.

5.4.4 Attainment of Concrete Operational Stage

The development of conservation among CVH was analysed in this study with respect to two concepts – Number and Quantity.

In both the two tasks, the developmental patterns among CVH agreed with Piaget’s findings with respect to three stages – NC, TC and CC. A definite developmental lag was observed CVH in both the conservation tasks. Concrete operational stage according to Piaget is marked by the discovery of conservation. Hence, it could be concluded that the CVH also attain Concrete Operational Stage as marked by conservatory thinking processes following more or less the same sub-stages. The time lag in the acquisition of Conservation thinking as observed in CVH seems to be different for two Conservation tasks – Number and Quantity.

As observed in the present study, only 50% of CVH were successful in Number concept and 13% in Quantity for an age group of CVH ranging from 13 to 15 years. This implied that the development of Conservation of Number and Quantity depends upon the nature of the task, the materials used and the techniques adopted.
In Piaget's (1952) study also the differences in the ages of onset of different concepts were observed which were further supported by many replication studies. The variations were attributed to different aspects of thinking in children influenced by both motivational level of the subject and the attributes of the objects used. The same interpretation holds good in the case of CVH too. The variations here are certainly influenced by the nature of early experiences inspite of the maturational level, the type of materials (the degree of familiarity of the objects to CVH) and the level of questioning for eliciting their modes of thinking to analyse the conservation. Therefore it could be inferred that the differences in attaining the Conservation of two different concepts – Number and Quantity reveal a different picture in the study of VH compared to that of Sighted.

The studies conducted by V. Sharma (1988) and Mandarvalli (1990) supported the present study with respect to both the developmental patterns as well as the lag. Conservation of Number was found to be easier than the Conservation of Quantity, which is similar to the finding of this study.

Thus, it could be finally concluded that CVH also attain Concrete Operational Stage as described by Piaget marked by Operational logic in the selected two Conservation tasks, but they attain the Concrete Operational Stage at a later age as compared with the Sighted children.
5.5 APPRAISAL OF ARITHMETIC CURRICULUM WITH RESPECT TO CVH

The first three sections (vide Section 5.1, 5.2, 5.3) of the data analysis was focused on analysing the development of arithmetic skills among the CVH quantitatively and qualitatively. Hypotheses of the study were statistically tested with the quantitative data apart from answering the relevant research questions qualitatively (vide Section 3.3 Supra).

In the pursuit of objective IV (vide Section 3.2 Supra) – appraisal of the mathematics curriculum with respect to its efficacy in implementation for CVH, it was considered appropriate to adopt qualitative analysis procedure. Interviews of heads of institution and teachers of special schools for CVH, analysis of syllabus, classroom observations formed the basis of curriculum appraisal.

Assessment of curriculum content requires a clear understanding of the structure and nature of the content to be assessed. The study aimed at analysing the achievement and development processes of basic arithmetic skills therefore, the study focused on assessing the mathematics curriculum specifically Arithmetic content strands for Children with Visual Handicap for Grades I-V at its operational level (how it is being implemented?) and experiential level (how it is being experienced by the teachers and students?). Appraisal of the curriculum was delimited7 to the content strands of the following chosen arithmetic skills.

7 Delimitations suggests how the study will be narrowed in scope (Creswell, 1994, p. 110). In this instance, the scope of assessment of arithmetic curriculum covered the arithmetic content strands Number, Place Value, Addition, Subtraction, Multiplication and Division.
"Curriculum" in the context of this study refers to textbooks, teaching strategies, learning material (Braille, Taylor Frame) and any other material that is helpful to the teacher to implement the prescribed syllabus by State Government of Karnataka.

Thus, an attempt is made in this part to answer the Research Question raised in the pursuit of objective IV. The Research Question is restated below:

*What are the major factors that contribute to affect the quality of Arithmetic teaching learning in special schools for Children with Visual Handicap at Lower Primary level?*

The ‘Proforma for Structured Interview’ (vide Appendix – III) was developed with the aim of not only conducting oral interviews in a structured format, but also had provision for the teachers to complete the proforma in writing. However, when the teachers were contacted for an interview appointment, all of the participants including teachers and head of the institutions preferred to give oral responses. Most of them requested that they would first give an overview of their teaching practice and the difficulties that they faced and then answer any other questions that the investigator had. Therefore, semi-structured interviews (based on the ‘Proforma for Structured Interview’) were recorded in writing, in a diary. Participants who agreed to respond to all the questions in the ‘Proforma for Structured Interview’ were recorded in writing on
the proforma itself. Only five of the participants agreed to give a detailed interview based on the 'Proforma for Structured Interview'. Main reason for the other participants for not participating in the detailed interview was based on the fear that the data collected may be reflective of their teaching practice/institution and the data may be shown to the administrators. In some institutions, the 'Head of the institution' preferred the teacher to give interview in their presence only. As the investigator was aware of this fear factor, before conducting the formal interview, the investigator conducted an informal discussion session with the teachers and head of the institutions and oriented them regarding the study and how the outcomes of the study would inform the educationists of the needed intervention in curriculum planning specifically for CVH. Though most of the participants were comfortable after the orientation, some of them were still hesitant. In such instances, responses were recorded in a diary in a very informal interview and when the teachers spoke, investigator probed them based on the criteria listed in the structured interview proforma. Thus, the data collected for analysis of the curriculum included, classroom observation recorded in a diary, semi-structured interview recorded in a diary and formal structured interview recorded on the proforma (vide Appendix – III).

As the data collected were qualitative in nature, responses to the questions on the structured interview proforma, classroom observations and semi-structured interviews were analysed qualitatively. The responses received were grouped into major categories for the purpose of better understanding on how the mathematics curriculum – arithmetic in particular is being
considered/perceived by the teacher in all its essential details for Children with Visual Handicap. As arithmetic skills are generic in nature, irrespective of the type of school (special school for CVH; special school for deaf and blind) and the instructional process, investigator made an attempt to collect the curriculum samples from various special schools in the southern region of India and also from the National Institute of Visually Handicapped. Details of the schools visited are given in the following Table 63.

**Note:** The study focused on assessing the development of Arithmetic Skills among the CVH at the end of lower primary level as an achievement score; hence, curriculum content strand prescribed for Grade V in various selected schools was considered for analysis.
Table 63

List of Special Institutions

<table>
<thead>
<tr>
<th>No</th>
<th>Name of the Institution</th>
<th>Resource Person</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sighted  VH</td>
<td>Sighted  VH</td>
</tr>
<tr>
<td>1.</td>
<td>Rangarao Memorial Blind School for Girls, Mysore, Karnataka</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Government Blind School for Boys, Mysore, Karnataka</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Ramana Maharishi School for Blind, Bangalore, Karnataka</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>NIVH, Dehradun</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Hellen Keller School for deaf and deaf blind, Byculla, Mumbai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Kamla Mehta Dadar School for Blind, Dadar, Mumbai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Happy Home and School for Blind, Worli, Mumbai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>NIVH, Regional Centre, Ponamallee, Chennai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>
5.5.1 Descriptive analysis of classroom observations

From the eight schools visited for the collection of data, due to administrative restrictions it was possible to conduct classroom observations in only six schools. A total of six classroom observations were collected. Though a classroom observation schedule was envisaged for the purpose of observations, due to administrative restrictions and institution management restrictions teachers were hesitant to allow the investigator to record the classroom observation formally and hence, observations were recorded in a diary in a very informal manner. Further a pre-observation discussion and post observation discussion was conducted with the teacher thus, making the teacher comfortable of the data collected. As the selected sample was very small, hence no statistical measures were employed. Below an excerpt of the classroom observation including the pre and post discussions with a teacher is produced below.

<table>
<thead>
<tr>
<th>Name of the School:</th>
<th>Rangarao Memorial School for the Blind</th>
<th>Type of School:</th>
<th>Special school for the blind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Observation</td>
<td>31 July 1998</td>
<td>Total time of Observation: (Including pre and post discussions)</td>
<td>1 hour</td>
</tr>
<tr>
<td>Teacher:</td>
<td>Rekha (Partially Sighted)</td>
<td>Qualification:</td>
<td>Bachelor of Education, and special training in teaching for Children with Visual Handicap</td>
</tr>
<tr>
<td>Grade</td>
<td>V</td>
<td>No. of Students</td>
<td>8</td>
</tr>
</tbody>
</table>

Management had reservations regarding teachers on divulging any information to outsiders, as it may be reflective of the institutions and its management practices.
Investigator introduced herself and provided an overview of the research study. Provided permission letter from the head of the institution to visit the school and interact with the teacher.
Investigator briefed Rekha on classroom observation and how the details will be recorded. Rekha was comfortable with the intention of observation, however asked the following question “How will this research study help us?” She said that “Many people come here to collect data but we never get to know what happens with the data and how it will help us”.

Investigator answered that the data collected for the current study will inform the educationists while planning the curriculum of the major factors that need to be kept in mind for catering to the needs of Children with Visual Handicap.

Inside the classroom the Teacher (Rekha) and the investigator waited for the students. Students started coming in and settled themselves in their places.

Observation: Children were very comfortable manoeuvring around the classroom. They wished the teacher ‘good afternoon’ when they entered.

Teacher: Wished the students. Introduced the investigator to the students.

Observation: Students were very curious to know why the investigator was there and what will she teach. Upon clarification from the teacher that the investigator was not going to teach but only observe, students exclaimed, “if she [investigator] was going to test us then we are not prepared”. The teacher again clarified that investigator was not going to test, will only observe how we learn mathematics.

Teacher: Is everyone ready with the Taylor Frame and the ‘types’.

Students: No miss, wait a minute!

Teacher: [after 2 minutes] Ok, now we will do some addition problems.
Sample Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>5648</td>
<td>8740</td>
</tr>
<tr>
<td>7635</td>
<td>3065</td>
</tr>
<tr>
<td>3750</td>
<td>6805</td>
</tr>
<tr>
<td>3520</td>
<td>865</td>
</tr>
</tbody>
</table>

Observation: Teacher read the problems aloud one after the other and then instructed the students to solve it.

Teacher: [after 10 minutes] Have you all finished?

Students: all together ‘Yes’; “No”

Teacher: Ok who all finished raise your hands

Students: Six of them raised the hands

Teacher: to the other two students, do you need help?

Students: No answer

Teacher: What happened? Why are you silent?

Student1: Miss I do not have enough ‘types’.

Student2: Miss I don’t know whether the answer is right?

Teacher: That’s ok, all of you bring your Taylor Frame to me, I’ll check the solution

Observation: Teacher individually checked the problem and the solution on the Taylor Frame. If the answer was wrong, the teacher probed them how the student arrived at that solution number?
Post-Observation Discussion

Rekha stated the following in relation to the performance and understanding of the concept taught:

- Concept of zero and place value of zero is not well developed.
- Each student has to be assessed individually – presenting the problem and checking the answer.
- Catering for individual attention consumes lot of time.
- Presenting statement problems is a challenge. As students take the numbers read in the problem but forget the context in which it was read.
- If at first attempt, the answer for the presented problem is wrong then the instructions need to be repeated and the child should be asked to attempt again.
- Concept of borrowing is not very clear among CVH.

Investigator probed on the use of the modality (Taylor Frame), which was used for solving the addition problem in the classroom observation.

Rekha explained that use of Taylor Frame is recommended from the Grade III onwards. Though it is handy to use the modality in terms of reusing it, has inherent limitations and challenges us for teaching various concepts for eg:

- Many students still lack the touch skills – hence may not be able to perceive the ‘types’ properly.
- While keeping the ‘types’ the direction may change [without the knowledge of the child], though the calculation may be correct but the display of the answer might be wrong owing to wrong direction of the ‘type’.
- Child may place the ‘type’ completely opposite for eg: 9 and 0 wherein the difference is of flat raised end for 9 and two raised dots at the corner of the ‘type’ for 0.
- It is essential to check the algorithm for solving the problems and also usage of proper sign and symbol, again calling for individual attention, which consumes lot of time.

Note: Snapshots of the diary pages on which the observations were recorded is produced vide Appendix - VII.

Similar six classroom observations for grade V were recorded and responses were compared to extract qualitative findings. Concept taught in all of the six classroom observations included teaching place value (1 observation), addition (2 observations), subtraction (1 observation) and multiplication (2 observations). Some of the noteworthy findings from the classroom observations are:
• CVH in a classroom is a heterogeneous group, paying individual attention consumes lot of time.

• Concept attainment in the group may vary to a great extent, for e.g. a child may still be learning the skills to handle Taylor Frame to that of a child who is very comfortable in using the modality and has moved on to solve complex mathematical problems e.g. Four digit addition in three or more rows with carryover and zero at various place values.

• In five of the six schools, teachers did not have any written lesson plans to follow.

• Teachers did not use any manipulative material or other exploratory material for teaching the concepts – place value, addition, subtraction and multiplication.

• In one of the class students’ attention span was a challenge for the teacher to manage. Teacher struggled to get a grip on proceeding with the lesson. The teacher reported that there was minimal help available to them for managing such issues.

All of the six classroom observations done by the investigator were at a stage when the concept had already been taught and drill work was being done to strengthen the concept. A major lacuna in the classroom observations of this study was inability to collect data on introduction of a concept. Hence, the above findings though highlight the teachers’ perceptions and certain difficulties in teaching arithmetic are insufficient to generalise on a larger population.
5.5.2 Descriptive analysis of responses collected through structured and semi-structured interviews

Responses on interviews – structured and semi-structured were collated to analyse certain curricular areas – arithmetic syllabus, teaching-learning strategies and assessment, with the members of the teaching staff of specials schools visited by the investigator. Oral interactions with the participants gave the investigator a first hand experience in understanding the problems encountered by both the teachers and students in their Arithmetic classes. Responses on both the semi-structured interviews and Proforma on Structured Interview were collated under item number of the Proforma. Comments that were common were grouped together and qualitative interpretations were done based on not only the interview responses but also the classroom observations done by the investigator.

Some of the significant and noteworthy observations made by the investigator are given below:

5.5.2.1 Descriptive analysis of responses on items 2 to 6

Data collected on the ‘proforma for the Structured Interview’ is presented in the below Table 64
Table 64
Proforma for Structured Interview – Teachers in Special Institutions – Responses on items 2 to 6

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Criteria</th>
<th>%</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sex</td>
<td>Male</td>
<td>55.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>44.4%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Vision</td>
<td>Sighted</td>
<td>44.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partially Sighted</td>
<td>5.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completely Blind</td>
<td>50.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onset of Blindness</td>
<td></td>
<td>-</td>
<td>Participants were unable to recall the exact time of onset of blindness. Their responses varied between an age range of 3 – 7 years</td>
</tr>
<tr>
<td>3</td>
<td>Education</td>
<td>Degree</td>
<td>88.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-Graduate</td>
<td>11.1%</td>
<td>Head of the institutions of two schools held post-graduate degree in education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Experience</td>
<td>Less than 10 years</td>
<td>16.6%</td>
<td>Of all the participants interviewed, only the teacher trainees had experience less than 10 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 – 30 years</td>
<td>83.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 years and above</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Special Training in the teaching of visually handicapped</td>
<td>Workshop</td>
<td>5.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refresher Course</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation Course</td>
<td>5.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching preparation programme</td>
<td>5.5%</td>
<td></td>
</tr>
</tbody>
</table>

From the above Table, it can be found that

- Teachers who had some form of visual impairment expressed that it was difficult for them to cover the syllabus, as the textbooks were not available in
Braille. Teachers (Visually Impaired) of only few of the schools visited expressed satisfaction on the availability of materials for teaching the CVH.

- Teachers teaching the CVH had formal training in the field of education. However, when teachers were probed on specific training in relation to teaching CVH, only two teachers (11.1%) were found to have undergone formal training (Teacher Certification programme - VH).

- Most of the teachers had not attended any workshop, orientation programmes or refresher course. Teachers expressed that though there was provision for them to attend such programmes owing to less resources in the school, they were unable to accommodate such programmes in their teaching schedule. When Head of the Institutions were probed on the reasons for not accommodating the training programmes for teachers answered that, they were very keen for their teachers to participate in such programmes, but as most of the programmes were held at places for which the teacher had to take leave of minimum two days and also many training programmes were held when it was the examination time of the students studying in Higher Primary, hence teachers were unable to participate. However, the Head of the Institutions expressed that they were working on providing in-house refresher programmes so that it did not affect the teaching schedule of the teachers.
5.5.2.2 Descriptive analysis of responses on item 7b and c

Proforma for Structured Interview – Teachers in Special Institutions – Item 7b and 7c

7. Comments on

b. Teaching methods

c. Modalities and strategies adapted for CVH. List advantages and limitations of using – Oral, mental mathematics, Abacus, Taylor Frame, Nemeth Code, Braille Reading and Writing

Data analysis of the response sheets and structured interviews yielded common teaching methods and strategies for teaching the arithmetic skills selected for the study. Some of the common methods and strategies used are detailed in Table 65:

Table 65

<table>
<thead>
<tr>
<th>Arithmetic Teaching Method/Strategies for CVH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
</tr>
<tr>
<td>Number</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Group Activity</td>
</tr>
<tr>
<td>Abacus</td>
</tr>
<tr>
<td>Objects – Marbles, Stones</td>
</tr>
<tr>
<td>Place Value</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Abacus</td>
</tr>
<tr>
<td>Addition</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Subtraction</td>
</tr>
<tr>
<td>Taylor Frame</td>
</tr>
<tr>
<td>Multiplication</td>
</tr>
<tr>
<td>Braille Slate</td>
</tr>
<tr>
<td>Division</td>
</tr>
<tr>
<td>Nemeth Code</td>
</tr>
<tr>
<td>Mathematics Laboratory*</td>
</tr>
</tbody>
</table>

* Available in only two schools for grade V (The lab consisted of Mathematics Kit for counting, Cylindrical shapes for place value, Place Value box, Abacus, Geometry Board etc.)
From the analysis, responses could be categorized into major groups namely Teaching Methods/Strategies; Learning Materials, Learning Process, Assessment and Other factors. Detailed responses are enumerated below:

**Teaching Methods/Approaches**

- Traditional approach of teaching Mathematics is followed for teaching the CVH in all of the special schools visited by the investigator i.e., oral method for numerals, multiplication tables, abacus for counting, and Taylor Frame for arithmetic operations. Structured activities like the Stern Apparatus, the Dienes Apparatus, the Cuisenaire Apparatus etc., are not commonly available for CVH. In one of the schools visited, a teacher reported that “until the CVH learns the basic concept he/she is retained in the same class for years together and no other alternative method of teaching is tried for these children” (Teacher, personal communication, November 24, 2004). Reinforcing the need for providing enriched activities for teaching the mathematical concepts, Mukhopadhyay et al. (1987) suggests “it is observed that a good learner of mathematics will be able to organise ideas, put them in a sequence, arrive at results and interpret them easily. Most of the teaching of Mathematics to the Sighted children is done through working on the blackboard supplemented by oral instructions and they grasp the ideas by organising and sequencing in a way the matter is presented on the blackboard. A child with visual handicap is losing this important information in learning. His limitations lead to a lot of difficulties in the remaining processes i.e., the result and interpretations” (pp. 203-204). For e.g. if the following
example on Division were to be shown to a Sighted child it would be presented as below on the blackboard

\[
\begin{array}{c}
9) & 2948 & (327 \\
27 & & \\
24 & & \\
18 & & \\
68 & & \\
63 & & \\
5 & & \\
\end{array}
\]

If the same example of Division were to be shown to CVH, then for a grade V CVH student, wherein teaching-learning of mathematics is mainly through Taylor Frame, the example will need to be displayed on Taylor Frame using the 'Types'. The Taylor Frame with the example will need to be passed on to each child for perceiving the algorithm and teacher may have to repeat the information regarding the process of Division over and over again. Alternatively, the teacher will need to place the example on Taylor Frame for each child and when all the children have their respective Taylor Frame with the example, the teacher can explain the algorithm. Depending on the perceptual skills of the child, he will be required to perceive all the 'Types' and in the sequence it is shown above. Though the child may be able to perceive the algorithm, but at the same time has to memorise each and every step and mentally organise it and sequence it in order to arrive at the answer.

- Aggravating the situation, CVH have to learn numeration through four modes of learning (Oral, Abacus, Taylor Frame and Braille). Each mode of learning is totally divorced from the other mode. Mukhopadhyay et al. (1987) remarks that teaching all Mathematical codes through all the modes may be
convenient for a teacher but the CVH may not generate sufficient interest on
account of a feeling that they have to learn too many things resulting in the
mismatching of their capabilities. Teachers would appreciate if newer
concrete methods of teaching Mathematics to CVH were provided, including
innovations in Mathematics Curriculum.

• Reading and writing Braille is very essential and hence, emphasised at lower
levels. Most of the classes are allotted for this purpose and less emphasis is
laid on teaching of mathematics specifically using either Taylor Frame or
Nemeth Code. Oral instruction, abacus, blocks are used for teaching various
arithmetic concepts like – counting, place value and simple addition and
subtraction at lower grades (I-IV), and emphasis on other improvised
apparatus (e.g. cylinders for place value, playway methods to teach
statement problems etc.) is not given enough consideration due to lack of
time and resources (Amount allotted for purchasing materials was mostly
spent on Braillers, orientation and mobility resources – sticks etc.). Only one
of the schools (Ramana Maharishi School for the blind had improvised
teaching models for teaching concepts like place value. One of the schools
had developed cylindrical shape vessels, which holds plastic rings equivalent
to the place value.

• Instruction with Nemeth code was one of the major points raised by the
teacher in all the schools. According to them, Braille pervades class I-V with
respect to basic reading and writing skills; though Nemeth code is prescribed
from grade III onwards, it is not taught to them. Even after introducing at
grade V very few children pick it up and feel comfortable at using it at grade V or VI.

- It is very difficult to present the statement problems to CVH at lower grades, as they tend to take only the numbers read in the problem on the Taylor Frame/Braille and forget the context in which the numbers were read.

- Mental mathematics for CVH was an area, which was not discussed about by the teachers in their interview. In couple of interviews, teachers expressed that though they knew that mental mathematics would help CVH in learning, but they were not familiar with the strategies to foster mental mathematics.

**Modalities and Strategies**

- Oral method was used to teach counting and multiplication tables

- Abacus was generally used for teaching the concept of Place Value. However, as CHV may differ in their motor skills for handling abacus, the tool was not emphasised much. Instead orally the concept of units and tens was taught. Once the children were introduced to Taylor Frame, the placevalue concept was taught on that modality.

- Braille reading and writing was part of the general curriculum and hence there was no specific emphasis on teaching it while teaching arithmetic.

- Nemeth code was prescribed from Grade III onwards however, students were not comfortable in writing braille at Grade III hence, Taylor Frame was the most preferred for teaching arithmetic.
In order to know the efficacy and usability of Taylor Frame, discussion with teachers and students was conducted. Some of the questions and responses related to the use of this modality is given below:

- What is a Taylor Frame?

  Taylor Frame is a special board that holds type in 8-sided holes, which exists in rows on the slate. The types used to indicate number are embossed on both the sides. Embossed area provides specific meaning to the numbers. There are two different kinds of 'types' – arithmetic and algebra. Below picture gives the details of the 'arithmetic types' and the specific number assigned to the embossed area on the type.

![Taylor Frame with Arithmetic Type](image)

Picture 4: Taylor Frame with Arithmetic Type
What is your opinion on using Taylor Frame for teaching Mathematical concepts?

Teachers were of the opinion that even though Abacus could be used for teaching basic arithmetic skills and infact is recommended by the experts in the field at lower primary level, yet, owing to lack of good manipulation skills among CVH and presence of heterogeneous levels in manipulation skills (primary requirement to manipulate beads on Abacus) hence, they resort to Taylor Frame which according to teachers' is better as it allows them to show certain level of details/procedures of problem solving. Some of the teachers disagreed with Taylor Frame having any advantage over Abacus. Those teachers were of the opinion that Abacus was much easier to teach CVH and also less cumbersome to handle. Teachers considered Taylor Frame and the 'Types' were considered to be cumbersome to handle by CVH. Good finger dexterity is required for perceiving the correct side of the 'Type' for a specific number and further its placement in the 8-sided hole of Taylor Frame in a particular direction. Not all children have good finger dexterity and hence, add onto the heterogeneity of the group to teach arithmetic at same pace for all children even.
CVH might keep the ‘Type’ in wrong direction. Though the mental comprehension of the number may be right, but while placing it on the Taylor Frame, may place it wrongly; conversely while reading the child might perceive the ‘Type’ wrongly, hence, might give wrong answers.

As the ‘Type’ may be placed in various directions with different meaning/symbol attached to its placement in a particular direction in the hole, a child might place a ‘Type’ in completely opposite direction without his own knowledge e.g placing 2 (has flat raised end which needs to be oriented
towards left) and 6 (has has flat raised end which needs to be oriented towards left) on the Taylor Frame.

Higher math operations are problematic owing to the complexity involved in solving the problems and lot of ‘Types’ are required for solving such problems. Very limited amount of ‘Types’ are available for student use.

Students while using the ‘Types’ may loose some of the types as some of the types might fall down without the knowledge of the child. ‘Types’ are very costly and hence, the school cannot afford to provide lot of types to individual student. Further, as students do not own a Taylor Frame hence, cannot practice on them during free time. They are allowed to work on it only during the class time. Except for schools where good funding was available heads of the institutions reported their inability to provide more material for the teachers and students owing to financial restrictions.

Task analysis for solving any 4-digit addition problem in two rows with carryover and possible perceptual errors and algorithmic errors due to the modality (Taylor Frame) is given below:
Taylor Frame (TF)

Tactile perception of holes in rows

Tactile perception of types

Listen to the oral instruction (problem)

Put types for addend 1 on TF

Put types for addition symbol (+)

Put types for addend 2 on TF

Perception of numbers in column from Unit end

Incorrect Solution

Read Solution

Incorrect Solution

Algorithmic Errors

- Read numbers in wrong column
- Does not know how to write zero (the child has to remember to reverse the side of the type and place it in the direction of two for indicating zero)
- Does not know how to carry over
- Starts with addition and ends with subtraction owing to misconception of symbol

Perceptual Errors

- Put wrong types for addend 1 on TF
- Put wrong types for symbol
- Put wrong types or in wrong place for addend 2 on TF
- Read wrong numbers
- Put wrong types

Figure 6: Task analysis of problem solving an addition problem (presentation mode = oral and response mode = Taylor Frame + Oral)
In a post interview discussion with a teacher of Rangarao Memorial school for the Blind, the teacher demonstrated a work sample of a multi row addition problem with carryover on Taylor Frame, which is shown below:

<table>
<thead>
<tr>
<th></th>
<th>With Type this becomes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>1918</td>
</tr>
<tr>
<td></td>
<td>246</td>
</tr>
<tr>
<td></td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>403</td>
</tr>
<tr>
<td></td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>__________</td>
</tr>
<tr>
<td></td>
<td>2718</td>
</tr>
</tbody>
</table>

Picture 6: Addition problem using 'Types' on Taylor Frame

Teacher commented regarding the above example that there is not much difference between the placement of 1 and 9; 2 and 0. The child has to remember to reverse the side of the 'Type' in order to get the correct number, further while perceiving as well, the child has to remember to associate the embossed side and dots to the specific number or symbol.

It is very difficult to show the algorithmic procedures for solving an arithmetic item specifically in relation to computational operations. Though
Taylor Frame provide some scope of showing the algorithmic procedure, still it has its inherent limitations with the amount of 'Types' to be used for the purpose and feeling the procedure displayed by touch doesn't provide holistic experience to the child.

Teachers also, find Taylor Frame to be very unwieldy. If they (both students and teachers) are not in touch with it regularly then forgetting the usage (placement directions of 'Types') is easy and takes longer time to relearn and get adjusted to it.

Thus, it can be seen from the above account that though Taylor Frame is most commonly used and preferred modality and has inherent limitations for the purpose of teaching arithmetic to CVH especially at lower primary level. At lower primary level children are primarily getting adjusted to the residential schools and are more focused on learning the basic skills of mobility training, basic reading and writing skills using Braille. An appropriate substitute for this modality or improvising the modality to suit the specific needs of learners and teachers but also for the administrators in being cost-effective is warranted.
5.5.2.3 Descriptive analysis's of responses on item 7a and 9a

Proforma for Structured Interview – Teachers in Special Institutions – Item 7a and 9a

7. Comments on

   a. Arithmetic syllabus


   a. Content/Syllabus and Textbooks

Government of Karnataka has prescribed a mathematics textbook that is widely implemented in all the schools run by State Government. Special Schools for Children with Visual Handicap still follow the textbook as prescribed by the State Government of Karnataka. Analysis of the interview responses regarding the syllabus (item 7a and 9a on the Proforma for the Structured Interview vide Appendix – III) yielded following findings:

- Textbooks are the most important teaching aids at schools for Blind. Only three schools (NIVH Dehradun, NIVH, Ponamallee and Hellen Keller Institute for the Blind) had Braille transcribed mathematics textbook for not only for teachers but also for students. However, there were no teaching guides and manuals that provided help/ suggestion in pursuing a strategy to teach an arithmetic concept. Goel (1985) reports that elementary schools for Blind in Prague was supplied with Braille transcribed textbook compiled and published by the State Pedagogical House in Prague. And for each textbook there is a methodical guide for the pedagogues and the "translation" of Braille into
normal print. Such methodical guide and manuals are warranted for teachers of Blind in India as well.

- Though the state prescribed mathematics syllabus is followed, in most of the schools visited, many areas are omitted or substituted at various lower grade (I-V) levels owing to the difficulty in teaching the algorithmic procedures related to such omitted concepts e.g.: fractions, money value etc. Commenting on the disadvantages faced by the CVH regarding the content covered in the special schools for the blind and schools with IED, Mukhopadhyay et al. (1987) remarks that “In a special school while teaching mathematics, some specific areas that are considered complicated are omitted by the teacher. This mass omission may not cause a discrepancy among the students in learning the subject. In the end, all the students may have missed the same amount of information. This would not affect the homogeneity of performance among the students of a class” (p. 203). However, a Sighted student in a regular school is learning that omitted topic, the CVH is at a disadvantage of not being provided with the same content as for the Sighted.

- Textbooks for Sighted is full of colour pictures relating to situations that lead the child to develop the concept. “The visually impaired child cannot assimilate visual ideas presented in the textual material of primary school textbooks” (Mukhopadhyay et al., 1987, p. 78). Pictorial representations for developing mathematical concepts at primary grades is considered as a prerequisite for developing higher order complex arithmetic concepts like
algebraic equations (Kindt, Abels, Meyer, & Pligge, 1998; Roodhardt, Kindt, Burrill, & Spence, 1997) a unit for upper primary students. For e.g., students begin with a pictorial representation of a situation – building walls of different patterns using standing and lying bricks. Symbols become an efficient way to represent situations and to identify patterns.

\[
\begin{array}{ccc}
S & S & L \\
S & S & L
\end{array}
\]

Students begin by drawing the pattern that is being repeated, for example two standing bricks followed by one lying brick, followed by two standing and one lying. Students quickly find that drawing the pictures becomes very tedious and adopt or invent the use of symbols such as S and L to represent the attributes standing and lying. From a natural use of symbols, students expand their understanding of symbolic representation and order of operations using parentheses by describing a pattern of standing and lying bricks in a garden border using expressions such as \(4(2S + 5L) = 8S + 20L\), with the symbols replacing the numerals-unknowns. (Wijiers, Roodhardt, van Reeuwijk, Burrill, Cole, & Pligge, 1998). Through a series of units students progress to using a symbol to represent any number in an infinite set-variable (Kindt, Wijers, Spence, Brinker, Pligge, & Burrill, 1998), (Kindt, Roodhardt, Spence, Simon, & Pligge, 1998), (Roodhardt, Spence, Burrill, & Christiansen, 1998), (Roodhardt, Kindt, Pligge, & Simon, 1998). Topics such as linear growth, recursion, arithmetic and geometric sequencing, slope and intercepts can be introduced with the idea of plant growth and using the
NEXT/CURRENT reasoning along with the visual representation obtained by using graphs, (Roodhardt, Spence, Burrill, & Christiansen, 1998).

Some pictures that are available in the primary grade textbook to introduce the concepts selected for the study is given in pictures 1 -. These text books are based on the Minimum Levels of Learning for the Sighted and is prescribed by the Government of Karnataka. Same books are followed in special schools for the Blind. The pictures included below depict how pictures are helpful for the Sighted in understanding the concept of addition, subtraction, multiplication and ascending order. As the textbooks are available in the vernacular medium Kannada, hence an attempt has been made to transliterate the words/statements used in the pictures into English.

Picture 7: Concept of addition A - The picture is presented to the Sighted child for developing the concept of addition. There are 7 birds sitting on the tree and three are flying towards the branch (Ganita - 1, 1995, p. 73).
What do you see in the picture? How many birds are sitting on the branch? How many birds joined the already sitting birds?

Picture 8: Concept of Addition B - The three birds that were flying in the above picture are now sitting on a branch of the tree (Ganita - 1, 1995, p. 73).

Two-Digit addition with total not exceeding 99.

Picture 9: Concept of Place Value - Dotted representation used to reinforce place value concept while performing addition (Ganita – 2, 1995, p. 55).
As can be seen from the above pictures that development/reinforcement of a concept can be fostered using such pictorial representations. Such pictorial representations are available in the textbooks prescribed by the government of Karnataka for the Sighted. However, there are no such perceivable (tactile or object) situations prescribed for teaching CVH. In couple of visited schools mathematics textbooks were available in braille but did not have any tactile pictures (Teacher, personal communication, December 26, 1998) for teachers to use them and foster concept development. Mukhopadhyay et al. (1987) suggests "as visual attraction is important for a Sighted child, so is tactual attraction for a non-seeing child. Hence, the material presented in tactile form should be "edited". An efficient teacher can judge the right type of material required for the individual visually impaired child. Sometimes, teachers may
change the entire textbooks and provide the material in pieces to visually impaired children to develop the necessary concepts in a gradual manner. This should be based on the readiness of the visually impaired child (p. 78).

- Regarding play way method to teach mathematical concepts to CVH, though no suggestions are given in the textbooks, some teachers with self-motivation tend to create such improvised situations using the materials available and provide holistic experience to the child in developing a concept for e.g.: use marbles for teaching the concept of borrowing by play method using two children (Teacher, personal communication, November 30, 1998) as shown below.
Teacher gives equal number of marbles [e.g. 10 marbles] to two children (Child1 and Child2). Then she asks Child1 - "give me 13 marbles".

The Child1 answers, "But I have only 10 marbles".

The teacher says then you can borrow 3 marbles from child2

The Child1 borrows 3 marbles from child2

Teacher now asks Child1 "How many marbles do you have now?"

Child1 replies" now I have 13 marbles"

Teacher then says, now give me 13 marbles.

After the child gives 13 marbles to the teacher, the teacher probes both the children 'How many marbles both of you have now?"

Child2 replies I have 7"; Child1 replies, "I have none".

Then addressing both the children, teacher mentions that the game played involves two processes – subtraction and addition. Ok now lets put this problem on the Taylor Frame.

Child1: 10 + 3 = 13 – does addition

Child2: 10 − 3 = 7 – does subtraction with borrowing

Now, if we look at the situation of Child2, then we can see that we cannot subtract 3 from 0. Therefore, we borrow tens from the tens place and then do the subtraction i.e

\[
\begin{array}{c}
1 \quad 0 \\
\hline
3 \\
\hline
7
\end{array}
\]

Alternatively, we can solve this problem as (on Taylor Frame):

I had given 10 marbles to each of you, which means in total there were 20 marbles. Now lets remove 13 from 20. For doing that we need to start from the unit end, as we cannot subtract 3 from 0 we'll borrow tens from the next number that is twenty. Now the number becomes 10, if we remove 3 from 10 then we are left with 7 marbles. When we move to the tens place, we can see that we had already taken one tens from the twenty – so only ten is left, now if we subtract 10 from 10 we are left with zero.

\[
\begin{array}{c}
2 \quad 0 \\
\hline
1 \quad 3 \\
\hline
7
\end{array}
\]

Therefore the total number of marbles left after you give me 13 are 7 marbles.
Further, using of the traditional methods should not be limited to teaching the concept among the CVH. Enough practice and scenarios should be provided to generalise the concept. In this regard, Chander (1992) observes that "The present emphasis on rote learning and mechanical use of computational aids (e.g. Taylor Frame, Abacus etc.) without adequate understanding of the structure and process of mathematical relations and operations not only puts unnecessary burden on child’s memory but also defeating the very aims of teaching mathematics. Most of the learning in mathematics is structurally organised and the children should decipher their forms through activities. For example, when the children learn counting by memorising the sequence of number names they fail to recognise the number of members in a collection. The process of counting is not recitation but associating number names with collections of same kind of objects for e.g. the number three with three apples or three pens etc. they fail to generalise that the number can be associated with any collection having three members. Keeping the principle of mathematical variability in mind the children should be exposed to various aspects of a concept or operations for a fuller understanding" (p. 245).

Though a gradation of concepts is observed in the textbook, however as there are no guidelines available for teachers so as how to proceed with that gradation for CVH, teachers find it difficult to move onto complex arithmetic concepts. Owing to less time allotted for teaching a concept (vide Section 5.2.2.4 Infra), teachers find it difficult to teach new concepts without providing sufficient drill in the concept already taught. In a heterogenous class though
drill work would benefit CVH who lag behind their peers in acquiring the concept, but other who have understood the concept and are well versed at solving similar problems find it boring. Therefore, as a result, of this, teachers have observed that those students lose interest in the subject.

- Teachers find teaching the concept of zero as the most difficult one. Teachers mention that many of the students are unable to assign any place value to Zero and hence are not able to understand the concept. Therefore, most of the children rote memorise the concept and are unable to use the concept in a context for e.g.: borrowing. Few teachers use situations like: child is asked to count the number of chairs arranged in a row, with empty space in between. The child when reaches the empty space answers that there is nothing in that space, the teacher tries to relate that experience with the concept of zero. Still, many a children have understanding problem as according to them though there may be nothing in that space but if they moved further they could find another chair. As can be seen, the example situation used here by the teacher, might be considered relevant by the teacher however, is not appropriate for teaching the concept of zero. Textbooks lack suggestion for teaching such concepts for children with visual impairment.
5.5.2.4 Descriptive analysis of responses on item 8

Proforma for Structured Interview – Teachers in Special Institutions – Item 8

8. Teacher perceptions on effective mathematics curriculum

A. Highlight the areas of mathematics that are difficult to teach CVH. Why?
B. Highlight the sections of arithmetic that are generally omitted at lower primary level for CVH.
C. Comment on the time availability per class for teaching arithmetic.
D. Have you attended any inservice training with respect to teaching CVH?
   What is your opinion on such training?

- Highlight the areas of mathematics that are difficult to teach CVH. Why?

Highlight the sections of arithmetic that are generally omitted at lower primary level for CVH.

Many teachers were hesitant to answer the question on what portion of the syllabus was omitted for CVH? Most of them came up with a generic comment saying “we try to cover most of the syllabus that is prescribed, but due to lack of time and individual attention required to teach, we may miss out on covering the syllabus, not that we deliberately omit them”. Investigator was unable to fetch a satisfactory answer for the question, it is assumed that answering this question might be reflective of the teaching practices and hence, teachers were hesitant in answering it.
• Comment on the time availability per class for teaching arithmetic.

Number of hours allotted for teaching a subject content varied from school to school. In all the schools an average of 5 hours per week, forty five minutes to one hour per day was allotted for teaching mathematics to CVH. Couple of school timetables showed allotment of one hour thirty minutes divided into two classes per day. Where the time frame was more than one-hour teachers expressed the adequacy of time for the instructional process and where the time allotment was one hour or less, teachers discussed their basic problems in completing the content strand within the limited time frame. Their argument was mainly based on the heterogeneity of the class wherein few children were well versed with Abacus, Braille, Taylor Frame and others were still struggling at the basic skills. Teachers mentioned that providing individual attention to each child consumed lot of time and they cannot proceed with the same pace of teaching for all. Hence, it wasn't possible to cover the syllabus in its entirety prescribed for a year.

• Have you attended any inservice training with respect to teaching CVH. What is your opinion on such training?

In service training is not very common in all the schools. Teachers lag behind in updating their skills with the emerging technologies for CVH. It was observed that though teachers in general had a degree in the field of education for teaching primary grades, but were not specifically trained for teaching CVH. Initiative taken by Rehabilitation Council of India (RCI) in lieu of PWD Act 1995, various educational institutions are providing Diploma In
Education specifically in the field of special education i.e., visual handicap. Teacher training has been mandated by RCI hence, all teachers are being involved in training. Further, as suggested by teachers they would appreciate if training were provided in preparing improvised teaching aids for teaching CVH, not only with respect to arithmetic but all subjects in general.

5.5.2.5 Descriptive analysis of responses on item 10

Proforma for Structured Interview – Teachers in Special Institutions – Item 10

10) Suggest on improving the curricular content area, teaching methods and modalities.

- Teachers with Visual Impairment expressed the need of ready availability of Braille transcribed textbooks for mathematics.
- Teachers mentioned that within the textbook that is followed for the Sighted, if suggestion on how to teach concepts to CVH is also included, it will be helpful
- More tactile materials for teaching arithmetic e.g embossed cards with increasing size of a shape to denote the place value; embossed graphics to introduce the concept of arithmetic operations – addition, subtraction, multiplication and division would be very helpful. Provision of structured apparatus (e.g., Dienes apparatus etc.) will be appreciated by the teachers.
- In-house teacher training program was highly recommended by the Head of the Institutions
• Help in devising assessment method and strategies to record the development of a skill among CVH would benefit both the teachers and the students.

• The teachers considered orientation to the new emerging technologies as a must. They feel that they are left out because they spend time teaching through the traditional way that consumes lot of time because of which they are not self-motivated to learn or seek the new methods and strategies of teaching.

• Training in preparing improvised teaching aids was also one of the factors that the teachers highlighted that would help them in effective transaction of the prescribed curriculum.

5.5.2.6 General observations

• Preparation of teacher notes for the content strand was observed in only one of the school (Hellen Keller School for the blind). The notes were prepared in Braille in a very simple language and were specifically written for a child.

• Even with respect to team meetings of the teachers, which very few schools organised them, discussed case of each CVH. Such meetings helped them to adopt specific strategies in teaching various arithmetic skills. Each teacher would share their experience of teaching a particular concept and the method that they adopted for teaching.

• The investigator noticed that the classes were predominantly heterogeneous in terms of age, ability and the type of blindness. Hence, prescription of same
syllabus as that of Sighted without any adaptation or suggestion for teaching the CVH is not feasible in practical purpose.

- Negative attitude towards Mathematics among teachers of CVH and lack of adequate resources in case of some schools was also observed (for e.g. One of the school had limited Taylor Frames as compared to the number of children [2:10 ratio]) implying that provision of sufficient materials combined with effective training for teachers will help to improve the attitude of teachers and learners equally with respect to instructional process of arithmetic.

- It was also observed that, assessment of learning for CVH consumed a lot of time. As most of the children are well adept in using Taylor Frame, hence, evaluation is mostly done through Taylor frame in combination with oral instruction. Not all assessment is recorded, only the summative assessment is recorded. Keeping a record of all assessments is necessitated in the lieu of case study approach to plan Individualised Education Program for a child. Many children lose interest on account of repeated drill. However, teacher argues that if repetition is not provided, the concept is not well understood and commits obvious computational mistakes, specifically when the learning happens through Taylor Frame.

- It was observed in one of the schools that classes were not graded. Levels of basic skills were prescribed. As and when the child picked up the basic skills, the child was promoted to advanced level of studies that encompassed mathematics, science and social living skills.
A total of 18 responses (of structured and semi-structured interviews) based on the Proforma for the Structured Interview were descriptively analysed. Considering the small sample selected for the structured interviews, though the findings cannot be generalized, however, informs the educationists of certain inputs (e.g. braille textbooks, in-house teacher training programmes) that need to be considered for effective transaction of curriculum specifically for the CVH.

From the above account, restructuring of the curriculum to suit the special needs of CVH should be considered. Persons with Disability Act, 1995 (PWD, 1995b) in this regard states “Without prejudice to the foregoing provisions, the appropriate Governments shall by notification prepare a comprehensive education scheme which shall make Provision for- Restructuring of curriculum for the benefit of children with disabilities; (List number 30:g); All educational institutions shall provide or cause to be provided amanuensis\(^9\) to blind students and students with or low vision (List Number 31).

Thus, it could be concluded that the general notion of ‘mathematics is difficult for visually handicapped’ should be considered in the light of curricular factors contributing to the learning of mathematics rather than focusing on the absence of visual channel for comprehension among CVH.

\(^9\) It is also used in a specific sense in some academic contexts, for instance when an injured or disabled person is helped by an amanuensis at a written examination. (http://en.wikipedia.org/wiki/Amanuensis)
The Next Chapter

An attempt is made, in Chapter 6, to present an overview of the results in the previous chapter (Chapter 5) based on both quantitative and qualitative analysis, which yielded findings relevant to the field of special education of CVH and education in general. The chapter also deals with drawing conclusions and implications based on the findings of the study.