CHAPTER III

METHODOLOGY

3.1 Method Adopted
3.2 Design Selected
3.3 Variables of the Study
3.4 Tools, Techniques, Materials Used, Sample Selected and Administration of each Tool
3.5 Statistical Techniques Used
METHODOLOGY

Methodology can properly refer to the theoretical analysis of the methods appropriate to a field to study or to the body of methods and principles particular to a branch of knowledge. Methodology is the description of tools and techniques adopted in a research study. It occupies a very important position in any kind of research, as the validity and reliability of the findings depend upon the method adopted.

The selection of a method and specific design within that method appropriate to investigate a research problem will depend upon the nature of the problem and upon the kind of data that the problem entails. A preplanned and well-described method will provide the researcher a scientific and feasible plan for attacking and solving the problem under investigation. Here, it has been described under the following major heads.

(i) Method Adopted

(ii) Design Selected

(iii) Variables of the Study

(iv) Tools, Techniques, Materials Used, Sample Selected and Administration of each Tool

(v) Statistical Techniques Used

3.1 Method Adopted

Since the study was intended to identify the difficulties faced by the lower primary students in learning mathematics with special emphasis on ‘division’ and to evolve a strategy by considering the difficulties in problem solving of mathematics with special reference to division, the investigator used normative cum experimental method. The investigator selected normative method in which survey is the technique used.
Through survey, the researcher identifies the difficulties faced by the lower primary students in learning mathematics with special reference to ‘division’.

Experimental method is a systematic and logical method of hypothesis testing, under carefully controlled conditions. It is the most sophisticated, exciting and powerful method for discovering and developing an organized body of scientific knowledge. It provides for much control and therefore establishes a systematic and logical association between manipulated factors and observed effects.

Through experimental method, the researcher tried to find out the effect of the newly developed strategy in learning mathematics with special emphasis on ‘division’.

3.2 Design Selected

Experimental design is the blueprint of the procedures that enable the researcher to test hypothesis. In the present study, the Pre-test, Post-test Non-Equivalent Group design was used. This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups in intact classes, which may be similar (Best, 2001). Hence, without disturbing the normal settings of the classrooms, intact class groups, which are normally non-equated, were selected for the study. These non-equivalent class groups were statistically equated by applying appropriate statistical techniques.

3.3 Variables of the Study

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes.

3.3.1 Independent Variables

The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his or her attempt to ascertain their relationship to observed phenomena. In this experiment ‘Strategy of Teaching’ is the independent variable. Two forms of strategies such as present process-
oriented strategy and the newly developed strategy are used as independent variables.

3.3.2 Dependent Variables

The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces removes or changes independent variables. The dependent variables for the present study is the scores of ‘Test on division skills’.

3.4 Tools, Techniques, Materials Used, Sample Selected and Administration of each Tool

Tools, Techniques, Materials used for collection of data

Tools, techniques and materials used for the present study were as follows.

1. Division track test
2. Interview schedule for students
3. Interview schedule for teachers
4. Interview schedule for experts
5. Focus group discussion schedule
6. Learning material – Manchadi I
7. Learning material – Manchadi II
8. ‘Test on division skills’ for Third standard
9. ‘Test on division skills’ for Fourth standard

Description of the tools

3.4.1. DIVISION TRACK TEST

The first objective of the study is to identify the difficulties faced by the lower primary school students in learning mathematics with special emphasis on ‘division’. The researcher constructed a test to identify these difficulties. He named it as ‘division track test’. The division track test is used to measure a
student’s strength and weakness while learning ‘division’. It is used to identify the deficiencies in skill or performance while learning ‘division’. The division track test is designed to provide in depth measurement to locate the source of the difficulties faced by the students while learning the topic ‘division’. It is diagnostic in nature.

‘A diagnostic test is a test designed to locate specific learning deficiencies in case of specific individuals’ at a specific stage of learning so that ‘specific efforts’ could be made to overcome those ‘deficiencies’ (Aggarwal, 1997)

Cook (1958) has stated the following characteristics of an effective diagnostic test.

1. It should be an integral part of the curriculum, emphasizing and clarifying the important objectives.
2. Its test items should require responses to be made of to situations approximating as closely as possible to be functional.
3. It must be based on experimental evidence of learning difficulties.
4. It should reveal the mental process of the learner sufficiently to detect points of error.
5. It should suggest or provide specific remedial procedure for each error detected.
6. It should be designed to cover a long sequence or learning systematically.
7. It should be designed to check forgetting by constant review of difficult elements as well as to detect faulty learning.
8. It should reveal pupil progress in objective terms.

Construction of the ‘division track test’

By considering the characteristics of a diagnostic test the researcher constructed the division track test. The researcher made a thorough analysis of the mathematics text books, teacher’s source books and the curricular objectives involved in the 3rd, 4th and 5th standards. The researcher focused on the chapters of ‘division’ especially of 3rd and 4th standards because the basis of ‘division’ and
introduction of ‘long division’ are dealt in those books. The test was based on the syllabus of 3rd and 4th standards.

**Workshop for the preparation of the test**

The researcher conducted a workshop for the test construction. The researcher, 3 experienced teachers and 2 BRC trainers participated in the workshop. (Refer Appendix XXI). First of all a thorough discussion was made on the content, curricular, objectives and the teaching points. Each of the teaching points may include a number of stages. These may be identified and arranged in the sequential order of difficulty. The expected errors were also analysed.

**Preparation of the Draft test**

Thus the team identified the learning points that are to be covered. Then the draft of the test was prepared. There were 18 items in the draft test. The draft was verified and corrected by the guide.

**Try out**

The test was administered on a sample of 25 fourth standard students. These 25 students were selected 5 each from 5 different schools of Kasargod district namely GUPS Ayyampara, GUPS Pilicode, GUPS Kangirapoi, AUPS Olat and AUPS Udinoor. Answer sheets were valued.

**Preparation of the final test**

After a thorough discussion with in the team on the basis of try out and a thorough discussion with the guide the test was modified. There were only 21 items in the modified test. Then it was well examined and further modified by a team of experts (Refer Appendix XXVII). Copy of the final Division Tract Test is given in Appendices III and XI (English and Malayalam versions). Some of the items given in the test are discussed below.

**Item No.2:**

**Objective:** to test whether the child is able to share equally a fixed number of items (When the items are given in a jumbled order)
Item

Kuttan and his friends got nine mangoes. They decided to share it equally. How many mangoes does each one of them get. Round the picture given below?

Item No. 3

Objective: to find whether the child is able to identify the relationship between grouping and division

Item

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

Draw columns in the multiple of 6. How much is 18 ÷ 6 =

Item No. 8

Objective: - to test whether the child is able to identity that division is the inverse of multiplication with help of pictures.

Item

By watching the picture fill up the columns?

×× ×× ××

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>x 2 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>÷2 =</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Item: 13

Objective: - to test whether the child is able to find and write the product of the quotient and divisor in proper places and to test whether he is able to write the remainder

Can you fill up?

\[
\begin{array}{c}
7 \\
\hline
84 \\
\hline
14 \\
\hline
14 \\
\hline
14
\end{array}
\]

Item 18

Objective: - to test whether the child knows subtraction and multiplication and to test whether the child knows division even though he knows subtraction and multiplication.

Item

\[1 \times 3 = \ldots..\]
\[4 - 3 = \ldots..\]
\[18 - 18 = \ldots..\]
\[3 \times 6 = \ldots..\]

First fill the blanks. Then do \(48 \div 3\) by the long division

Administration of the test

The final test was administered on a sample of 600 students from Kasargod, Malappuram and Palakkad districts. 3 Schools from each district were selected. Due weightage was given to different stratas such as govt, aided, rural,
urban, boys and girls. After selecting the schools, the researcher contacted the heads of concerned schools and fixed the date of the test.

The researcher conducted the test with sincere co-operation from teachers of respective schools. The pupils were informed about the test before a few days. It was to win the confidence of the students and reassure them that the test is to help them in the improvement of their learning rather than for declaring a pass or fail. Each student was given the test material and asked them to answer in the space provided. The answer scripts were collected and incomplete response sheets were discarded. Finally 583 answer scripts were selected for final analysis.

Table 3.1

Sample of schools and students selected for the test and Analysis

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Name of School</th>
<th>District</th>
<th>Type of management</th>
<th>Locality</th>
<th>No. of sample selected for the study</th>
<th>No. of samples selected for analysis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>ACKNS GUPS Melangot</td>
<td>Kasargod</td>
<td>Govt.</td>
<td>Urban</td>
<td>75</td>
<td>46</td>
<td>28</td>
</tr>
<tr>
<td>2.</td>
<td>NKBMPUS Nileshwar</td>
<td>Kasargod</td>
<td>Aided</td>
<td>Rural</td>
<td>61</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>3.</td>
<td>GFUPS Kanhamgad</td>
<td>Kasargod</td>
<td>Govt.</td>
<td>Urban</td>
<td>70</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>4.</td>
<td>GUPS Kolappuram</td>
<td>Malappuram</td>
<td>Govt.</td>
<td>Rural</td>
<td>62</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>5.</td>
<td>MMET Melmuri</td>
<td>Malappuram</td>
<td>Aided</td>
<td>Urban</td>
<td>79</td>
<td>45</td>
<td>31</td>
</tr>
<tr>
<td>6.</td>
<td>AUPS Edakkaparmba</td>
<td>Malappuram</td>
<td>Aided</td>
<td>Rural</td>
<td>66</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td>7.</td>
<td>KPRHSS Kongad</td>
<td>Palakkad</td>
<td>Aided</td>
<td>Rural</td>
<td>63</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>8.</td>
<td>GUPS Kongad</td>
<td>Palakkad</td>
<td>Govt.</td>
<td>Rural</td>
<td>63</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>9.</td>
<td>GUPS Puthoor</td>
<td>Palakkad</td>
<td>Govt.</td>
<td>Urban</td>
<td>61</td>
<td>36</td>
<td>25</td>
</tr>
</tbody>
</table>
Out of 583 sample selected for analysis 315 were boys and 268 girls. The samples were selected from 9 schools of which 5 were govt. and 4 schools aided, and 5 schools were located in rural areas whereas 4 schools in urban area.

Table 3.2

Break up of the total sample with respect to Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. of students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>315</td>
<td>54.03</td>
</tr>
<tr>
<td>Female</td>
<td>268</td>
<td>45.97</td>
</tr>
<tr>
<td>Total</td>
<td>583</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3.3

Break up of the total sample with respect to the Type of management

<table>
<thead>
<tr>
<th>Type of management</th>
<th>No. of students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>324</td>
<td>55.57</td>
</tr>
<tr>
<td>Aided</td>
<td>259</td>
<td>44.43</td>
</tr>
<tr>
<td>Total</td>
<td>583</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3.4

Break up of the total sample with respect to the Locality of School

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. of students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>304</td>
<td>52.14</td>
</tr>
<tr>
<td>Urban</td>
<td>279</td>
<td>47.86</td>
</tr>
<tr>
<td>Total</td>
<td>583</td>
<td>100</td>
</tr>
</tbody>
</table>

3.4.2 INTERVIEW SCHEDULE

In order to identify the difficulties faced by the lower primary school students in learning ‘division’, the researcher conducted interviews with the students, teachers and experts. ‘Interview is a process of communication or interaction in which the subject or interviewee gives the needed information verbally in a face-to-face situation (Koul, 1999).
‘Schedule is a device consisting of a set of questions which are asked and filled in by an interviewer in a face to face situation with another person’ (Koul, 1999). Since the interview was structured in nature, a schedule was made use of.

### 3.4. 2.1 Interview Schedule for Students

By considering the difficulties in learning division, with the help of experienced teachers and a BRC trainer the researcher prepared the draft of the interview schedule. There were 8 items in the draft. The eighth item had 4 subdivisions. It was administered on a sample of 8 students from 4 primary schools of Kasargod district. 2 students of different levels were selected from each school. After the try out, Item No. 6 and 8(a) of the draft was modified and one more item was included in the schedule.

Then the schedule was verified and modified by the guide. The modified schedule was thoroughly examined by a team of 2 experts. (Refer Appendix XXVII) The final schedule consists of 9 items. The ninth item had 4 parts. A copy of the final schedule is given in the Appendix. (Refer Appendix IV and XII) Some of the items are described below.

The fifth item is ‘which is the most difficult operation in Mathematics? Why? Expected answers are given in bracket below the item. If the child fails to answer, options will be given. There is an additional part in the item. If their answer is not ‘division’, ask them whether they like to learn ‘division’ or not. The sixth item is to identify whether the child knows the relationship between ‘sharing’, ‘grouping’ and ‘recurring subtraction’ with division. The seventh item is to know the order in which the child learns ‘division’. The eighth item is to know whether the teacher use any teaching aids or materials in his class.

The ninth item has four parts. Here the interviewer shows 4 different cards one by one. The cards describe ‘equal sharing’, ‘recurring subtraction’, ‘division connected with multiplication’ and ‘long division’. The interviewer asks the child to go through different steps. Then he discusses with the child. Difficult areas may be identified through pinpointed questions. Details regarding some items are given below.
**Item 9(a)** the figure given below is connected with the grouping of some seeds. Ask the child to explain the figure

![Figure](image)

**Expected areas of difficulty** - don’t know grouping, don’t know counting, don’t know to relate grouping with division.

**Item 9(b)**

\[
\begin{array}{c}
15 - \\
5 - \\
10 - \\
5 - \\
5 - \\
5 - \\
0 - \\
\end{array}
\]

They were asked to describe the process involved in \(15 ÷ 5 = 3\). explain the relationship between division and the process involved.

**Expected areas of difficulty** - don’t know subtraction, don’t know recurring subtraction is a continuous process until getting zero as remainder, don’t know recurring subtraction is division, don’t know to connect subtraction and division.

**Item (6)**

Which mathematical operation is connected with sharing, grouping and recurring subtraction?

(a) Answer by the student.

(b) If the child fails to answer following option may be given.

\[
(i) \text{ Addition, (ii) subtraction (iii) Division (iv) Multiplication}
\]
Details regarding sample split up of interview with students

Samples were selected from 3 districts; Kasargod, Malappuram and Palakkad. 20 samples were selected from each district. Due weightage was given to different stratas such as gender of the students, locality of the school and type of management. From each school different levels of students (below average, average, and above average) were included in the sample.

Table 3.5
Details of the sample selected for Interview with Students

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Name of school</th>
<th>District</th>
<th>Type of management</th>
<th>Locality</th>
<th>No. of samples selected for interview</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>1</td>
<td>ACKNS GUPS Melangot</td>
<td>Kasargod</td>
<td>Govt</td>
<td>Urban</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>NKBMS UPS Nileshwar</td>
<td>Kasargod</td>
<td>Aided</td>
<td>Rural</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>GFUPS Kanhangad</td>
<td>Kasargod</td>
<td>Govt</td>
<td>Urban</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>GUPS Kolappuram</td>
<td>Malappuram</td>
<td>Govt.</td>
<td>Rural</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>MMET Melmuri</td>
<td>Malappuram</td>
<td>Aided</td>
<td>Urban</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AUPS Edakkaparumba</td>
<td>Malappuram</td>
<td>Aided</td>
<td>Rural</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>KPRHSS Kongad</td>
<td>Palakkad</td>
<td>Aided</td>
<td>Rural</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>GUPS Kongad</td>
<td>Palakkad</td>
<td>Govt</td>
<td>Rural</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>GUPS Puthoor</td>
<td>Palakkad</td>
<td>Govt</td>
<td>Urban</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>
Figure 3.1

Pie diagram showing details of the sample selected for Interview with Students

3.4. 2.2. Interview Schedule for Teachers

The researcher conducted interviews with primary school mathematics teachers to identify the difficulties faced by the students while learning ‘division’. At first the draft of the schedule was prepared by the researcher. Then it was discussed with 2-experienced primary school mathematics teachers. There were 11 items in the draft. It was administered to 5 mathematics teachers of different primary schools. After the try out, the researcher discussed with the guide and modified the draft. Four more items were added to the draft. There were 15 items in the final interview schedule. Copy of the final interview schedules is given in Appendices V and XIII (English and Malayalam versions). Details regarding some of the items are given below.

**Item No.7** – How does the concept ‘division’ form in children? (What are the steps through which the concept is to be formed?)

**Expected Answers:** sharing, recurring subtraction, relating with multiplication, long division or any other new method.
**Item No. 8**- what are the stages of difficulties while introducing ‘long division’ to pupil?

**Expected Answers:**- not able to recall the steps in their order, multiplication is difficult, don’t know subtraction, confusion in writing new dividends in each step, remainder becomes greater than the divisor, forget to put ‘zero’, when divisor becomes greater than the dividend; in ability to guess the quotient; unable to recognize the answer.

**Item No. 13**- Do grouping, sharing, recurring subtraction etc create the concept of division in children?

If not, suggestion if any?

**Item No. 14**- In long division, the operation is started from the right side. All other mathematical operations are starting from the left. Whether the shifting of the side creates any problem to the child?.

**Details regarding sample split up of interview with teachers**

A sample of 35 teachers was selected randomly from Kasargod, Malappuram and Palakkad districts.

**Table 3.6**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Districts</th>
<th>No. of teachers selected for interview</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>1</td>
<td>Kasargod</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Malappuram</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Palakkad</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
Figure 3.2

Pie diagram showing details of sample selected for Interview with Teachers

Table 3.7

Details of the qualification of Teachers selected for Interview

<table>
<thead>
<tr>
<th>Qualification</th>
<th>No. of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLC, TTC</td>
<td>5</td>
</tr>
<tr>
<td>PDC/VHSE, TTC</td>
<td>13</td>
</tr>
<tr>
<td>BA, TTC</td>
<td>2</td>
</tr>
<tr>
<td>BA, BEd</td>
<td>4</td>
</tr>
<tr>
<td>BA, TTC, BEd</td>
<td>2</td>
</tr>
<tr>
<td>MA, BEd</td>
<td>1</td>
</tr>
<tr>
<td>BSc, BEd</td>
<td>2</td>
</tr>
<tr>
<td>BSc (maths), BEd</td>
<td>5</td>
</tr>
<tr>
<td>BSc (maths), TTC</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>

3.4.2.3 Interview Schedule for Experts

In order to find out the difficulties faced by the students while learning division, the researcher conducted interviews with 3 experts in the field of Mathematics education. For that he prepared a schedule. There were 8 items in the schedule. Copy of the schedule is given in Appendices VI and XIV (English and Malayalam versions). Details regarding some of the items are given below.
Item No. 6 How to teach long division? Can you suggest any special instruction?

Here the researcher is expected to get guidelines about much simpler long division algorithms.

Item No.7 Plus two teachers very often blame high school teachers and high school teacher do the same with UP teachers and UP teachers always pin the blame on LP teachers. What is the reason behind it? Can you give any solution to discourage this tendency among teachers?

Here the researcher is expected to get some suggestions to overcome the blaming behaviour.

Details regarding the sample selected for interview

The researcher selected 3 experts, who were dominant personalities in the field of Mathematics education.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Educational Qualification</th>
<th>Service</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr.E. Krishnan</td>
<td>M.Sc., Ph.D.</td>
<td>31 years</td>
<td>Head of the Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Department of Mathematics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>University College.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thiruvananthapuram</td>
</tr>
<tr>
<td>2</td>
<td>Dr.C. Goguldasan Pillai</td>
<td>M.Sc., M.Ed., Ph.D.</td>
<td>30 years</td>
<td>Asst. Professor and Head of Curriculum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCERT, Thiruvananthapuram</td>
</tr>
<tr>
<td>3</td>
<td>K.M. Chandran</td>
<td>M.Sc., M.Ed.</td>
<td>17 years</td>
<td>Lecturer, DIET Kannur</td>
</tr>
</tbody>
</table>
Data collection Procedure for Interviews

The data concerning interviews were collected though survey. All the interviews were conducted by the researcher himself. The researcher approached the authorities of the schools to seek permission for conducting this study. The researcher met the heads of the schools and mathematics teachers and had a discussion with them; their corporation was hence assured.

A sample of 3 or 4 students were selected from the same school for interview. The researcher established rapport with the child and presented the interview schedule. Responses were recorded by the researcher himself.

The researcher himself interviewed the mathematics teachers. He contacted with the teachers and took permission for interview. Interviews are conducted form the schools at their leisure time. Responses were recorded by the researcher.

Interview with the experts were conducted from their concerned offices. The researcher contacted the experts and venue and timings for interview were fixed. The researcher discussed with the experts based on the interview schedule and recorded their responses

3.4.2. 4 Focus Group Discussion Schedule

A focus group discussion is a form of qualitative research tool in which a group of people are asked about their perception, opinion, belief and attitude towards a product, service, concept, advertisement, idea or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members (Wikipedia, 2010)

Focus groups (also called group interviews) are a valid and reliable method for collecting data. Faculty have rated focus groups as more accurate, useful and believable than either student rating or written comments, although all three methods tend to provide similar impression of overall quality (Ory and Braskanp,1981)
Focus groups are powerful means to evaluate services or test new ideas. Basically, focus groups are interviews, but of 6-10 people at the same time in the same group. One can get a great deal of information during a focus group session (Namara, 1997)

The researcher organised a focus group discussion in order

(i) to discuss and identify the difficulties faced by the teachers while teaching division.

(ii) to discuss the challenges that he faced during the research and for eliciting suggestions for improvement

15 teachers participated in the focus group discussion which includes 7 experienced primary school teachers who were handling mathematics, 4 experienced teacher trainees, 3 experts in curriculum construction and textbook writing and the researcher himself.

The discussion started with the presentation of the objectives of discussion. It continued with the discussion about the difficulties faced by teachers while teaching division. Major points were noted and the researcher presented the data, he collected about the problem which includes the data obtained through division track test, interviews with students, teachers and experts and through his personal experience.

A thorough discussion was done about the presentation. All the participants expressed their feelings about the problem. It continued for 2 hours. Each and every point was noted. The noted points were evaluated.

3.4. 3 PREPARATION OF THE LEARNING MATERIAL

After identifying the difficulties faced by the students while learning ‘division’, the researcher prepared the learning materials to overcome these difficulties and to make the learning of ‘division’ a fruitful experience. Preparation of the learning material giving emphasis to these difficulties was a challenge to the researcher.
To find out the content coverage and to identify the strategies used for the transaction of the topic ‘division’ the researcher followed the following steps.

(i) He thoroughly analysed the chapters, dealing ‘division’ in 3rd, 4th and 5th standard mathematics course books and teacher’s hand books of Kerala state syllabus.

(ii) He collected the mathematics text books of 2nd to 5th standards of NCERT, CBSE, Karnataka, Tamil Nadu, Andra Pradesh, Maharashtra, Rajasthan and West Bengal and analysed the ‘division’ chapter of all those text books.

(iii) He had gone through the mathematics textbooks of different countries such as US, Australia, Egypt, Singapore, Malaysia, France and Japan. Since the text books of France and Japan were in their regional language, they were translated to English with the help of a translator. He analysed all the chapters dealt with ‘division’

(iv) He made use of the E-resources.

The researcher has already interviewed 35 Maths teachers, 60 students of fourth standard, who had studied the topic ‘division’ and three experts in this field. He conducted a ‘division track’ test, which is meant to identify the difficulties faced by the students while learning division.

By considering the different aspects of the topic ‘division’, difficulties faced by the students while learning ‘division’, opinion of the experts and experienced teachers, E-resources and related literature the researcher started preparing the learning materials for 3rd and 4th standards.

Steps followed for the preparation of learning materials

- **Consideration given to different levels of students**

While preparing the learning material, the researcher gave special attention to include activities that will enrich the different levels of students coming under below average, average and above average. Activities are frames by providing chances to each and every student to progress in his learning according to his needs.
Simple to complex
Each teaching point was presented with simple activities with one or two mental processes. Gradually challenging activities with more mental processes were included. In each complex problem there will be a chance for entry question even for the below average student. It helps to develop self-confidence among the students and to create interest in the subject.

From immediate life situations to social situations
The child begins his learning from his very near circumstances, his house, his garden, by sharing sweets … Then he moves slowly to the society.

Active involvement of the child
Activities are framed by giving due consideration to the personal experience of the child, his real life. Maximum provision is given for creating problems in the class which leads to learning.

Various modalities for acquiring a particular objective
Proper care should be given to include various learning modalities of different dimensions for acquiring a particular objective.

Conceptual level understanding
Due weightage was given to concrete situations for conceptual level understanding.

In order to make the learning material attractive, pictures and illustrations were made use of its maximum possibility. In each learning activity there is a part to create the need awareness in children and to lead them emotionally vibrant. There were sufficient appropriate learning activities to transact the objectives. The researcher discussed the learning material in detail with 2 experienced teachers and a BRC trainer (Refer Appendix XXVIII) and made necessary changes. It was then corrected and modified by the guide. Further it was also examined by three experts (Refer Appendix XXVII) and made necessary corrections.

The newly prepared learning materials have 2 parts. Part I is meant for Std III and is named as Manchadi I and Part II - is for Std. IV and it is called ‘Manchadi II’.
3.4.  3.1 Manchadi- I

Manchadi I was prepared for learning the chapter on ‘division’ of Std. III based on the following objectives.

(i) to form the concept ‘division’ by ‘equal sharing’, ‘recurring subtraction’ and ‘connecting with multiplication’.

(ii) to introduce the ‘division sign’.

(iii) to divide a two digit number by a one digit number using the multiplication facts.

(iv) to analyse, solve and construct practical problems connected with division.

Over view of the content


Six learning activities are for ‘recurring subtraction’. Those are ‘Grandpa and children’, ‘Square game’, ‘Jumping of Rabbits’, ‘Gift of Vishu’, ‘Navya’ and ‘Milkman’. The last three are for formative evaluation. ‘The farmer’, ‘How many days?’, ‘Gopalan Chettan is cleaning his compound’, ‘A game with pencil’, ‘can you complete the tables’, ‘Numerical Circles’ and ‘Frogs’ are the learning activities for formative evaluation. The numerical circle-game can be repeated in 90 different ways. Ninety relations can be checked using the numerical circle.

In the last 2 pages different types of problems are given for evaluation. A division equation is given, asking them to explain the equation. Then 12 dots are grouped into 4 to write the division equations. A recurring subtraction is given.
Ask them to write the ‘division form’. Next is ‘to match division problems with answers’. Then ‘who is, inside the rectangle’? Next is ‘to find out the one who hides’. Some of the activities are discussed in detail.

The fourth learning activity of Manchadi I is ‘Cats of Earshad’

**Cats of Earshad**

From the fishes purchased from the market by his father, Earshad took 6 fish for his 3 cats. Once the cats got the smell of fish, the three cats came near Earshad.

6 fish were divided and given to 3 cats.

How many fishes each cat got?...

This can be expressed using symbol as $6 \div 3 = 2$

This is read as “6 part by 3 equal to 2” (this can also be expressed 6 divided by 3 is equal to 2).

Here Earshad disturbed 6 fishes for his 3 cats. First he disturbed 3 fishes. One fish for each of his 6 cats. Then he repeated the same. At the end of this activity the symbol of division is introduced. By the interview and Division track
test the researcher identified that the child knows sharing and the child knows division. But the child do not know both are same. By relating the symbol of division with sharing at the earlier stage it self may help the child to familiarize the relation with sharing and division.

The fifth learning activity in ‘Manchadi I’ is division of pearls’

**Division of Pearls**

Deepa teacher entered the class with a tray. The empty tray was divided in five columns (Partitions). Then she gave 10 pearls to the children and directed to put it equally in the partitions.

How many pearls in each partition? □

Using division symbol this can be expressed as $10 \div 5 =$ □

If there are 15 pearls and 5 partitions how many pearls will be in each portion? □

$15 \div 5 =$ □

If there are 20 pearls and 5 partitions how many pearls will be in each partition? □

$20 \div 5 =$□
There were 14 pearls and two partitions, how many pearls will be in each
partition?  

\[ 14 \div 2 = \square \]

If there are 18 pearls and 3 partitions, how many pearls will be in each partition?  

\[ 18 \div 3 = \square \]

**To the Teacher**

Activity shall be done in the classroom. Answers to be found out and entered in the book. Each and every student should get an opportunity to do the learning activity.

It is a practical work. It can be done from the class itself. First 10 pearls are equally dividing into 5 partitions of a tray. Then 15 pearls are equally dividing into 5 partitions. Next 20 pearls are equally dividing into 5 partitions. This experiment is repeated with 3 partitions and 18 pearls, 2 partitions and 14 pearls. At each stage the child has to write the answer by doing himself. Each child gets chance to do the work. At each stage the problem is written by a mathematical
equation using the ‘division sign’. This pleasurable experience helps the child to confirm what he had learn by the earlier activities.

The sixteenth learning activity in ‘Manchadi I’ is ‘Let us go for a journey’

**Let us go for a Journey**

Mother, father, uncle, grandfather, grandmother, their children and grand children, altogether 24 persons were going to visit Kollur Mookambika temple.

They got down from the train at Mangalore. For reaching the bus stand they have to hire an Auto. The maximum number of persons that can be accommodated in an Auto is 3. (even if children). To reach the bus stand how many autos will they have to hire?
• Total number of persons?…..
• The number of persons that can be accommodated in an Auto? …………. 
• Make groups with……………. persons in each group
• Number of groups obtained………….
• Number of Autos required……………
• If □ persons are accommodated in an Auto the number of Autos to be required □

To the teacher

By changing the number of persons to be accommodated in an Auto, the question can be repeated. Let the students create questions

It was an activity for self-evaluation. Here the child gets chance to frame similar questions.

The Twenty ninth learning activity in ‘Manchadi I’ is ‘Gopalan chettan is cleaning the compound’.
‘Gopalan chettan is cleaning the compound’

More plants grew up in the compound as a result of heavy rain this year. Gopalan chettan has been engaged to clear up all these plants. He worked until noon for two days. Father gave him 90 rupees for 2 days coolie. Then, what will be Gopalan chettan’s coolie for a day?

\[
\begin{align*}
2 \times \underline{} &= 90 \\
90 \; 2 \div &= \underline{} 
\end{align*}
\]

Coolie of gopalan chettan for a day ………

It is an activity for concept formation of division connecting with multiplication. Coolie for 2 days is 90. Then what will be the coolie for a day. First the child has to find out what has to be multiplied with 2 to get 90. then it is converted into division form.

Thirty eight learning activity in ‘Manchadi I’ is can you write the division sentence of the picture

**Can you write the division sentence of the picture?**
It is an evaluation problem. Here 30 cups divided equally in to 5 partitions. In each partition there are six cups. The child has to write an apt division sentence for the figure.

**Sample selected**

To find out the effectiveness of the newly developed learning material ‘Manchadi I’, it was administered to a selected sample of students. A sample of 214 students were selected randomly from 3 districts Kasargod, Malappuram and Palakkad for the experimental study. Out of the 214 samples 107 were of the experimental group and 107 were of the control group. The experimental group was instructed with ‘Manchadi I’ and the control group was instructed through the present process–oriented strategy with the division chapter “Let us share” of Mathematics text book for standard III for the year 2007-2008 of Kerala State Syllabus.

Details regarding the sample selected are given below in table 3. 9

**Table 3.9**

**Details of the sample selected for the Administration of ‘Manchadi I’**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of school</th>
<th>District</th>
<th>Type of management</th>
<th>Locality of school</th>
<th>No. of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>1</td>
<td>UBMC ALPS</td>
<td>Kasargod</td>
<td>Aided</td>
<td>Urban</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>UBMC ALPS</td>
<td>Kasargod</td>
<td>Aided</td>
<td>Urban</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>UBMC ALPS</td>
<td>Kasargod</td>
<td>Aided</td>
<td>Urban</td>
<td>19</td>
</tr>
<tr>
<td>2.</td>
<td>GMUPS Koalppuram</td>
<td>Malappuram</td>
<td>Govt.</td>
<td>Rural</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>GMUPS Koalppuram</td>
<td>Malappuram</td>
<td>Govt.</td>
<td>Rural</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>GMUPS Koalppuram</td>
<td>Malappuram</td>
<td>Govt.</td>
<td>Rural</td>
<td>18</td>
</tr>
<tr>
<td>3.</td>
<td>GUPS Thenkara</td>
<td>Palakkad</td>
<td>Govt.</td>
<td>Rural</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>GUPS Thenkara</td>
<td>Palakkad</td>
<td>Govt.</td>
<td>Rural</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>GUPS Thenkara</td>
<td>Palakkad</td>
<td>Govt.</td>
<td>Rural</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>52</td>
</tr>
</tbody>
</table>
From each school equal numbers of students were selected for both experimental and control groups.

3.4. 3.2 Manchadi II

Manchadi II was prepared for fourth standard based on the following objectives,

i. ‘to divide a two digit number by a one digit number by ‘long division’.

ii. ‘to identify the quotient and the reminder’.

iii. ‘to analyse and solve practical problems of the four fundamental operations’

iv. ‘to know how to construct practical problems’

Overview of the content

There are 52 learning activities in Manchadi II. The first activity ‘Lotus pond’ and the second activity ‘chocolate box’ are for reviewing sharing. The third activity ‘vegetable garden’ is for reviewing division connecting with multiplication. Most of the teachers interviewed remarked that one of the reasons that the child feels very difficult to do division problem is that they haven’t got a concrete idea about multiplication table. The fourth activity ‘Distribution of books’ helps the child to construct the multiplication table. They knew the multiplication table of 2, 3, 4 and 5. Using this they are constructing multiplication tables of higher numbers. The fifth activity ‘A bus journey’ is for reviewing recurring subtraction.

The sixth activity ‘Distribution of learning aids’ introduces division with recurring subtraction then it gives freedom to the child to subtract any multiple of the divisor. The seventh activity ‘How many Autorickshas’ gives chance to the child for guessing the answer and then to verify it. It persuades the child to find out other ways to solve the problem. The Eighth activity is for reviewing the above. In Ninth activity, there are 4 problems. All of them are for self evaluation. Activities 10 to 12 are also for self-evaluation.
Activity 13 ‘A game with currencies’ is a concrete example for how a digit attain a new value while considering it’s position. It is to practice in the class. Activity 14 has four subdivisions and all of them are for self-evaluation. Activity 15 ‘A game with a circle’ is a game. It is for self-evaluation. Activity 16, ‘can you write the answer’ is for self-evaluation. The seventeenth activity is ‘Chackochan and children’, The eighteenth activity ‘Try please’ and the nineteenth activity ‘ribbon’ are for the concept formation ‘quotient and reminder’. Activity 20-22 are for self-evaluation. Activity 23, ‘A game with reminder’ is a game for practice. Activity 24 is for self-evaluation.

The 25th learning activity ‘who is right’ is to introduce long division as a higher form of recurring subtraction. Activities 26-29 are for self-practice. Activities thirty ‘How many notebooks will each get’, Thirty one, ‘Banana Merhant’, Thirty two ‘Tour’ are practical problems to analyse and solve. Activities 33, 34, 35, 36, 37; ‘ribbon’; 38, ‘complete the pattern’; 39, ‘can you fill’; 40, ‘can you construct using numbers’; 41, ‘can you fill the number sum’; 42 ‘can you construct the number sum’ and 43, ‘can it escape’ are for self-evaluation.

Activity 44, gives an idea, about how to construct problems by analysing the situation. Activities 45 to 48 are problems for practice and self-evaluation. Activities 49 and 50 are puzzles based on division. Activity 51 is to practice division by ‘division frame’ it is not compulsory. If the child likes, he can practice it. The last activity, 52 is given as a project. It is to find out the relationship between dividend, divisor and quotient. Some of the learning activities are discussed in detail. The sixth learning activity of ‘Manchadi II’ is distribution of ‘Learning aids’.

Distribution of learning aids

Anu’s school got grant for learning aids. They purchased colour pencils for students. Fourth std. students got 48 pencils. If these pencils are distributed equally among three groups, How many pencils will each group get? – asked the teacher.
Anu put aside 3 pencils each. 16 times he put aside.

Maimuna did this way

\[
\begin{align*}
48 & (-3) 10 \text{ pencils given to 3 groups} \\
45 & (-3) 15 \text{ pencils are given to 3 groups} \\
42 & (-3) 18 \text{ pencils are given to 3 groups} \\
39 & (-3) 21 \text{ pencils are given to each of the 3 groups} \\
36 & (-3) 24 \text{ pencils are given to each of the 3 groups} \\
33 & (-3) 27 \text{ pencils are given to each of the 3 groups} \\
30 & (-3) 30 \text{ pencils are given to each of the 3 groups} \\
27 & (-3) 33 \text{ pencils are given to each of the 3 groups} \\
24 & (-3) 36 \text{ pencils are given to each of the 3 groups} \\
21 & (-3) 39 \text{ pencils are given to each of the 3 groups} \\
18 & (-3) 42 \text{ pencils are given to each of the 3 groups} \\
15 & (-3) 45 \text{ pencils are given to each of the 3 groups} \\
12 & (-3) 48 \text{ pencils are given to each of the 3 groups} \\
9 & (-3) 51 \text{ pencils are given to each of the 3 groups} \\
6 & (-3) 54 \text{ pencils are given to each of the 3 groups} \\
3 & (-3) 57 \text{ pencils are given to each of the 3 groups} \\
0 & (-3) 60 \text{ pencils are given to each of the 3 groups}
\end{align*}
\]

16 pencils are given to each of the three groups.

I got, Roshan said.
Look, how I did Unni raised his book.

\[
\begin{array}{c}
48 \\
-6 (2 \times 3) \\
-12 (4 \times 3) \\
-30 (10 \times 3) \\
\hline
0 (16 \times 3)
\end{array}
\]

2 pencils are given to 3 groups
4 pencils are given to 3 groups
10 pencils are given to 3 groups
16 pencils are given to each of the three groups

It is an item for concept formation. Here Anu subtracted 3, 16 times and he got the answer 16. Then Maimuna subtracted 30 first and 18 the nth. Both 30 and 18 are multiples of 3 and 30 = 10 \times 3, 18 = 6 \times 3. By adding 10, 6 she got the quotient 16. While Roshan subtracted 15, three times and finally 3. 15 = 5 \times 3, 15 = 5 \times 3, 15 = 5 \times 3, 3 = 1 \times 3. By adding 5, 5, 5, 1 he got the Quotient 16. Unni subtracted 6, 12 and 30. 6 = 2 \times 3, 12 = 4 \times 3 and 30 = 10 \times 3. By adding 2, 4, 10 he got the Quotient 16. This experience gave the child the idea that he could subtract any multiple of the divisor from the dividend. By adding the no. of times he subtracted the divisor, he would get the quotient. It would be surely a pleasurable experience for the child.

Moreover, from the interview with students, teachers and from the division track test the researcher felt that the child knows recurring subtraction and he also knows what is division. But he doesn’t have the feeling that recurring subtraction is division. This experience will be very helpful to identify that recurring subtraction is division.

The fifteenth learning activity in ‘Manchadi II’ is ‘A game with a circle’.
**A game with a circle**

Make a circle as given in the picture. Fix it anywhere so that it can be rotated. Hang a weight from the centre of the circle. Let the participant in the game rotate the circle. Wait until the rotation completes. Check the position of the thread. Divide the larger number by the smaller.

Write down the quotients. (Don’t consider the remainders). Let the child rotate the circle for a definite no. of time. Add the quotient got by each one. Declare one who gets the maximum number, as winner.

This game is for self-evaluation of the child. Each of them simply rotates the circle and applies what he had learned earlier. The game can be repeated for a no. of times by changing the number inscribed in the circle. While completing the game, the content would be thoroughly imbibed.

The twenty fifth learning activity in ‘Manchadi II’ is ‘who is right?’.

**Who is right?**

Deepa teacher reached the class with 96 chart papers for maths exhibition. Children were grouped in 6 teams and they were asked to prepare chart. The whole chart papers were divided equally. So how many chart paper will get to each group?

Sajeer, Rose and Arjun are eager to find the answer.
It is for concept formation. Here long division is introduced as a higher form of recurring subtraction. In earlier learning activities the child has the freedom to subtract any multiple of the divisor. Here Rosa subtracts 30, 30 and 6 from the dividend. She wrote the multiple number on the top of the process and by adding these numbers she got the quotient 16. While Sajeer subtracts 60, 36 from the dividend. He also wrote the multiple numbers on the top of the process and by adding these numbers he got the answer 16. While Arjun did the problem by ‘long division algorithm’.

My answer is correct

\[
\begin{array}{c}
10+6 = 16 \\
6 \\
\hline
96 \\
60 \\
\hline
36 \\
36 \\
\hline
0 \\
\end{array}
\]

Whose answer is correct? ________________
By a simple explanation by the teacher, the child easily understood what long division is. It would be clear from this experience that long division is a contracted form of recurring subtraction.

The thirty first learning activity in Manchadi II is ‘Banana Merchant’.

**Banana Merchant**

Abbas, the banana merchant went to market to sell banana. He has three bunches of banana having 28, 37 and 27 number of banana respectively in each bunch. He made them into small group of 7 numbers each the rest was kept aside. Out of this he sold 8 groups. How many banana left with him then?

The total number of bananas brought for sale.

The number of bananas in one group?

Total number of groups

The no. of bananas not kept in the group

The no. of bananas sold?

The number of bananas left after selling

It is a practical problem. The four fundamental operations addition, subtraction, multiplication and division are included in the activity. The activity is subdivided into different stages.

By going through these stages, the child will reach the answer. The 42\textsuperscript{nd} learning activity in ‘Manchadi II’ is can you construct the number sun?’.
Can you construct the number sun?

It is an activity for self-evaluation. It is an extension of the activity 41. It will be very interesting for the child. Each child in the class gets chance to construct his own number sun. He will have freedom to construct as many number of suns as he likes.

The 46th learning activity in ‘Manchadi II’ is ‘Milk shop’.

Milk shop

Your Question

Paid 84 rupees for seven packets of milk
It is an application level evaluation problem. Here the child is asked to frame a question by evaluating the situation.

Sample selected

It was already selected a sample of 214 students from 3 districts; Kasargod, Malappuram and Palakkad to find out the effectiveness of the learning material ‘Manchadi I’. The same sample was selected to find out the effectiveness of the newly developed learning material ‘Manchadi II’ Out of the 214 samples, 107 were from experimental group and 107 from control group. The experimental group was instructed with the “Manchadi II” and the control group was instructed through the present process-oriented strategy with the division chapter, ‘Let us divide’ of Mathematics text book for standard IV for the year 2008-2009 of Kerala state syllabus.

Administration of learning materials – Manchadi I and Manchadi II

The researcher contacted the Heads of the selected schools and contacted the concerned teachers who were handling mathematics in 3rd standard in the first year and 4th standard in the next year. After discussing with the concerned teachers 2 classes were selected from each school for experimental study. They were treated as the control group and experimental groups.

Workshops were conducted at GUPS Kolappuram, Malappuram district in the two years. The mathematics teachers of concerned standards of the experimental schools, a BRC trainer and the researcher himself attended the two workshops (Refer Appendix XXV and XXVI). Each item of the learning material was discussed in detail. Planning for the classes was done. Priority was given to activities. The researcher collected all the necessary teaching-learning materials which include three types of tray with pearls, sweets, picture cards, paper and pens for 3rd standard and play notes, number circles, dices, division frames, charts, markers and pencils for 4th standard. The researcher himself had handled both the experimental and control groups of the three schools.
Pre-test and Post-test

Before the administration of Manchadi I and Manchadi II pre-tests were administered both in the experimental and control groups. The tests were based on the division chapters ‘Let us share’ of 3rd standard and ‘Let us divide’ of 4th standard. After completing Manchadi I in the experimental group and the division chapter, “Let us share” through present process-oriented strategy in the control group; the same achievement test was administered to both the groups as post-tests. Both the answer scripts of the pre-test and post-test were collected, valued and subjected to further analysis. The same procedure is adopted in the next year for the 4th standard.

3.4.4 Preparation and standardization of ‘Tests on division skills’

For the present study the investigator developed and standardized 2 ‘tests on division skills’, which is achievement in nature.

An achievement test is “a test that measures the extent to which a person has ‘achieved something, acquired certain information, or mastered certain skills usually as a result of planned instruction or training” (university of Wisconsin – stout, 2007).

Out of the 2 ‘tests on division skill’, one was for standard III and the other was for standard IV. These tests were constructed to test the effectiveness of the learning materials, ‘Manchadi I’ and ‘Manchadi II’. The ‘test on division skills’ were administered as pre-test and post test.

3.4.4.1 Test on division skills for 3rd standard

i. Planning of the test

The first step in the construction of the test on division skills is planning. He read the mathematics text book and Teachers source book for third standard and consulted with 2 experienced teachers and a BRC trainer. Both the four discussed the topic in detail. With the consultation of the guide the researcher decided to the maximum time, marks, no of questions and nature of the test. The test is based on the unit ‘Let us share” of 3rd standard. It is for one hour duration with a maximum of twenty five marks.
ii. Preparation of the test items

The main purpose of an evaluation tool is to assess what knowledge did child achieved and to what extent did he achieved. For such an assessment it is necessary to test his conceptual understanding, skills and competency he achieved. By considering the practicability and easiness in administration, scoring and objectivity in assessment the researcher decided to construct all the items as objective-multiples choice type.

With the help of experienced teachers, the researcher prepared the test items. Since the test is to be standardized, a double no of objective multiple choice type items (50 items) were prepared for the preliminary test so as to ensure that sufficient number of acceptable items will be available at the end. Then the researcher discussed with the guide and necessary changes were made. The items were presented before 2 experts for critical examination and correction. Two DIET Lectures (refer AppendixXXVII) who were expertised in primary mathematics checked the items and made necessary changes.

20 items are prepared under the objective ‘To form the concept division’ 6 items are to test how ‘division sign’ is familiar to the student. Another 6 items are for testing how the students is able ‘to divide a two digit number by a one digit number using multiplication’ 18 items are prepared to test whether the child is able to ‘analyse and solve practical problems which includes division’.

(iii) Organisation of the test

After finalizing the items, these were arranged in a mixed order. While arranging the items, care was taken that the first few inclusions were not difficult. Before the items the preliminary details and instruction for answering the questions were included in the appropriate places. Also there are spaces for writing the name, school, sex and type of school.
### Table 3.10

**Details of the sample selected for Administration of the draft test**

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Name of School</th>
<th>No. of students included in the pilot study</th>
<th>No. of answer script selected for item Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Govt. LPS Hosdurg theruvath Kasargod district</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td>2.</td>
<td>GFUPS Kanhangad Kasargod dt.</td>
<td>48</td>
<td>46</td>
</tr>
<tr>
<td>3.</td>
<td>GUPS Ayampara . Kasargod dt.</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>4.</td>
<td>GWUPS Kodakkat Kasargod dt.</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>5.</td>
<td>GLPS Kallingal Kasargod dt.</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>6.</td>
<td>GUPS Kangirapoil Kasargod dt.</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>7.</td>
<td>KKNM AUPS Olat Kasargod dt.</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>8.</td>
<td>AUPS Chathamath Kasargod dt.</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>9.</td>
<td>AUPS Pattiyamma Kannur dt</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>10.</td>
<td>AUPS Puthilot Kasargod dt.</td>
<td>34</td>
<td>32</td>
</tr>
<tr>
<td>11.</td>
<td>NKBMUPS Nileshwar Kasargod dt.</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>12.</td>
<td>ALPS Karayil Kasargod dt.</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>399</strong></td>
<td><strong>370</strong></td>
</tr>
</tbody>
</table>

(iv) **Item analysis**

Item analysis is an integral part of both reliability and validity of the test through the process of difficulty index and discriminating power. Thus the procedure of item analysis helps to select the very best items for final test.
The analysis of students responses to objective test item is a powerful tool for test improvement and for accumulating a bank of high quality items. The researcher had done the item analysis, using the following procedure. In the present study, in order to find out the difficulty index and discriminating power, 370 scored answer scripts were taken and followed these six steps.

1. Arranged the scored answer scripts in descending order.

2. The highest 27% and the lowest 27%, with respect to the total score is separated. As total answer script is 370, 27% of the number will be almost equal to 100 and hence the top most 100 scripts and the lowest 100 scripts can be separated.

3. Examined each answer script in either group and determine the no of examines in the group who have answered each item correctly.

4. Difficulty Index: - It represents the percentage of students who respond to it correctly. More percentage of the correct responses, easier is the item. N is the number of examinees in the upper or lower group and if U and L are the numbers in the two groups in the order, that have given correct responses to an item, the difficulty index will be indicated by the relation

\[ \text{Di} = \frac{U + L}{2N} \]

5. The discriminating power of an item is to discriminate between the upper and lower groups. If N is the no. of examinees in the upper and lower groups and if U and L are the numbers in the two groups in the order, that have given correct response to an item, the discriminating power will be indicated by the relation.

\[ \text{Dp} = \frac{U - L}{N} \]

The difficulty index and discriminative power of each item of the test on division skills draft for 3rd standard is given in Appendix XXI.
Criteria for selection of items

On the basis of the difficulty index and discriminating power, considered at the same time, items are rated.

1. The difficulty index was fixed from 0.44 to 0.62 with the additional restriction that all possible value in the range should be covered.

2. Within the difficulty criteria specified above it was decided to select items with the maximum discriminating power. Items having discriminating power 0.36 and above were taken.

Finalisation of the test

25 items were selected according to the blue print. Copy of the Test on division skills for 3rd std’ is given in the Appendix VII English and Appendix XV Malayalam.

Table 3.11
Details of the items selected for the final ‘Test on division skills’

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Sl No. of the items in the Draft test</th>
<th>Difficulty index Di = U+L/200</th>
<th>Discriminating power Dp=U-L/100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>0.61</td>
<td>0.45</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>0.45</td>
<td>0.43</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>0.62</td>
<td>0.46</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>0.58</td>
<td>0.39</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>0.54</td>
<td>0.66</td>
</tr>
<tr>
<td>7</td>
<td>17</td>
<td>0.58</td>
<td>0.62</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>0.54</td>
<td>0.42</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>0.58</td>
<td>0.64</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>0.5</td>
<td>0.63</td>
</tr>
</tbody>
</table>
Design developed for the ‘Test on division skills’ for 3\textsuperscript{rd} standard

The researcher developed the design of the test with the help of the team. The team analysed the unit ‘Let us share’ in terms of the objectives and determined the relative weightage to each objective and sub units in the content. It was decided that the test would be of objective type with 4 distracters and due weightage should be given for difficulty level.
a. Weightage given to instructional objectives in the ‘Test on division skills’ for 3rd standard

The utility, appropriateness and practicability of the objectives were considered to determine the relative importance of each objective. By considering the suggestions of the expert teachers and the guide the researcher gave weightage to these objectives. (1) to form the concept division (i) by sharing equally (ii) by recurring subtraction (iii) by connecting with multiplication (2) to introduce division sign (3) dividing a two digit number by a one digit number (using multiplication) (4) to analyse and solve practical problems which includes division.

Table 3.12

Weightage given to instructional objectives in the ‘Test on division skills’ for 3rd standard

<table>
<thead>
<tr>
<th>No.</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To form the concept division</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>i) by sharing equally</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) By recurring subtraction</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii) By connecting with multiplication</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>To introduce division sign</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Dividing a two digit number by a one digit number (Using multiplication)</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>To analyse and solve practical problems which includes division</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
b) Weightage given to content areas in the ‘Test on division skills’ for 3rd standard

Since the test is on division based on the unit ‘Let us share’ of third standard the content area is limited to the unit ‘Let us share’ of the third standard.

c) Weightage given to form of questions in the ‘Test on division skills’ for 3rd standard.

Objective test items only were considered in the test because such items are more economical, timesaving, reusable and tend to possess higher score reliability and content validity. Scoring will be hundred percent objective. Therefore the researcher decided to include only objective type multiple choice items.

d) Weightage to difficulty level

By considering all levels of the student the researcher decided sixty percentage of the items of average difficulty with twenty percentage on either side of the distribution.

Table 3.13

Weightage given to difficulty level in the ‘Test on division skills’ for 3rd standard

<table>
<thead>
<tr>
<th>No.</th>
<th>Levels of difficulty</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

e. Blueprint of the ‘test on division skills’ for 3rd standard

Here blueprint is a two dimensional chart indicating objectives and difficulty level since all the questions are of objective type multiple choice, the type of the question is not mentioned in the blueprint.
Table 3.14

Blueprint for the ‘Test on division skills’ for 3rd standard

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>To form the concept division</th>
<th>To introduce division sign</th>
<th>Dividing a two digit number by one digit number (using multiplication)</th>
<th>To analyse and solve practical problems which includes division</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>40.29 (2)</td>
<td>10 (1)</td>
<td>28 4 (2)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>23, 31 (2)</td>
<td>6, 14 18</td>
<td>11 (1)</td>
<td>8.20 (2)</td>
<td>43, 45, 46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41 (4)</td>
<td></td>
<td>47, 17 (5)</td>
<td>15</td>
</tr>
<tr>
<td>Difficult</td>
<td></td>
<td>27 1)</td>
<td>22 (1)</td>
<td>21, 48 (2)</td>
<td>5</td>
</tr>
<tr>
<td>Sub total</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>25</td>
</tr>
</tbody>
</table>

The number outside the bracket indicates the serial number of the test items in the draft.

The number inside the bracket indicates the total no of items.

**Preparation of the scheme for evaluation and scoring**

In order to maintain objectivity, the scoring is made strictly, in accordance with a pre-designed scheme of evaluation. The scoring key was prepared and the answer scripts were scored by the researcher. It was decided to give one score for each correct response and no score for wrong responses. Incomplete answer scripts were discarded and finally 370 scripts were selected for the Item analysis.

**Validity and Reliability of the test**

The validity and reliability of the achievement test were assessed before it was used for the final data collection.
Determination of validity

Validity is the extent to which a test measures what it intended to measure. In the present study the researcher determined the content validity and empirical validity.

Content validity

‘Content Validity is concerned with the extent to which the test is representative of a defined body of content consisting of Topic and process (William Wiersma, 1995). This involves proper coverage of the content to be learned as well as the instructional objectives to be realized. The researcher prepared the items with the help of expert teachers. (Refer Appendix XXVIII)

A design was prepared which shows weightage to each subunits, instructional objectives. Items were constructed for evaluating all those objectives. Then the items were verified by the guide and thoroughly examined and corrected by a team of 2 experts (Refer Appendix XXVII). By this process the researcher ensured the content validity.

Empirical Validity or statistical Validity

‘Statistical validity is similar to internal validity. Here the question is, Was the observed relationship between the independent and dependent variables a true cause effect relationship, or Was it accidental, or Was the number of subject so small that the result happened purely by chance? (Burney, mc 2001) ‘The empirical validity of the test is calculated by correlating the scores of the test with marks of a recently conducted test obtained from the school’ (Ebel, 1991)

Here empirical validity of the test was calculated by correlating the test scores with the second terminal examination maths score of the same students. The coefficient of correlation obtained by calculating the product moment correlation is 0.75. This ensures the empirical validity of the test.
Reliability of the test

‘A test is reliable if it consistently yields the same, or nearly the same, ranks over repeated administration’ (Tom Kubis zyn, 1993)

In the present study, the researcher used Split-half method to establish reliability

Split-half method

The achievement test is divided into two equal halves and each half is considered as a separate test. These independent subjects are then used as a source of the two independent scores needed for reliability estimation. Here the researcher considered odd items and even items separately to develop the half tests.

Internal consistency calculated by this method is actually a way of finding alternative form reliability for a test half as long. However, since a test is usually more reliable, if it is longer, therefore the split-half (or odd-even) reliability coefficient should be corrected or adjusted upward to reflect the reliability that the test would have if it were twice as long.

In the present study responses of 100 were used to develop half tests. Then the correlation between the two sets of scores was determined statistically. The coefficient of correlation obtained in this was 0.86. The reliability coefficient of the whole achievement test was then calculated using spearman Brown prophecy formula

\[ R = \frac{2r}{r + l} \]

The obtained reliability coefficient was 0.92 which indicates that the test may be highly reliable.

3.4. 4.2 Test on division skills for 4th standard

Test on division skills for 4th standard was prepared by following the same procedure for the preparation of ‘Test on divisions skills’ for 3rd standard. Details of the sample selected for administration of draft test is given in the Appendix XXVIII
Item Analysis

For item Analysis 370 answer scripts were selected. Based on the scores obtained, the answer scripts were arranged in descending order from the highest to the lowest. The responses of the top scoring 27 percentage and the bottom scoring 27 percentage were used for Item analysis. Items having difficulty index between 0.40 to 0.64 and discriminating power 0.40 and above were selected for the final test. 25 items were selected according to the blueprint. The item analysis data of the draft ‘Test on division skills’ for 4th standard is given in Appendix XXVII.

Table 3.15
Details of the items selected for the final ‘Test on division skills’

<table>
<thead>
<tr>
<th>Sl. No. of Item</th>
<th>Sl. No. of the item in the Draft test</th>
<th>Difficulty index ( \text{Di} = \frac{U + L}{200} )</th>
<th>Discrimination power ( \frac{U - L}{200} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>3</td>
<td>0.59</td>
<td>0.45</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>0.56</td>
<td>0.53</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>0.48</td>
<td>0.61</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>0.59</td>
<td>0.41</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>0.56</td>
<td>0.49</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>0.55</td>
<td>0.63</td>
</tr>
<tr>
<td>7</td>
<td>17</td>
<td>0.64</td>
<td>0.53</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>0.48</td>
<td>0.72</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>0.52</td>
<td>0.65</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Sl. No. of Item</td>
<td>Sl. No. of the item in the Draft test</td>
<td>Difficulty index $Di = \frac{U + L}{200}$</td>
<td>Discrimination power $U - L$</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------</td>
<td>---------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>11.</td>
<td>26</td>
<td>0.45</td>
<td>0.40</td>
</tr>
<tr>
<td>12.</td>
<td>27</td>
<td>0.40</td>
<td>0.64</td>
</tr>
<tr>
<td>13.</td>
<td>28</td>
<td>0.44</td>
<td>0.59</td>
</tr>
<tr>
<td>14.</td>
<td>31</td>
<td>0.50</td>
<td>0.61</td>
</tr>
<tr>
<td>15.</td>
<td>32</td>
<td>0.49</td>
<td>0.64</td>
</tr>
<tr>
<td>16.</td>
<td>35</td>
<td>0.54</td>
<td>0.62</td>
</tr>
<tr>
<td>17.</td>
<td>36</td>
<td>0.57</td>
<td>0.67</td>
</tr>
<tr>
<td>18.</td>
<td>38</td>
<td>0.42</td>
<td>0.47</td>
</tr>
<tr>
<td>19.</td>
<td>42</td>
<td>0.43</td>
<td>0.52</td>
</tr>
<tr>
<td>20.</td>
<td>44</td>
<td>0.57</td>
<td>0.65</td>
</tr>
<tr>
<td>21.</td>
<td>45</td>
<td>0.55</td>
<td>0.58</td>
</tr>
<tr>
<td>22.</td>
<td>46</td>
<td>0.45</td>
<td>0.57</td>
</tr>
<tr>
<td>23.</td>
<td>47</td>
<td>0.42</td>
<td>0.59</td>
</tr>
<tr>
<td>24.</td>
<td>48</td>
<td>0.50</td>
<td>0.59</td>
</tr>
<tr>
<td>25.</td>
<td>50</td>
<td>0.40</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Weightage given to instructional objectives in the ‘Test on division skills’ for 4th Standard.

By considering the suggestions of the experts and the guide the researcher gave weightage to the objectives as table follows.
### Table 3.16

**Weightage to instructional objectives**

<table>
<thead>
<tr>
<th>No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>To divide a two digit number by one digit number by long division</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Where regrouping is not in the tenth place</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) Where regrouping is not in the unit and tenth places</td>
<td>4</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>iii) Where regrouping is in the tenth place</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iv) Where regrouping is in the unit and tenth places</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>To identify the quotient and the dividend</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>To analyse and solve practical problems which includes the four fundamental operations</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

**Weightage given to content area in the ‘Test on division skills’ for 4th standard**

Since the researcher is constructing an achievement test on ‘division’ based on the unit ‘Let us divide’ of 4th standard, the content area is limited to the unit ‘Let us divide’ of the 4th standard.
Weightage given to form of question in the ‘Test on division skills’ for 4th standard

In the present study the researcher decided to include only objective-type multiple choice item.

Weightage of difficulty level

By considering all levels of students the researcher gave weightage to different difficulty levels as follows.

Table 3.17

Weightage given to difficulty level in the ‘Test on division skills’ for 4th standard

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Levels of difficulty</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Difficulty</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Blueprint of the test

Here blueprint is a two dimensional chart indicating objectives and difficulty level. Since all the questions are of objective type- multiple choice, the type of question is not mentioned in the blueprint.
Table 3.18
Blueprint for the ‘Test on division skills’ for 4\textsuperscript{th} standard

<table>
<thead>
<tr>
<th>Levels Of Difficulty</th>
<th>Dividing a two digit number by a one digit number</th>
<th>Identify the quotient and remainder</th>
<th>Analyse and solve practical problems in connecting with the four fundamental operations</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regrouping is not in the tenth place</td>
<td>Regrouping is not in the unit and tenth places</td>
<td>Regrouping in the tenth place</td>
<td>Regrouping is in the unit and tenth places</td>
</tr>
<tr>
<td>Easy</td>
<td>13,35, 45, 17 (4)</td>
<td>14(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Average</td>
<td>3, 32, 44 (3)</td>
<td>18, 31, 36 (3)</td>
<td>8, 20, 46 (3)</td>
<td>28(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10, 24, 38, 47, 48(5)</td>
<td>15</td>
</tr>
<tr>
<td>Difficult</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Number out side bracket indicates their number in the draft test.
Number inside the bracket indicates the total number of questions.
Validity and Reliability of the test

The validity and reliability of ‘Test on division skills’ was assessed before it was used for the final data collection.

The content validity, empirical validity and reliability were established following the same procedure of the ‘Test on division skills’ for 3rd standard.

3.5 Sample Selected for the study

The population consisted of primary school pupils of Kerala state syllabus. Keeping in view of the nature of the study, it demands and limitations the researcher selected samples from the Kasargod, Malappuram and Palakkad districts. These districts have the least pass percentage in mathematics of the SSLC examination 2002 to 2006. Details regarding the sample selected are given below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Purpose</th>
<th>No. of Samples selected for the final study</th>
<th>Details regarding the samples selected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Division track Test (For survey)</td>
<td>583</td>
<td>4th standard students of Kasargod, Malappuram and Palakkad districts.</td>
</tr>
<tr>
<td>2</td>
<td>Interview with teachers (For survey)</td>
<td>35</td>
<td>Mathematics teachers of primary schools of Kasargod, Malappuram and Palakkad districts</td>
</tr>
<tr>
<td>3</td>
<td>Interview with students (For survey)</td>
<td>60</td>
<td>4th standard students of Kasargod, Malappuram and Palakkad districts</td>
</tr>
<tr>
<td>4</td>
<td>Interview with experts (for survey)</td>
<td>3</td>
<td>Experts in the fields of mathematics education</td>
</tr>
<tr>
<td>5</td>
<td>Focus group discussion</td>
<td>15</td>
<td>7 experienced primary school teachers, 4 experienced teacher trainers, 3 experts and the researcher</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Purpose</td>
<td>No. of Samples selected for the final study</td>
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</tr>
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</tr>
</tbody>
</table>
| 6      | To test the effectiveness of newly prepared teaching materials. (experiment) | 214 | UBMC ALPS Kanhangad (Kasargod)– 68  
|        |         |                                           | GUPS Kolappuram (Malappuram) – 76   
|        |         |                                           | GUPS Thengara (Palakkad)-70         
|        |         |                                           | (2 divisions from each school)       
|        |         |                                           | Half of the students from each school is experimental group and the next half is control group. Same students of 3rd and 4th standard were selected for the experimental study for the continuous 2 years. |

### 3.5 Statistical Techniques adopted

The pre-test scores and post-test scores of the experimental and control groups were consolidated for statistical analysis. For this following statistical techniques were used.

1. Statistical constants such as Mean, Median, Mode, SD, QD, Skewness and Kurtosis.
2. Testing the significance of mean difference
3. ANCOVA

The details of the analysis of data using relevant statistical methods have been compiled in the next chapter.