Chapter - III

Plan and procedure of the study
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Plan and procedure of the study

"Research is the careful inquiry or examination to discover new information or relationships and to expand and to verify existing knowledge".

- Francis Rummel

3.1. Introduction: In the first two chapters of this report the significance of the study and review of the related literature were presented respectively. The present chapter is intended for the plan and procedure of the investigation. This section explains the design of the study in detail. The size and selection of the sample, the variables and the controls employed the sources of data, the tools and methods of gathering data, the reliability and validity of instruments selected were carefully described. This would give an accurate and detailed description of how this work was done.

3.2 Statement of the problem: The present investigation intended to find out the learning of mathematical concepts of IX class pupils is also intended to find out whether learning of these mathematical concepts in any way is related to spatial ability and their problem solving skills. This investigation is intended to find answers to the following questions:

i) Is the learning of the mathematical concepts related to the spatial ability of IX class pupils?
ii) Is learning of the mathematical concepts related to the problem solving skills of IX class pupils?

iii) Does the learning of Mathematical concepts differ with respect to gender, academic achievement and type of concepts?

iv) Does the learning of mathematical concepts differ with respect to the environmental variables like status of the school, its location, educational background and economic background of the parents?

v) Does the learning of mathematical concepts differ with respect to the frequency of usage of teaching aids in classes?

To find answers to the above questions the topic is titled as under.

3.3. Title of the study:

"Learning of mathematical concepts in relation to spatial ability and problem solving skill among secondary school pupils"

3.4. Operational definitions of the key terms:

Learning of mathematical concepts: Includes learning and solving the problems in sets, mensuration and symmetry.

Spatial ability: Spatial ability is the ability to find spatial relations.

Problem solving skills: Problem solving skills are the abilities to approach or avoid any problem, problem solving confidence and personal control.
3.5 Objectives of the study:

1. To find out the level of learning of Mathematical concepts of secondary school pupils and classify them.

2. To find out the level of learning of Mathematical concepts in different areas in i) Sets ii) Mensuration iii) Symmetry of secondary school pupils.

3. To find out the spatial ability of secondary school pupils and classify them.

4. To find out the problem solving ability of secondary school pupils and classify them.

5. To find out the relation between learning of mathematical concepts and spatial ability of secondary school pupils.

6. To find out the relation between learning of mathematical concepts and problem solving skills of secondary school pupils.

(a) To find out the relation between the learning of mathematical concepts and approach avoidance of the problem in secondary school pupils.

(b) To find out the relation between learning of mathematical concepts and problem solving confidence in secondary school pupils.

(c) To find out the relation between the learning of mathematical concepts and personal control of the secondary school pupils.

7. To find out the relation between the learning of Mathematical concepts, spatial ability and problem solving skill of secondary school pupils.
8. To find out the relation between the learning of mathematical concepts and academic achievement of secondary school pupils.

9. To find out the influence of gender (Boys and Girls) on the learning of mathematical concepts of secondary school pupils.

10 (a) To find out the influence of location (Rural/Urban) on the learning of mathematical concepts of secondary school pupils.

(b) To find out the influence of status of the school on the learning of mathematical concepts of secondary school pupils.

(c) To find out the influence of the educational background of the parents on the learning of mathematical concepts of secondary school pupils.

(d) To find out the influence of economic background of the parents on the learning of mathematical concepts of secondary school pupils.

11 (a) To find out the influence of type of concept on learning on mathematical concepts of secondary school pupils.

(b) To find out the influence of use of teaching aids on the learning of mathematical concepts of secondary school pupils.

3.6 Hypotheses of the study:

1. Secondary school pupils differ in their levels of achievement in mathematical concepts.

2. Secondary school pupils differ in their levels of achievement in different areas of learning of mathematical concepts.
3. Secondary school pupils differ in their levels of learning of spatial ability.

4. Secondary school pupils differ in their levels of learning of problem solving skills.

5. There would be no significant relationship between the learning of mathematical concepts and spatial ability of secondary school pupils.

6. There would be no significant relationship between the learning of mathematical concepts and problem solving skills of secondary school pupils.

(a) There would be no significant relationship between the learning of mathematical concepts and approach avoidance character of secondary school pupils.

(b) There would be no significant relationship between the learning of mathematical concepts and problem solving confidence of secondary school pupils.

(c) There would be no significant relationship between the learning of mathematical concepts and personal control of the secondary school pupils.

7. There would be no significant relationship between the learning of mathematical concepts, spatial ability and problem solving skill of secondary school pupils.

8. There would be no significant relationship between the learning of mathematical concepts and academic achievement of the secondary school pupils.
9. There would be no significant difference between boys and girls in learning of mathematical concepts of secondary school pupils.

10 (a). There would be no significant difference between the rural and urban secondary school pupils in learning of mathematical concepts.

(b) There would be no significant difference between secondary school pupils of different schools in learning of mathematical concepts.

(c) There would be no significant difference between the pupils of parents with different educational background in learning of mathematical concepts.

(d) There would be no significant difference between the secondary school pupils of different economic backgrounds in learning of mathematical concepts.

11 (a) There would be no significant difference in the learning of mathematical concepts in relation to the type of concept.

(b) There would be no significant difference in the learning of mathematical concepts in relation to the use of teaching aids.

3.7 Method of research:

The survey method gathers data form cases at a particular time on what is happening and what is available at present time. It is not concerned with the characteristics of individuals as individual. It is concerned with general statistic that when data are abstracted from a number of individual cases. It is essentially cross sectional. The researcher thought that normative survey method is suitable to collect data through questionnaires and tests to pupils on
learning of mathematical concepts, on spatial ability and problem solving skills. The scores were compared variable wise to find out if there are any significant variations.

The survey is an important type of study. It requires expert and imaginative planning, careful analysis and interpretation of data gathered and logical and skillful reporting of the findings.

3.8 Sample and sampling:

A sample is a collection of objects or individuals of characteristics, which are found in the population. Sampling is the process of selecting a sample from the population. For the present study the investigator has taken up a stratified random sample of 31 schools and 620 pupils from IX class in Krishna District.

The details of the distribution of sample Table 1.
### Table 1: The Plan of the Sample

<table>
<thead>
<tr>
<th>S.No</th>
<th>Location/Type of School</th>
<th>No. of Schools</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td></td>
<td>Urban Schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1. Govt. Schools</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2. Private Schools</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>3. Private Aided Schools</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>4. Local Body</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Municipal</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>b. Corporation</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>14</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Rural Schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1. Govt. Schools</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2. Private Schools</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>3. Aided Schools</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>4. Local Body</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Z.P. Schools</td>
<td>12</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>31</td>
<td>270</td>
</tr>
</tbody>
</table>
The given below pie diagram shows percentage of gender.

Description of the sample distribution:

The total sample of 620 pupils include 56% of girls and 44% of boys.

Table 3: Distribution of the sample with respect to ‘Locality’

The students under the study are categorized into Rural and Urban area.

The following table shows the distribution.

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>340</td>
<td>55%</td>
</tr>
<tr>
<td>Urban</td>
<td>280</td>
<td>45%</td>
</tr>
<tr>
<td>Total</td>
<td>620</td>
<td>100%</td>
</tr>
</tbody>
</table>

Out of 620 students, the numbers of rural students are 340 and that of urban students are 280. Sample distribution shows that more number of students are taken in rural area than the urban area. Because the number of government schools are more in rural area than the urban area. There area large number of private schools than the government school.
3.9 Variables of the study:

a) Student Variables: Gender

b) Environmental Variables: Location, Status of the school, Educational background of the parents, Economical status.

c) Subject Variables: Mathematical Achievement, Type of concept, and Use of Teaching aids.

3.10 Variable wise distribution of the sample

Table 2: Distribution of the sample with respect to 'Gender'

The students under the study are categorized into boys and girls. The following table shows the distribution.

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>270</td>
<td>44%</td>
</tr>
<tr>
<td>Girls</td>
<td>350</td>
<td>56%</td>
</tr>
<tr>
<td>Total</td>
<td>620</td>
<td>100%</td>
</tr>
</tbody>
</table>

Out of 620 students, the number of girls students are 350 and that of boys are 270. Sample distribution shows that more number of girls are aware of education because the influence of government publicity about women education and print media, mass media plays an important role on women education.
Graph: 2 The given below pie diagram shows percentage of locality:

![Pie chart showing percentage of locality]

Description of the sample distribution:

The above graph shows the variable is locality and the total sample is 620 the percentage of rural pupil is 55 and the percentage of urban pupils is 45.

Table 4: Distribution of the sample with respect to ‘Status of the School’

<table>
<thead>
<tr>
<th>School Status</th>
<th>No. of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>80</td>
<td>13%</td>
</tr>
<tr>
<td>Private Aided</td>
<td>80</td>
<td>13%</td>
</tr>
<tr>
<td>Private Unaided</td>
<td>60</td>
<td>10%</td>
</tr>
<tr>
<td>Local Body</td>
<td>400</td>
<td>64%</td>
</tr>
<tr>
<td>Total</td>
<td>620</td>
<td>100%</td>
</tr>
</tbody>
</table>
Out of 620 pupils, the equal number of pupils are taken in government and private aided schools i.e. 80 for each, 60 pupils are taken for private unaided schools and 400 pupils are taken for local body schools (Z.P, Municipal, Corporation). Difference in the number of pupils for government, private aided, private unaided, local body schools are due to the difference in the number of schools under different managements in this area.

**Graph : 3 The given below pie diagram shows percentage of Status of the school:**

The above graph is shows the variable status of the school. The total sample is 620. the percentage of pupils of government schools is 13 pupils of private unaided is 13% pupils of private aided is 10% and the pupils of local body is 64%.
Table: 5 Distribution of the sample with respect to ‘Parental Education’

The pupils under the study are categorized into Illiterate/Elementary, secondary education and college educated parents. The following table shows the distribution.

<table>
<thead>
<tr>
<th>Parental Education</th>
<th>No. of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate/Elementary</td>
<td>343</td>
<td>55%</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>202</td>
<td>33%</td>
</tr>
<tr>
<td>College Education</td>
<td>75</td>
<td>12%</td>
</tr>
<tr>
<td>Total</td>
<td>620</td>
<td>100</td>
</tr>
</tbody>
</table>

Out of 620 pupils, the number of Illiterate/Elementary educated parents are 343, secondary education is 202 and college education is 75 most of the parents are Illiterate/Elementary background, few are secondary education and very less are college education.

Graph: 4 The given below pie diagram shows percentage of ‘Parental education’
Description of the sample distribution:

The above graph shows the variable is parental education and total sample is 620, the percentage of pupils with parents having illiteracy and elementary education is 55, secondary education is 33% and the college education is 12%.

Table 6: Distribution of the sample with respect to 'Economic Status'

The pupils under the study are categorized into poor, lower middle, upper middle and rich group. The following table shows the distribution.

<table>
<thead>
<tr>
<th>Economic Status</th>
<th>No. of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>231</td>
<td>37%</td>
</tr>
<tr>
<td>Lower Middle</td>
<td>305</td>
<td>49%</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>80</td>
<td>13%</td>
</tr>
<tr>
<td>Rich</td>
<td>04</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>620</td>
<td>100%</td>
</tr>
</tbody>
</table>

Out of 620 pupils the number of poor economic status are 231, lower middle economic status are 305, upper middle economic status are 80 and rich are 4. Most of the parents are poor and lower middle economic status, few are upper middle and very less are rich economic status.
Graph 5: *The given below pie diagram shows percentage of ‘Economic Status’*

![Pie Chart]

Description of the sample distribution:

The above graph shows the variable economic status of the total sample 620. The percentage of pupils from poor economic status group is 37, the percentage of pupils of lower middle economic status is 49, the percentage of pupils of upper middle economic status is 13 and the percentage of pupils of rich economic status is 1.

Justification of the variables:

**Gender**: While investigations in the distant past showed significant difference in the levels of learning of mathematical concepts between boys and girls in favour of the boys the recent ones did not show any significant difference. To verify whether they really differ through this investigation gender is taken as a variable.
Mathematical achievement: Learning influences performance of pupils in mathematics also depends on their learning of mathematical concepts. They do influence each other. Five levels of achievement are included in the present study i.e., 40 below, 40-49 score, 50-59 score, 60-69 score above 70. Hence achievement in mathematics is taken as a variable.

Type of concept: There are three types of concepts namely conjunctive concepts, disjunctive concepts and relational concepts. Each type has a logic of its own. There are no investigations covering this area. Hence the type of concept is selected as a variable for the present study.

Location: Urban people have better learning environmental than rural people. Urban area parents are highly and mostly educated than rural area parents. Even human and material resources are better in urban schools whether these affect the learning of mathematical concepts by the pupils in the urban area schools. Would be found. Hence the location is taken as a variable.

Status of the school: Type of management influences the functioning of a school which in turn influence the learning of pupils. They were categorized as Government, private aided and private unaided and the schools managed by the local government bodies like municipal schools, corporation schools and Z.P. Schools. They may not have the similar human and material resources and their management which may affect the teaching learning programmes. Therefore the status of the school is taken as a variable.
Parental educational background: The educational background of the parents influences the academic achievement. The parental education background is divided into three groups that is illiterate/elementary, secondary education and college education. The children of educated parents are influenced by both heredity and environment. Positively the development of mathematical ability and educated parents can give all the necessary help, support and guidance and create all sorts of opportunities to learn well, live comfortably and cope with the life. Hence the researcher thought that support is the basis of good mathematical ability, and the learning of mathematical concepts of their children. Hence it is taken as a variable.

Economic background: Researcher feels that the children belonging to poor, lower middle, upper middle economic status are better in the development of problem solving skills, because every day they need to go to some shop for purchases and make things done. Economic background of the parents is divided into four groups poor, lower middle, upper middle and rich. Therefore they use to face different types of problems in day to day life regularly where as the children of rich families do not have such a need. The opportunities for community living the need for usage of what the learned for lower and upper middle class children are more. Economic background of the parents is divided into four groups poor, lower middle, upper middle and rich therefore the economic background is taken as a variable.
3.11. Tools used in the study:

1. A test was constructed on mathematical concepts in practical situations on three areas containing 60 problems from VIII class mathematics text book by the investigator.

2. A Standardized tool on spatial ability, a differential aptitude test containing 40 questions was used.

3. Problem solving skills scale was framed by C.G.Venkatesha Murty of R.I.E Mysore and used by him. It is including approach avoidance character of the person in problem situations, problem solving confidence and personal control, containing 22 questions was used.

**Construction and description of the tool 1:**

**Mathematical achievement test for tryout:** This tryout test contains 60 multiple choice questions selected from three areas Mensuration, sets and symmetry from VIII class mathematics text book. Each question carried 1 mark. The student had to select exact answer from the given alternatives. The total marks allotted to this test are 60 (60 x 1M).
Table 7: Concept wise test items for 'tryout'

<table>
<thead>
<tr>
<th>S.No</th>
<th>Concept</th>
<th>Total No.of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set concept (Definition)</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Element belongs to and doesn't belong to</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Set Roster form</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Set Builder form</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Subset Concept</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Finite set</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Infinite set</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Null set</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Cardinal number of a set</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Equivalent sets</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Equal sets</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Union of sets</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Intersection</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>Universal set</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>Complement set</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Difference of sets</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Symmetrical difference of sets</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Disjoint sets</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>Power set</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>Super set</td>
<td>1</td>
</tr>
<tr>
<td>21</td>
<td>Vene diagrams in sets</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Frequency</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>22</td>
<td>Demorgan laws in sets</td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>Square</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>Rectangle</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>Triangle</td>
<td>2</td>
</tr>
<tr>
<td>26</td>
<td>Quadrilateral</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>Parallelogram</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>Rhombus</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>Trapezium</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>Circle, semicircle</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>Circular path</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>Sector</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>Right angle triangle</td>
<td>2</td>
</tr>
<tr>
<td>34</td>
<td>Equilateral triangle</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>Symmetry</td>
<td>2</td>
</tr>
<tr>
<td>36</td>
<td>Line symmetry</td>
<td>3</td>
</tr>
<tr>
<td>37</td>
<td>Point symmetry</td>
<td>2</td>
</tr>
<tr>
<td>38</td>
<td>Linear symmetry</td>
<td>2</td>
</tr>
<tr>
<td>39</td>
<td>Reflection symmetry</td>
<td>2</td>
</tr>
<tr>
<td>40</td>
<td>Image of line segment</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 8: Tool 1. A test on mathematical concepts:

This test was prepared with 60 items covering the following the content areas: 1. Mensuration 2. Sets 3. Symmetry. The split of items is as follows

<table>
<thead>
<tr>
<th>S.No</th>
<th>Content Area</th>
<th>No.of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mensuration</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Sets</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td>Symmetry</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>60</td>
</tr>
</tbody>
</table>

The investigator made an intensive study of the contents mentioned above. The key concepts were identified in each content area. The test items were prepared basing on the nationalized text book by government of Andhra Pradesh prescribed to eighth class pupils. These were subjected to the scrutiny of 10 senior most mathematics teachers teaching eighth class. Their suggestions in all aspects were considered and necessary changes were made in the test items. The test thus ready for administration was given to a sample of 100 IX class pupils drawn on random basis in five schools. The heads of the institutions are consulted and prior permission was obtained. As per the schedule given by the heads, the investigator approached them for pilot study.

Prof. LINDQUIST says that "Except in rare occasions, the items must be tried on a sample, representative of the universe for which the final test is intended." Therefore 60 items were prepared for tryout. The difficulty level and discriminating power of each test item were calculated. Thus out of 60
items 12 items were deleted owing to their poor discriminating power and the remaining 48 items were retained for the final test.

The performance of the sample was treated under three heads (1) item selection (2) item difficulty (3) item validity.

**Item selection:**

**Reliability and validity of item selection**

Item selection was based on content validity. The sampled items were drawn from the topics mensuration, sets and symmetry of eight class text book. Content validity was essentially based upon the judgement of the experts. In the case of present questionnaire, a systematic effort was made by the investigator to examine the test items related to the objectives of the study. While preparing the test, the investigator consulted around 10 experts in the field of mathematics.

**Table 9:**

<table>
<thead>
<tr>
<th>Area</th>
<th>Item No</th>
<th>Difficulty level</th>
<th>Discriminating power</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>1</td>
<td>59.25</td>
<td>0.74</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>72.22</td>
<td>0.40</td>
</tr>
<tr>
<td>N</td>
<td>3</td>
<td>88.88</td>
<td>0.25</td>
</tr>
<tr>
<td>S</td>
<td>4</td>
<td>79.62</td>
<td>0.40</td>
</tr>
<tr>
<td>U</td>
<td>5</td>
<td>68.51</td>
<td>0.21</td>
</tr>
<tr>
<td>R</td>
<td>6</td>
<td>48.14</td>
<td>0.29</td>
</tr>
<tr>
<td>A</td>
<td>7</td>
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<td>-0.25</td>
<td>*</td>
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</tr>
</tbody>
</table>

Note: Items with '*' Mark are deleted for final study

112
The difficulty level and discriminating power of each test item was calculated. 12 items indicated by the ‘*’ marks were deleted. Then again with the remaining 48 items the final test was conducted. (Ref. Measuring Educational Achievement, Robert L Ebel, Page No. 364).

Table 10: Discriminating power:

Scale followed to identify the items in terms of validity (Refer: Robert L Ebel Page No. 364)

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<tr>
<th>Range</th>
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<td>0.20 – 0.29</td>
<td>Average</td>
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<tr>
<td>0.30 – 0.39</td>
<td>Good Items</td>
<td>7</td>
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<tr>
<td>0.40 - Above</td>
<td>Best Items</td>
<td>33</td>
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</table>

Items which were negative and which had below 0.2 discriminating power were cancelled. Thus 12 items were rejected.

Table 11:

Difficulty level and discriminating power of test items of the final study

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<th>Area</th>
<th>S.No</th>
<th>S.No. in the final test</th>
<th>S.No. in the original test (tryout)</th>
<th>Difficulty level</th>
<th>Discriminating power</th>
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**Description of the tool:**

The tool on mathematical concept consists of 48 items. Items from 1 to 36, 40 to 42 and 44 to 48 were each given four alternative names A, B, C & D. The item numbers 37 and 38 were to verify and correct the problem. The item numbers 39 and 43 were to draw a picture.

**Scoring procedure:**

Each item was given a mark for the correct answer.
Tool 2: Spatial ability test:

Reliability and Validity of the tool 2:

Space relations are one of the differential aptitude tests. DAT is a multiple factor test battery. This battery was originally brought out by the psychological corporation in 1947, as a guidance battery for use at the secondary school level. The tests of the DAT are essentially power tests. All these tests are intended for with in grades standardized upon a population sample of 64000 boys and girls.

Reliability:

DAT test batteries include verbal reasoning mechanical reasoning, abstract reasoning, numerical ability, special relations, language usage in part I and part – ii, Clerical speed and accuracy. The reliabilities of the parts or the power tests are about 0.90. All DAT tests are essentially power tests whose reliability coefficients are high (P.No 379-382). Concurrent validity was found Anne Anastasi psychological testing (1976) IV edition Macmillan publishers New York.

Concurrent validity:

Concurrent validity refers to the usefulness of a test in closely relating to other measures, such as present academic grades, teacher ratings, or scores on another test of known validity.
There are quite substantial correlations between the corresponding factors of the DAT and the GATB. Representative values from one study of U.S. employment service in 1967 had the correlational value for spatial relations is 0.65. One important difference between DAT and GATB tests is that in most cases it is purely power tests, while the GATB tests are quite highly speeded. The manual for the DAT provides extensive data on the correlations of each of the subtests with achievement in a number of school subjects.

Table 12: Correlation values of Scores of spatial relations and different school subjects were as given below.

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<th>Test</th>
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</tr>
<tr>
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<td>Maths</td>
<td>.30(6.5)</td>
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<td>Science</td>
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<td>.30(7)</td>
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<td>.32(4)</td>
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</table>

Spatial ability test is one among the differential aptitude test batteries. This test consists of 40 items. All these problems are framed with geometrical shapes. This is meant for testing the ability in spatial visualizations by presenting two-dimensional geometric figures (Variously shaded). These are imaginatively manipulated, each to frame three dimensional figures. The purpose is to test ability to visualize constructed figures, variously rotated.
The pupils have to analyze the picture and identify the alternative correct pictures in three dimensional shapes. The examinee must visualize and indicate which solid figure could be produced by folding the flat figure.

**Scoring for tool :2 Spatial ability test :**

Each of the right answers was given a mark.

**Tool : 3 Problem solving skill scale tryout :** The scale framed by Dr. C.G.Venkatesha Murthy of R.I.E, Mysore was adopted. The present questionnaire contains 22 items. Problem solving skills scale includes three sub components - approach avoidance character of the person in problem situations, problem solving confidence and personal control. This scale contains 13 positive items and 9 negative items. Pupils are to select the correct option among the six given options i.e., completely agree, mostly agree, agree to some extent, to some extent not agree, mostly not agree and never agree.

**Reliability and Validity of the scale on problem solving skill:**

**Reliability:**

Reliability of a test is the consistency with which a test measures, a trait for which it is intended. According to Garret (Garret, 1971). "A test score is called reliable when we have reasons for believing the score to be stable and trust worthy". (A test cannot be valid unless it is reliable according to Guilford (Guilford, 1950). Every valid test will be reliable).
"The concept of reliability under lies error of measurement of single score where by the range of fluctuation likely to occur in a single individual score as a result of irrelevant chance factors can be predicted"

**Internal consistency:**

As all the values obtained are more than the table values at 0.05 level 11.07, at 0.01 level 15.086, all the 22 items were retained as they were found valid. Internal consistency value was calculated after the tryout of the scale. Cronbach Alpha was applied and the value of reliability was found 0.60112.

**Validity of problem solving skill:**

The index of reliability is taken as a measure of validity. As the test is found (P. No 349, Garret) reliable it is valid.

Test and retest were conducted to a sample of 100 IX class students of five high schools situated in and around Gudiwada. Students were selected on random basis $\chi^2$ values were calculated and given below.

**$\chi^2$ Values of items of problem solving skill:**

All the responses were tabulated in the form of a matrix for all the 22 items and the chi square value for each item was calculated, and present in the following table.
Table No 13: $\chi^2$ values for the scale on problem solving skill:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>$\chi^2$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>259.5625</td>
</tr>
<tr>
<td>2</td>
<td>64.5</td>
</tr>
<tr>
<td>3</td>
<td>31.375</td>
</tr>
<tr>
<td>4</td>
<td>94.25</td>
</tr>
<tr>
<td>5</td>
<td>14.625</td>
</tr>
<tr>
<td>6</td>
<td>84.125</td>
</tr>
<tr>
<td>7</td>
<td>64.5</td>
</tr>
<tr>
<td>8</td>
<td>91</td>
</tr>
<tr>
<td>9</td>
<td>31.625</td>
</tr>
<tr>
<td>10</td>
<td>39.375</td>
</tr>
<tr>
<td>11</td>
<td>30.5</td>
</tr>
<tr>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>13</td>
<td>144.5</td>
</tr>
<tr>
<td>14</td>
<td>68</td>
</tr>
<tr>
<td>15</td>
<td>62</td>
</tr>
<tr>
<td>16</td>
<td>71.25</td>
</tr>
<tr>
<td>17</td>
<td>70.25</td>
</tr>
<tr>
<td>18</td>
<td>92.75</td>
</tr>
<tr>
<td>19</td>
<td>74.75</td>
</tr>
<tr>
<td>20</td>
<td>73</td>
</tr>
<tr>
<td>21</td>
<td>83.5</td>
</tr>
<tr>
<td>22</td>
<td>67.625</td>
</tr>
</tbody>
</table>
Table No 14:

**Details of the type of items in the questionnaire of problem solving skill**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of Item</th>
<th>Question No's</th>
<th>Total No.of Q.No’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive</td>
<td>1,2,4,6,7,13,14,15,16,17,18,19,21</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Negative</td>
<td>3,5,8,9,10,11,12,20,22</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

Table 15: The question numbers of problem solving sub skills in the questionnaire

<table>
<thead>
<tr>
<th>S.No</th>
<th>Problem solving skills</th>
<th>Question Number</th>
<th>To. No. of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Approach avoidance of the problem</td>
<td>1,2,5,7,8,11,12,13,14,16,21,20</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Problem solving confidence</td>
<td>3,4,6,15,17,18,19</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Personal Control</td>
<td>9,20,22</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

Table 16: Scoring procedure of the scale on Problem solving skill:

The following scoring procedure was used to assess the responses

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Completely Agree</th>
<th>Mostly Agree</th>
<th>Agree to some extent</th>
<th>To some extent not Agree</th>
<th>Mostly not Agree</th>
<th>Never Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Questions</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative Questions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
3.13 **De limitations** : The study is limited to

1. The following mathematical concepts - Mensuration (Arithmetic), Sets (Algebra) and Symmetry (Geometry), drawn from VIII class State syllabus only.

   The main reason for the three concepts selected to the present study were Mensuration deals with the measurement of the length of sides, areas and volumes to geometric figures. The set concept and set language play an important role in mathematics in unifying different braches of mathematics. The theory of sets influenced and enriched every branch of mathematics. Due to the uniformity or ever ness in the shapes of objects, they appear to be beautiful. This quality s known as symmetry. It touches aesthetic side of mathematics..

2. The sample is limited to Krishna district only.

3. The size of the sample is 620 pupils of IX Class only.

4. The sample consists of only Telugu medium students.

3.14 **Administration of the tools and collection of data** :

   The required data were collected from 31 schools of Krishna District. The investigator personally went for data collection with prior permission from the heads of the institutions. The investigator spent a day in each school in order to conduct the 3 tools of the study one by one with short intervals.

   The investigator also gave a detailed introduction about the need and importance of the present study and then the test was conducted. Before
conducting the test, detailed instructions were given to the students. All the required material like Geometrical shapes on paper cuttings (Models) were shown before giving the spatial ability test. All the requirements were provided to the students for writing the test. All the H.M's, mathematics teachers and students cooperated well in the collection of data for the study.

3.15. Techniques of data analysis:

The statistical techniques that are employed objective wise are given as the following.

Objective 1 : Mean, S.D, Percentage of Mean, $\frac{1}{\sqrt{5}}$ Mean, comparison with normal distribution, classification scale.

Objective 2 : Mean, S.D, Percentage of Mean, Area wise Mean, $\frac{1}{\sqrt{5}}$ Mean, comparison with normal distribution, classification scale.

Objective 3 : Mean, S.D, Percentage of Mean, $\frac{1}{\sqrt{5}}$ Mean, comparison with normal distribution, classification scale.

Objective 4 : Mean, S.D, Percentage of Mean, $\frac{1}{\sqrt{5}}$ Mean, comparison with normal distribution, classification scale.

Objective 5 : Analysis of variance (r), Chi Square ($\chi^2$) test.

Objective 6 (a) : Analysis of variance (r).

Objective 6 (b) : Analysis of variance (r).
Objective 6 (c) : Analysis of variance (r).

Objective 7 : Multiple correlation.

Objective 8 : Analysis of variance (r), Chi Square ($\chi^2$) test.

Objective 9 : Mean, S.D, Percentage of Mean, t-value.

Objective 10 (a) : Mean, S.D, t-values, F-Value.

Objective 10 (b) : Mean, S.D, t-values, F-Value

Objective 10 (c) : Mean, S.D, t-values, F-Value.

Objective 10 (d) : Mean, S.D, t-values, F-Value

Objective 11 (a) : Mean, S.D, t-values.

Objective 11 (b) : Mean, S.D, t-values, F-Value.

3.16. Conclusion:

In this chapter statement of the problem, objectives, hypotheses, variables, delimitations, method of investigation, sample and sampling construction on description of tools, administration of the tool and collection of data, statistical techniques are discussed and detailed. In the forth coming chapter, the investigator is going to analyze the collected data and interpret the results.