Chapter 4
Planning and procedure of the Test

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4.1.0 Introduction:

The previous chapter dealt with summary of studies held earlier. From reviewing such studies, the investigator has decided to work on Spatial Ability Test. This chapter deals with planning and execution of test construction.

4.2.0 Origin of the problem:

Today, in the age of competition, we have to face the competitive examinations. These competitive exams are useful for selection, classification and also to measure the attitude of testee. Admission, promotion and recruitment can be done with the help of such exams. The percentage of failure is more than that of successes testee in each competitive examination. Such situations are outcomes of our present education system. It hasn’t given focus to prepare the testee. Our educational system is not in position to generate motivation for competitive exams among testee. Therefore, testee has lack of attitude to prepare well in advance for the same.

Generally, students after 10 + 2, use to get admission in engineering branch if they have studied in science stream. At present, there is no such test, which can be utilized as an admission test for the admission in architect engineering. So that the investigator decided to construct and standardize the Spatial Ability Test for the pupils of Gujarat state.
4.3.0 Population:

In any research, the researcher has to think of the population to which the results are to be applied. The population is a universal set of subjects to whom the result are to be applied.

According to K. S. Sidhu (1985),

"Population means an aggregate or the totality of the subject regarding which inferences are to made in a sampling study."

Here, the investigator has decided to prepare Spatial Ability Test (SAT) for the pupils studying in standard - 11th and 12th. Therefore, the pupils of those classes of Gujarat state became the population for this study.

4.4.0 Selection of Sample:

It is not easy to cover entire population for investigation. So that one has to select representative subjects from the population. A sample is a small proportion of a population selected for observation and analysis.

According to W. G. Corrate,

"In every branch of science we lack the resources to study more than a fragment of the phenomena that advance our knowledge."  

The main characteristics of a good sample are as follows.
(i) The sample can represent almost all characteristics of the entire population.

(ii) The sample should not be biased in any characteristics.

(iii) The sample must have all the other factors in equal proportion that of the whole population.

(iv) the distribution of variables under investigation, must be distributed normally.

4.4.1 Techniques for Sampling:

It is very difficult to select bias less and equal proportion of all factors present in the population sampling. So, those different techniques of selecting the sample are used. They are as follows:

(i) Random Sampling Technique.

(ii) Systematic Sampling Technique.

(iii) Stratified Sampling Technique.

(iv) Stratified Random Sampling Technique.

(v) Double Sampling Technique.

(vi) Cluster Sampling Technique.

(vii) Sequential Sampling Technique.

(viii) Accidental Sampling Technique.

(ix) Purposive Sampling Technique.

(x) Multistage Sampling Technique.

Each one has some merits and limitations. In test standardization, multi stage sampling technique was used.
4.4.2 Sample for first Tryout:

The investigator selected Vakharia P. J. Higher Secondary, from semi city area for first tryout. It is situated in Kalol. Sample is presented in table 4.4.2.

Table: 4.4.2
Sample for first tryout

<table>
<thead>
<tr>
<th>Stream</th>
<th>Standard - 11</th>
<th>Standard - 12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Total</td>
</tr>
<tr>
<td>Science Stream</td>
<td>12</td>
<td>08</td>
<td>20</td>
</tr>
<tr>
<td>General Stream</td>
<td>18</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>

Thus, investigator selected 95 pupils by Stratified Randomize sampling technique for first try out.

4.4.3 Sample for second Tryout:

For the second tryout, the investigator selected 8 different schools randomly. From that, 4 were from city area and rests were from semi city area, to keep representativeness of area. The list of schools is attached in Appendix I. A stratified randomize, cluster sampling technique was used for second tryout. The actual sample is given in table 4.4.3.
Table : 4.4.3
Sample for second tryout

<table>
<thead>
<tr>
<th>Area</th>
<th>Stream</th>
<th>Standard - 11</th>
<th>Standard - 12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td>City area</td>
<td>Science</td>
<td>25</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>29</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54</td>
<td>47</td>
<td>44</td>
</tr>
<tr>
<td>Semi city area</td>
<td>Science</td>
<td>24</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>30</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54</td>
<td>47</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>108</td>
<td>94</td>
<td>95</td>
</tr>
</tbody>
</table>

4.4.4 Sample for Final Run:

The main object of this study was to standardize the Spatial Ability Test for higher secondary school of Gujarat state. And as per Para 1.5.0 of chapter 1 the population was pupils from Gujarati medium of higher secondary schools of middle zone of Gujarat state.

For this, the investigator selects 23 higher secondary schools from middle zone of Gujarat state. Among them 10 schools were from city area and 13 were from semi city area. This was done by stratified Randomized Sampling Technique. The names of these schools are given in appendix II.

A class of standard - 11th and standard - 12th from each schools and each stream were selected by Random Sampling technique. Boys and girls were selected according to the class strength by cluster sampling technique.
Thus, the investigator has selected a stratified Randomize Cluster Sample for final tryout. The size of the sample for final run is shown in table 4.4.4.

Table: 4.4.4
Sample for Final run

<table>
<thead>
<tr>
<th>Area</th>
<th>Stream</th>
<th>Standard - 11</th>
<th>Standard - 12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td>City area</td>
<td>Science</td>
<td>121</td>
<td>75</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>108</td>
<td>98</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>229</td>
<td>173</td>
<td>197</td>
</tr>
<tr>
<td>Semi city area</td>
<td>Science</td>
<td>117</td>
<td>58</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>190</td>
<td>187</td>
<td>191</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>307</td>
<td>245</td>
<td>272</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>536</td>
<td>418</td>
<td>469</td>
</tr>
</tbody>
</table>

4.5.0 Method of research:

There are different methods of Educational Research. Some of them are as follow.

(i) Historical Method.

(ii) Research in Assessment studies.

(iii) Research in Evaluation studies.

(iv) Descriptive Method.

(v) Experimental Research.

(a) Quasi experimental Research.

(b) Single subject experimental Research.

Looking to the present investigation, it would be a process of establishing present status of the Spatial Ability of
pupils, and establishment of Norms for Spatial Ability, the most suitable method would be survey. So that the investigator has selected Survey method.

4.6.0 Test Construction:

The first main objective of the present study was to construct a test for Spatial Ability. It was a challenging task. For that the investigator has to pass through various steps of test construction. The steps were as follows.

4.6.1 Selection of type of Test:

There are two types of tests. The first one is Objective test and the other is Essay type test. A test which has objective items is called Objective test and a test containing essay types items is called Essay test.

The investigator studied advantages of both types of test. The comparative advantages of Objective and Essay type tests are given follows.

<table>
<thead>
<tr>
<th>Learning outcomes measured</th>
<th>OBJECTIVE TEST</th>
<th>ESSAY TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Efficient for measuring knowledge of facts. Some types (e.g. multiple choice) can also measure understandings, thinking</td>
<td>Insufficient for measuring knowledge of facts. Can measure understandings, Thinking skills and other complex learning outcomes (especially useful)</td>
</tr>
<tr>
<td><strong>Skills, and other complex outcomes. Inefficient or inappropriate for measuring ability to select and organized idea, writing abilities and some types of problem solving skills.</strong></td>
<td>where originality of response is desired). Appropriate for measuring ability to select and organize ideas, writing abilities and problem solving skills requiring originality.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Preparation of questions</strong></td>
<td>A relative large number of questions needed for a test. Preparation is difficult and time consuming.</td>
<td>Only a few questions are needed for a test. Preparations is relatively easy. (But more difficult than generally assumed).</td>
</tr>
<tr>
<td><strong>Sampling of course content</strong></td>
<td>Provides an extensive sampling of course content, due to the large number of questions that can be included in a test.</td>
<td>Sampling of course content is usually limited, due to the small numbers of questions that can be included in a test.</td>
</tr>
<tr>
<td><strong>Control of pupil’s response</strong></td>
<td>Complete structuring of task limits pupil to type of response called for. Prevents bluffing and avoids influence of writing skill. However, selection type items are subject to guessing.</td>
<td>Freedom to respond in own words, enables bluffing and writing skill to influence the score. However, guessing is minimized.</td>
</tr>
</tbody>
</table>
### Scoring

<table>
<thead>
<tr>
<th>Scoring</th>
<th>Objective scoring which is quick, easy and consistent.</th>
<th>Subjective scoring which is slow, difficult and inconsistent.</th>
</tr>
</thead>
</table>

### Influence of Learning

| Influence of Learning | Usually encourages pupil to develop a comprehensive knowledge of specific facts and the ability to make fine discriminations among them. Can encourage the development of understandings, thinking skills and other complex outcomes, if properly constructed. | Encourages pupils to concentrate on larger units of subject matter, with special emphasis on the ability to organize, integrate and express ideas effectively. |


From that details the investigator find out some advantages of objective test. They were as follows.

- Effective evaluation of great aims like knowledge, logic and use of knowledge can be made by these items.
- Responses of respondents are so accurate that validity of evaluation made by these items would be highest.
- In short time limit many items can be responded by the respondent.
Knowledge and educational experiments of pupils can be covered nicely by these items.

Checking of these types of response of respondents takes very less time. Key scoring can also applied.

With the help of statistics, difficulty value and discriminative value of each item can be estimated easily and accurately.

Choice of items for test in order to difficulty value can be made.

Keeping these advantages of objective test, the investigator decided to construct an Objective type Spatial Ability Test. As the test was constructed for Gujarati medium pupils, the instruction for respondent were prepared in Gujarati.

4.6.2 Planning of the test:

The investigator studied the principles enlisted for item construction.

The test should demand mental activities with the limit of the academic achievement and school training of students of higher secondary schools of Gujarat state.

Those activities should be suitable to the intellectual maturity and interest of boys and girls of higher secondary school.

The content should be based on the Spatial experience of pupils living in both types of area.

There should be a variety in type of content in the test item.

The test should have safeguard against over simplification and should be made capable of complex mental processes.
The test as a whole must be a good predictor of Spatial Ability.

The test should be suitable for group administration.

The method of response should be simple.

With these principles, the investigator decided to construct Spatial Ability Test for higher secondary school pupils. The following two criteria were kept to plan the test.

The test should contain the items which can estimate the Spatial Ability.

The test should not be very short because reliability of the test was to be measured by split-half method.

4.6.3 Preparing the test and its items:

After finalization of the topic and studied selection criteria of the subtest, it was the first step to select subtests and its items for Spatial Ability Test.

4.6.3.1 Content of Universe:

In different western countries, many tests have been constructed but they are of no use in our country or state. Therefore, it was decided to construct tests in the following patterns of western tests.

To solve this problem, first of all, the investigator critically studied Aptitude Test Batteries, the books of Engineering drawing and interaction with the lecturers of Architect college, who directly deals with Spatial Ability.
4.6.3.2 Selection of subtest and items:

Generally, ability test consist of more than one types of subtest. The investigator had to make a judicious selection of the types of subtests from these subtests. The selected subtests were as follows.

(a) Diagram seen after cutting 2-D figure.
(b) Diagram seen from certain direction of 3D figure.
(c) Diagram that is not seen after cutting 3D figure.

Numbers of items were coined for inclusion in the test. 90 items were found to be the best were selected out and those items were included in subtests. As it was discussed in 4.2.0, our education system hasn’t given focus to prepare the pupils for such type of ability. To make the pupils familiar with Spatial Ability, illustrative items were given in the beginning of each subtests. These illustrations with their answer and the reason of that, were also discussed with them.

The test was to be designed for higher secondary school pupils, the time required for the subtests should be fit with the school timetable and which may not cause any inconvenience to the routine work of the schools. When the test would be administered to the pupil for fixing norm. Numbers of items were selected in such a way so that entire test can be completed within 35 minutes by most of the respondents.

Response of items:

Each item carries four responses say A, B, C, D. Out of which only one response was correct while remaining three were...
distracters. For registering responses, a separate answer sheet was prepared. In the beginning of the test, one illustration was given for each subtest to know whether the respondents are able to understand how to register their responses.

4.6.4 Administration of test:

The following typical indices can be poured out with the administration of the test.

➢ The facility value of each test items.
➢ The discrimination value of each test items.
➢ The effectiveness of each distracters for each test items.
➢ The equivalence of the items in the various form of the test.
➢ The adequacy of direction, the time limit and the test format.
➢ To standardize the test.

4.6.4.1 First tryout:

The investigator carefully studied the objectives of first tryout of the test. They were as follows.

➢ To find out the range of the applicability of the test.
➢ To standardize the instruction to be given for the whole test and also for each individual subtest.
➢ To find out if any items needs any change in its form.
➢ To fix time the limit for each subtest.
Keeping these objectives in his mind, the investigator administered the Gujarati form of test and its response sheets are given in Appendix III.

To measure the time taken by respondents, separate time column at the end of each subtest was given. During the first tryout full time was given to every respondent to response all the items of the test. They were requested to note down the time taken by them in their answer sheet at the end of each subtests.

The table containing Item wise responses is shown in Appendix IV.

All the respondents noted the time in the time column. The frequency distribution showing time used were prepared for each subtest. The frequency distribution of time took by respondents is given in table : 4.6.4.1

Table : 4.6.4.1
Time took by pupils at first tryout

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Subtest - I</th>
<th>Subtest - II</th>
<th>Subtest - III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Pupils</td>
<td>Frequency</td>
<td>Per.</td>
</tr>
<tr>
<td>1 - 10</td>
<td>1</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>11 - 20</td>
<td>3</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>21 - 30</td>
<td>8</td>
<td>8.42</td>
<td></td>
</tr>
<tr>
<td>31 - 40</td>
<td>78</td>
<td>82.11</td>
<td></td>
</tr>
<tr>
<td>41 - 50</td>
<td>3</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>51 - 60</td>
<td>2</td>
<td>2.11</td>
<td></td>
</tr>
</tbody>
</table>

80
From the table – 4.6.4.1, one can see that the most of respondents took time to response for each sub test is 31 to 40 minutes. Very few pupils took much or less time for responses. No major problem was occurred during first tryout regarding instruction and process of recording responses and the illustrations were capable to understand the theme of subtests. Therefore, no changes were made in instructions and illustrations for second tryout. However, the first tryout of the test provided an experience for administrating the test.

4.6.4.2 Second tryout:

The test for second tryout was administrated with the pre permission of the schools to the sample discussed in 4.4.3, along with necessary instruction and was supervised properly. At the end of prescribed time answer sheet and test booklets were collected.

The collected answer sheets were checked for scoring. The responses of respondent were assessed and facility value and discriminative value were calculated. On the basis of facility value and discriminative value only 30 items were selected for final test. These facility value and discriminative value of each items are given in Appendix V.

During the administration of the test, it was observed that 100 minutes time for responding the test was sufficient. As there were 30 items in the final test, the time fixed to response was 35 minutes. It was also decided to give 5 minutes more for instruction and to write personal details. It means the total administration time
for the final ran out was 40 minutes. This final test with its answer sheet is given in Appendix VI.

4.6.4.3 Final Run:

1100 copies of re-usable test booklets with necessary instruction and 2400 answer sheets were printed. Each test booklet contains 30 items. A space for personal detail was also given in answer sheet.

The investigator approached the schools including in final run, as discussed in 4.4.4, and requested for giving permission and allotting time for administrating the test well in advance. After getting permissions and time allocation, the investigator visited the said school and collected pupils in a separate class, made sitting arrangement and administered the test with instructions decided. During the administration of the test, proper supervision was made with the help of assistance. At the end of 35 minutes, the booklets and answer sheets were collected from respondents. A key for scoring the responses of the respondents was used for scoring and allocating score for each answer sheets.

The detail of further calculations is given in chapter: 5.
4.7.0 Methods for data analysis:

Collected data was analyzed by using following methods.
>
- Collected data was analyzed by spss / pc+ and Microsoft Excel 2002 software with proper data file.
- Facility value and discriminative value were calculated for each items during second tryout.
- Descriptive statistic i.e. mean, S.D., Coefficient of variance, etc.
- To test the different objectives, ‘t’ was calculated.
- For reliability and validity coefficient of correlation(r)s were calculated.
- To find the factorial validity, factorial analysis was done.

4.8.0 Conclusion:

The present test is in a non verbal form and is meant for the higher secondary pupils of Gujarat state. The abilities and limitations of the pupils kept in a view while coining the items of the test. Looking to the convenience in administration, the test was divided in to three subtests. The final form was administered to 1827 pupils from population, and reliability and validity were estimated on sample of 200 pupils. Estimation of reliability and validity is being discussed in chapter following chapter, i.e. in chapter : 5
Endnotes


2. Ibid : Page No. : 195