CHAPTER V

TEST CONSTRUCTION

Before a reliable and valid test can be constructed, it is of utmost importance to specify 'what is to be measured and how to measure it?' The present work is meant to measure scientific aptitude of the pupils. To decide the sub-tests to be included in the present test battery, the investigator made a critical study of the following tests which were easily available in India:

1. Stanford Scientific Aptitude test
2. Physical Science Aptitude Examination
3. Iowa placement examinations in different science subjects
4. Science Aptitude Examination of Science Clubs of America.

7. Scientific Aptitude Test Battery of Central Bureau of Educational & Vocational Guidance, Delhi.

8. Non-verbal Science Selection Test of Manasayan, Delhi.


Over and above the critical study of the above tests, the reviews and references about the following tests were also studied:

1. Hunter Scientific Aptitude test
2. Co-operative Science tests of Educational Test Service.

A critical study of the contents of the above tests reveals that the following types of sub-tests are generally included in the test batteries for measuring the scientific aptitude of the pupils:

1. Scientific information,
2. Scientific comprehension,
3. Mathematics,
4. Number series,
5. Formulation,
6. Mechanical Comprehension,
7. Figures,
8. Spatial relationship,
9. Vocabulary,
10. Reading,

The investigator also made a critical study of differential aptitude test for which extensive data on the correlations of each of the sub-tests with achievements in a number of school subjects are available. The study reveals that numerical ability test, abstract reasoning (comprehension) test, space relation test and mechanical reasoning (or comprehension) test have got highest correlations with the science subjects. ¹

SELECTION OF THE SUB-TESTS:

To select the contents of the present test, the investigator decided to analyse 'scientific aptitude' in terms of basic abilities associated with the success in the science courses. The investigator interviewed a number of successful Doctors, Engineers and Scientists and prepared a list of abilities which contributed to their success in

their profession. The list of abilities thus prepared is given below.

1. Ability to comprehend the common scientific principles.

2. Ability to perceive spatial relation.

3. Accuracy of calculation (numerical ability).

4. Discrimination of values in selecting and arranging the experimental data.

5. Power of suspended judgement.

6. Ability to study scientific information.

7. Accuracy of observation.

8. Ability to understand the scientific principles underlying the mechanical operations.

9. Ability to reason.

10. Ability to form generalization.

11. Ability of creative imagination

12. Ability to understand scientific terms.

A panel of 10 experts was requested to rank these abilities according to their importance in making them successful in their fields. (Appendix A). The average rank calculated for each of these abilities arranged in order is
as under :-

1. Ability to comprehend the common scientific principles (1.5)
2. Accuracy of calculation (Numerical ability) (1.9)
3. Ability to study scientific information (2.8)
4. Ability to understand the scientific principles underlying the mechanical operations (4.3)
5. Ability to perceive spatial relationship (4.5)
6. Discrimination of values in selecting and arranging the experimental data (6.3)
7. Power of suspended judgment (7.4)
8. Accuracy of observation (7.9)
9. Ability to form generalization (8.4)
10. Ability to reason (9.3)
11. Ability to understand scientific terms (10.5)
12. Ability of creative imagination (10.8)

The above table indicates the order of importance given to various abilities by the experts while rating them.

It is advised by most of the educationists to measure only the most important elements of aptitude which are significant in the guidance and selection of students.2

Freeman also adds, "The new technique is to reduce the number of sub-tests and to improve them so that the smaller number have as much predictive value as the larger." Accordingly, the investigator decided to incorporate a small number of sub-tests which would measure the most important basic abilities suggested by the experts.

The sub-tests for the present test have been selected on the basis of the above mentioned findings supported by the analysis of the contents of the existing tests of scientific aptitude. The following sub-tests, which measure almost all the important basic abilities associated with scientific aptitude have been included in the present test:

2. Scientific comprehension test
3. Mechanical comprehension test.
5. Space relation test.

CONTENTS OF THE SUB-TEST:

1. Science information test is designed to test the factual knowledge of science information contained in the syllabus for General Science of S.S.C. Examination Board of Gujarat State.

2. **Scientific comprehension test** is designed to measure the ability of comprehending the scientific information and application of scientific principles bearing in mind the syllabus for General Science of S.S.C. Examination Board of Gujarat State. Some additional items will be incorporated in this sub-test to assess the comprehension of the common scientific principles of everyday life.

3. **Mechanical comprehension test** aims at measuring the problem-solving ability and power of suspended judgement. This test will consist of a combination of pictures and questions which may permit wider coverage of content and more emphasis on the understanding of mechanical principles.

4. **Numerical ability test** is designed to assess the accuracy of calculation and judgement. Hence this sub-test will consist of items constructed to cover the general principles of the syllabus for Elementary Mathematics (mainly of Arithmetic and Algebra which are concerned with numerical ability) of the S.S.C. Examination Board of Gujarat State.

5. **Space relation test** is meant to assess the ability to perceive spatial relation which is considered
to be highly significant in making prediction for success in the science course. This sub-test will consist of different figures of incomplete rectangles which can be completed by selecting one of the four figures given against them.

ASSIGNING WEIGHTAGE:

The next question that arises at this stage is regarding the weightage to be assigned to each sub-test. There are two possibilities of assigning weightage to the sub-tests—one is to assign weightage to each sub-test and other is to assign weightage to the items constituting the sub-test. Numerous investigations that have been made on this subject indicate that little, if anything, is gained by taking the time to assign various weights to various items."4 Bean States: "consideration of how many questions to ask on each topic will make the examination weigh itself properly. Thus no weighed scores will be necessary."5

Hence, the investigator decided to devise the number of items on each sub-test in proportion to the weightage to be given to that sub-test. In consultation with the experts, the investigator decided to devise the number of items in each sub-test as per the following schedule:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Subject</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Science information test</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Scientific comprehension test</td>
<td>30</td>
</tr>
<tr>
<td>3.</td>
<td>Mechanical comprehension test</td>
<td>15</td>
</tr>
<tr>
<td>4.</td>
<td>Numerical ability test</td>
<td>25</td>
</tr>
<tr>
<td>5.</td>
<td>Space relation test</td>
<td>10</td>
</tr>
</tbody>
</table>

SELECTION OF TEST-FORM:

After deciding the sub-tests, the next step is to decide upon the test forms.

According to Lindquist, multiple choice type of item is 'definitely superior to other types' for measuring educational objectives as inferential reasoning, reasoned understanding, or sound judgment and discrimination on the part of the pupil."6 The investigator, therefore, decided to incorporate the multiple choice test form in the present work.

Far more important than the type of the test is the skill with which it is used. Cronbach states:

"When a multiple-choice test is made up of correct answers, together with incorrect alternatives chosen from among the wrong answers given by students who have answered the same questions with free response, the multiple-choice test has a high correlation with free response test." 7

Accordingly, to construct the multiple-choice items, numerous recall type of items were framed and administered to a group of students. The responses given by different students were analysed. The items, to which four or more than four responses were obtained, are selected for the test and four possible responses, out of which one is correct, are selected as choices.

After selecting the items for the multiple-choice type, it was found that some important items measuring scientific information were left out as they had only two alternative responses. The investigator, therefore, decided to incorporate true-false type of items in the present test as the same would also be useful in creating interest for the test.

WRITING THE TEST ITEMS:

Item writing is essentially creative. As Lidquist States, "there can be no set of rules that will guarantee the production of good test items." 8 Generally, good tests in

English are translated into regional language with some changes here and there. But, in most of the cases, such test items are not found to be valid. In the present test, it is not possible and wise to translate test items from English to Gujarati due to (i) different environmental influences and (ii) Language intricacy. Hence, the items were constructed by the investigator in collaboration with the experts e.g. experienced science professors and head masters with specialization in science subjects.

In this way, 172 items of five sub-tests were prepared. The following table gives the number of items prepared for various sub-tests.

**TABLE NO.I**

**NUMBER OF ITEMS IN VARIOUS SUB-TESTS**

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Sub-test</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Scientific information test</td>
<td>40</td>
</tr>
<tr>
<td>2.</td>
<td>Scientific comprehension test</td>
<td>50</td>
</tr>
<tr>
<td>3.</td>
<td>Mechanical comprehension test</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>Numerical ability test</td>
<td>42</td>
</tr>
<tr>
<td>5.</td>
<td>Space relation test</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>172</strong></td>
</tr>
</tbody>
</table>
ASSEMBLY OF THE TESTS:

The test items were assembled on a rough estimate of difficulty level which was calculated by administering the sub-tests to a class of 40 S.S.C. pupils and calculating the percentage of correct responses given to each item. In the beginning, the sub-tests were arranged on an arbitrary base according to the judgment of the investigator; while they were arranged according to the difficulty level in the final form.

DIRECTIONS TO THE STUDENTS:

It is needless to state that special attention has to be paid to framing the directions of a standardized test to maintain its objectivity. Feder points out that,

"Builders of standard test should recognize the importance of adequate but not cumbersome directions and of determining by experimental procedures the best directions before marketing their products."

Hence, the investigator paid enough attention to framing the directions of the present test. In the directions, the students are clearly told what to do, how to do and how to mark their responses. One illustration is also given in the beginning of each sub-test to explain the directions. The general directions regarding the whole test battery are given on the cover page of the battery.

SCORING KEY:

The correct answers to all the items were decided in a discussion meeting of experts specially arranged for this purpose. For the tryout, each correct response was encircled on the answersheet which itself was used as a scoring key. To make the work of scoring easier, in the final form, the students were asked to put a 'X' (cross) in the column for the correct answer in the answersheet. The perforated scoring key was specially prepared by perforating the correct response to the item of each sub-test of the final form.
SELECTED REFERENCES

   New York, 1953.

   York, 1953.


Educational Journals:
