Statistical item analysis is no substitute for meticulous care in planning, constructing, criticizing, and editing items. It does supplement that intuitive process, however, by revealing unsuspected defects or virtues of the specific items.

- Ross and Stanley.

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4.1 Introduction:

Designing is an essential step in the process of test construction. Reduced to the simplest of terms, research design is a mapping strategy. As McGrath puts it:

"The activities relating to design in research are comparable to those of the architect in designing an intricate structure. As the architect does his designing before construction activities get underway, so should the researcher do his designing before he gets his project underway."

In setting up research plan, the researcher must consider certain fundamental steps that are essentially the same regardless of the type of research design he proposes to use.

"The factor that must often differentiate between good and poor research is not the funds available, the size of the sample or the sophistication of the statistics, it is the care and thought that goes into the research plan."

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Reliable test cannot just happen. It is not the fruit of a few hours or days. It encompasses number of operations, carried out with patience, zeal, accuracy and industriousness for months and years. For such a long process, planning demands utmost care and insight. The design of a test involves the preparation of an outline of specification of the ability to be measured, the content through which the ability could be measured, types of test items to be framed to measure the ability, arrangement of the test items, selection of the type of test, assigning weightage to the items deciding length of the test, preparation of directions for administration of the test, the testing material that is to take shape, so on and so forth.

4.2 Study of Different Tests of General Mental Ability:

Before preparing a design for the present test, some of the existing tests, both in foreign countries and in India, were reviewed with a view to selecting, the base of the types of items to be included in the present test. The lists of the tests, reviewed for the purpose have been given under 2.4, 2.5 and 2.6 of Chapter II.

From the review of various tests, it was observed that they contain some of the sub-tests with the ability components like (1) reasoning (2) imagination (3) perceptual (4) memory (5) spatial (6) information, etc. It was also observed that different sub-tests were selected to test specific function of general intelligence. The types of items were also varied. The types most common to the tests
are classification, substitution, reflected image, analogy, similarities, picture reconstruction, series, progressive series, missing part, geometrical construction, absurdity, substitution table, maze etc.

4.3 Deciding the Types of the Present Test:

After reviewing the tests of general intelligence, it was decided to construct a non-verbal group test of general ability that included items measuring information (cultural) and reasoning (non-cultural). J.C. Flanagan's Tests of General Ability being prepared on the same lines were more critically studied.

Flanagan has advocated for the inclusion of items measuring information (cultural) and reasoning (non-cultural) in the tests of general ability by advancing two reasons. First it appeared that these two abilities are dominant in most definitions of general intelligence. Second, a review of the literature indicated that these two abilities usually provide the best predictions of school success.³

As regards the information part of the Tests of General Ability, Flanagan states that it tests student's familiarity with the world around him through his experiences in the school, at home and in the community.

There are test items from various fields of culture, science, social science, community affairs and the arts.

The test items relate to the student's general knowledge of his surroundings gained through his observations, his hobbies, radio, films, field trips, conversations with other people. As regards reasoning part, it is aimed at testing the student's powers of abstract reasoning. This part of the test presents equal challenge to all regardless of their cultural backgrounds. The number of right answers of both the parts of the test are added together to obtain the student's IQ Score. 4

After fixing the ability components of the test to be designed, the next step was to select the type of the test. There are two openings to this problem.

1. To adopt the Test of General Ability (TOGA) and to standardize it on the population of Gujarat.

or

2. To adopt the principle of the Test of General Ability in toto, and to construct an original test on the same lines.

In TOGA, most of the items on information part are culture fair items, based on cultural background of U.S.A. Moreover in reasoning part too, the items are too difficult to be included in the present test. Hence, it was very

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difficult to adopt the TOGA.

But the second method was worth considering. As there was no test developed in Gujarat as well as in India, on these lines, it was decided to construct an original test of general ability on the same principle of TOGA and to standardize it on the population of Gujarat State.

The characteristics of the test were decided as under:

1. The test should be a non-verbal group test and the test items at all the grades should be pictorial in form.

2. Items included in the test should be pertaining to information (cultural) and to reasoning (non-cultural).

3. The test should be power cum speed test.

4.4 Age and Grade:

After deciding the type of the test, it was essential to decide age-range and grade for the standardization of the test. According to Compulsory Education Act, 1964 of Gujarat State, the lower compulsory age is 6 years. It is compulsory to get the child admitted at the age of 6th year. Moreover, the children who have completed 5 years are only allowed to be admitted to primary schools. Sometimes ambitious parents prepare their children at home and ask
for permission to allow them to appear at the annual examination of class I of the primary school, when the child enters 6th year of age.

Thus, if a child enters primary school at the age of 6 years, he will reach Class VIII at the age of 13 years. But, there might be variations in the age on account of acceleration in years because of ambitious parents. There might be cases of late entry in the school and of detention for one or more years in the same class or in different classes. Hence, it is obvious that in every class there are children of different age-groups. Looking to this fact it was decided to administer the test classwise and to standardize it on the population of classes VIII, IX and X.

In Gujarat State, the stages can safely be recognised as (1) classes I to IV (2) classes V to VII (3) classes VIII to X and (4) classes XI and XII, as the higher secondary stage is almost determined. For the present investigation, it was decided to construct and standardize General Ability Test, to measure general mental ability of the pupils of classes VIII, IX and X i.e. High-School stage pupils.

4.5 Selection of Test Material:

To decide the components of general ability as basis for the selection of different types of items for the test, is the crux of the problem. After a critical study and careful observation of the components that contribute to the measurement of general ability, selection
of the ability components and the types of items that can best measure the ability was to be done. It is advised by most of the psychologists to measure only the most important abilities that contribute to 'g' factor. It is here that several points require due consideration. The first point is how many abilities are to be measured? The second is whether psychologists have an exhaustive list of separate abilities, and if so is it agreed upon by all? The third point is whether it is necessary to include maximum number of abilities in the test or to include minimum required abilities.

Looking to the existing tests, the minimum number of ability components vary from two to ten. Freeman opining on this point states, "The new technique is to reduce the number of sub-tests and to improve them so that the smaller number has as much predictive value as the larger".5

At the time of selection of ability components the following views of Flanagan6 are worth considering:

"All tests of general intelligence include items which measure general ability developed through the influence of the following factors:

1. Heredity refers to the genetic constitutional differences in general ability which are inherited and affect the individual's performance throughout life.

2. Acculturation refers broadly to general (or out-of-school) learning experiences. This includes learning for which the family, early home environment, and other general cultural factors are largely responsible.

3. Specific school learning includes the development of the natural capacities of the individual through reading and other formal school learning experiences.

Flanagan believes that the third factor viz. specific school learning, should not be included in the tests of general ability because they are meant to measure individual's potential ability to learn. TOGA, therefore, included two types of items. One is reasoning type item designed to measure intelligence with as little influence from acculturation as possible. These reasoning items are intended to measure the child's ability to develop concepts from series of drawings. It is hoped that the student's ability to perceive the rule involved in a series of figures will be relatively independent of both school learned skills and acculturation factors. The other type of item in TOGA measures the child's acquisition of information, vocabulary, and concepts. Much of this information is from home, family or community environment rather than from academic knowledge.

It was decided to follow the principle of Flanagan to measure general ability and to select ability components.

7. Ibid., p. 6.
and types of items as shown in the following table. The content validity and construct validity were established by consulting reputed psychologists.

**TABLE NO. 4.1**

The Ability Components and The Types of Items included in the Test to measure each Ability

<table>
<thead>
<tr>
<th>Test Part</th>
<th>Ability Component</th>
<th>Type of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Information</td>
<td>1. Recognition of a pictured object when its name is given.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Recognition of a pictured object when a classifying characteristic is given or implied.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Selection of a pictured object, person or action that represents a given quality or symbol.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Selection of a picture that is an example of a given abstract concept.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Selection of a pictured object, the use of which involves a given principle or abstract concept.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>co ntd..</td>
<td></td>
</tr>
<tr>
<td>Test Ability Type of item</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Component</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Selection of a pictured object that illustrates the same implied principle as a given principle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Selection of a picture that depicts an element essential to an idea or social institution.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Reasoning 1. Concepts involving characteristics of simple lines or figures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Concepts involving simple relations between lines and figures with one distracting factor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Concepts involving simple relations between lines and figures with two or more distracting factors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Concepts relating to artistic effects and assembly of lines and figures.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.6 **Guiding points for preparation of test-items:**

(A) **For Information Part:**

1. The items should test individual's ability to grasp meanings, and to recognise relationships and underlying principles of natural and social environment.

2. The information items should include simple factual types of information, absorbed from surroundings.

3. The items should test ability to systematize and relate new information, recently acquired to knowledge that the testee already possesses.

4. The test items should include as far as possible, general (out of school) experiences.

5. The information items should be based on various environments like home, community, nature and recreation, science and social science.

6. Items based on Indian culture should be included in the information part of the test.

7. All the items in this part should be multiple choice items, pictorial in form, involving recognition or selection of a picture out of a row of five pictures in an item.
8. Clarity in language of the problem to be read before the class should be carefully considered.

(B) **For Reasoning Part**:

1. The items included should measure the testee's ability to develop concepts from series of line drawings.

2. The items should include series of figures that will be relatively independent of school learned skills and acculturation factors.

3. The items should include student's ability to understand relationships from line drawings and figures.

4. All the items should be multiple-choice items. In each item, four of the figures to be constructed on the basis of a specific rule and the remaining fifth figure should be different, to which rule should not apply.

**For Both the Parts**:

1. The items should be constructed keeping in mind the different types shown in the Table No. 4.1.

2. Span of experience of pupils and level of different classes should be kept in mind while framing the items.
3. While framing multiple-choice test items, care should be taken to avoid random occurrence of correct responses in the items.

4.7 Assigning Weightage:

The next essential point that was to be considered, was regarding weightage to be assigned to (1) each part of the test and (2) each type of the items in every part of the test.

For that, the expert opinions were taken from various teachers of psychology, experts in test construction and psychologists.

As to the weightage to be given to both the parts of the test viz. information part and reasoning part, it was the opinion of all of them that equal (i.e. 50%) weightage should be given to each of the parts. They opined that looking to the age and grade level of the children to be tested, there should be variation in the weightage to be given to each type of items in every part of the test.

The following tables No. 4.2 and No. 4.3 show the weightage determined by various expert consultants.
### TABLE NO. 4.2
Statement showing Weightage given by Experts to Different Types of Items of Information Part

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Information Item Types</th>
<th>Weightage in Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ability to recognise a pictured object when its name is given.</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>Ability to recognise a pictured object when a classifying characteristic is given or implied.</td>
<td>30</td>
</tr>
<tr>
<td>3.</td>
<td>Ability to select a pictured object, person, action or interaction situation that represents a given quality or symbol.</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>Ability to select a picture that is an example of a given abstract concept.</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>Ability to select a pictured object the use of which involves a given principle or abstract concept.</td>
<td>12</td>
</tr>
<tr>
<td>6.</td>
<td>Ability to select a pictured object that illustrates the same principle implied as a given principle.</td>
<td>12</td>
</tr>
<tr>
<td>7.</td>
<td>Ability to select a picture that depicts an element essential to an idea or social institution.</td>
<td>4</td>
</tr>
</tbody>
</table>
### Statement showing Weightage Given by Experts to Different types of Items of Reasoning Part

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Reasoning Item Types</th>
<th>Weightage in Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Concepts involving characteristics of simple lines and figures.</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Concepts involving simple relation between lines and figures with one distraction factor.</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Concepts involving simple relations between lines and figures with two or more distracting factors.</td>
<td>40</td>
</tr>
<tr>
<td>4.</td>
<td>Concepts relating to artistic effects and assembly of lines and figures.</td>
<td>20</td>
</tr>
</tbody>
</table>

### 4.8 Construct and Content Validity:

The concept of general ability as discussed in Chapter II is very broad and abstract. The principles of selection of test items have been laid down to make the items specific, concrete and precise. The items consist of definite limited tasks based on both the components of general ability. The problem of preparing a test that has
concept or construct validity is that of bridging the gap from broad general concept to specific tangible tasks or test items. The procedure that was followed to establish the construct validity of the present test has been discussed at length in the foregoing pages of this chapter.

On the principles formulated to construct test items, a number of items were constructed. All of them were fully discussed with a number of teachers of high schools and lecturers and professors of psychology. They were critically gone through by experts, interested in test construction. A pre-tryout was done in different groups and only valid and good items were selected.

It is here, that the validity of a test is laid down by a rational analysis of the ability components included in the test. This type of analysis is done to ascertain content validity of the test. Thorndike and Hagen states, "In practice, establishing the content and concept validity of a test are often closely interwoven." The analysis of the types of items and areas of environment for information part of the test and the analysis of the reasoning type items measuring abstract concepts, correspond to the concepts set out to appraise. In this chapter the detailed analysis of the behaviour components is done with a view to ascertaining the construct and content validity of the test.

4.9 **Description of Test, Parts and Types**

As stated in the foregoing pages of the chapter, the General Ability Test consists of mainly two parts viz. (1) Information Part and (2) Reasoning Part.

**The Information Part:**

The information part of the test consists of items measuring ability to grasp meanings, recognise relationships and understand basic concepts and underlying principles of natural and social environment. It provides an index of the student's intellectual curiosity and inquisitiveness by sampling his understanding of general phenomena and the simple factual types of information he has acquired from his surrounding environment. It also measures his ability to systematise and relate new information he has acquired to knowledge that he already possesses.

The information items are classified into seven types.

The examples of the seven types of items are as follows:

**Type 1:** Recognition of a pictured object when its name is given.
Problem: Find the Screw

Type 2. Recognition of a pictured object when a classifying characteristic is given or implied such as function, source, form, appearance etc.

Problem: Find the one from which we get protein

Type 3. Select a pictured object, person or action that represents a given quality or symbol.

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* From the rows of five pictures, the testee has to select the picture denoting current answer in case of types 1 to 7 in Part I.
Problem: Find the one that is the symbol of an organisation that gives aid to the suffering.

Type: 4. Selection of a picture that is an example of a given abstract concept.

Problem: Find the one which is symmetrical.

Type: 5. Selection of a pictured object, the use of which involves a given principle or concept.

Problem: Find the one that requires combustion for its operation.
Type 6. Selection of a pictured object that illustrates the same implied principle as a given example.

Problem: Find the one that functions by the same principle that causes the boat to float in water.

Type 7. Selection of a picture that depicts an element essential to an idea or institution.

Problem: Find the one that is essential to democracy.
The information items have also been classified under five broad areas relating to content. These include home, community, nature and recreation, science and social science.

The Reasoning Part:

The reasoning part consists of items testing the ability to understand relationships and to form concepts. In each item, four of the figures are constructed on the basis of specific rule. The remaining figure is different; the rule does not apply. These items test the ability to derive concepts of various types which involve a wide range of difficulty. The concepts the students are required to understand in these items may be classified into four principal types:

Type 1. Concepts involving characteristics of simple lines or figures.

Included are concepts of curvilinearity, number of sides and elements, shading, shape, area, length, type of lines, size of angles.
In this example, the concept of curvilinearity is crucial.

Type 2. Concepts involving simple relations between lines and figures with one distracting factor.

Included are concepts of shape, parallelness, similarity, perpendicularity, symmetry, position, orientation, intersection, overlap, etc.

In the following example the small circle-stars are diagonally opposite in all but one of the figures. Position is the distractor in this item.
Type : 3.  Concepts involving simple relations between lines and figures with two or more distracting factors.

In the following example, the position of the figures is crucial. The direction and the repetition of two small figures at the ends are distractors.

Type : 4.  Concepts relating to artistic effects and assembly of lines and figures.

Included are concepts of shading, parts of a whole, perspective, etc.

In this example, shading and shape are the distractors. Linkage is crucial.
4.10 *Directions for Test - Administration*:

Along with the selection of test material and test items, special attention was given to preparing directions for the administration of the standardized test to maintain its objectivity.

This being a non-verbal test, directions to testers for administering the test were prepared. The directions consist of general instructions and specific instructions to the teachers. In general instructions, methods of using test booklets and answer-sheets, method of reading specific instructions, technique of introducing practice items, etc., have been clearly explained.

While in specific instructions, the preliminary work of filling personal particulars of the testees, the method of reading problems of information part, explanation of the reasoning items, assigning time to administer the test-parts, etc., have been clearly stated. It was planned to prepare a manual of directions along with the standardized test.

4.11 *Testing Material*:

The General Ability Tests are to be constructed on the design discussed in this chapter and to be standardized for measuring individual differences in general ability of pupils studying in classes VIII, IX and X of the secondary schools of Gujarat State.
Each student to be tested will need one test booklet and one answer-sheet. The test administrator will need directions for giving the tests, scoring key and ready-recknor for obtaining IQs.

Thus, the following testing material is planned to be developed along with the construction and standardization of the test:

1. Test Booklets
2. Answer-sheets
3. Scoring keys
4. Directions for Administering the Test
5. Ready-recknor for obtaining IQs.