CHAPTER 2

CONSTRUCTION OF SUBTESTS FOR THE
PRELIMINARY FORM
CHAPTER 8

CONSTRUCTION OF SUBTESTS FOR THE PRELIMINARY FORM

The modern test constructor of intelligence or general mental ability is more fortunate than his predecessors of earlier days for several reasons, the foremost being the availability of a rich literature on the subject to guide him in theoretical formulations and practical application of methods in test construction. The ancestry, of which he is a proud scion, is grained by bracing tissues of monumental authorship by the pioneer psychologists who solved step by step many intricate problems before testing took a definite shape and spreaded to its present proportions. When Wundt in Germany organized the first psychological laboratory, our understanding of intelligence was hazy and its testing, in the modern sense of the term, was unknown; when Galton in England devised many brilliant methods of examining psychological phenomena, our understanding of intelligence was no better and testing had yet to take the embryonic form; when the elder Cattell in America published that grand list of psychological tests and went about testing pupils in institutions, the position was still obscure but preparations were on the right track for the final assault by Binet in devising the first scale of intelligence test. It is providential that
Binet's name is associated with the first test scale, for things were poised in such a manner that it would have been Ebbinghaus, or Cattell, or Burt or any other psychologist had Binet failed in his task. By amplifying what Boring (1950, p. 572) states about the situation we can say that intelligence testing was not precipitated by the brilliant insight of any one man, but it was the natural development of the period.

From Binet to Guilford it is a long period of inexhaustible activity, and test construction in the field of intelligence is not so problematic now as it used to be in Binet's time. For a routine work like the present one, the constructor can readily find out what type of material he should use for his test or what type of material is capable of measuring a certain function (like education of relations) that he may want to include in his test.

In order to examine those commonly selected materials or 'elements' in well-known tests, several group verbal tests in English are taken into consideration as shown in Table 2.1. From the point of view of commonly selected elements in these tests, it can be observed that synonyms, antonyms, analogies, arithmetical reasoning, number-series are frequently selected elements and more than half the test constructors in the Table favour the use of these elements. As these test elements are found to be based upon relational thinking with abstract symbols, a decision is made at this
Table 2.1  Showing the use of various elements in different group verbal tests of intelligence. (Tests shown without a date are taken from Whipple, 1923)

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1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18
| Test                                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|
| Lorge-Thorndike Tests, 1957              | x | x |    |    | x |    | x |    |    |    |    |    |    |    |    |    |    |    |    |
| Thurstone Test of M. Alertness, 1952     | x |    |    | x |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| ACE Psychol. Ex. High School, 1953       |    | x |    | x |    |    |    |    | x |    |    |    |    |    |    |    |    |    |    |
| ACE Higher tests, 1959                   | x | x |    |    |   | x |    |    | x |    |    |    |    |    |    |    |    |    |    |
| Cattell Int. Test II, 1935               |    | x |    | x |    |    |    |    |    |    | x |    |    |    |    |    |    |    |    |
| Modified Alpha, 9, Wells, 1941           | x | x |    |    | x | x | x |    |    |    |    |    |    |    |    |    |    |    |    |
| West Yorkshire, Tomlinson, 1951          | x | x |    | x |    |    |    |    |    |    | x |    |    |    |    |    |    |    |    |
| Tenen-McNemar (Anastasi, 1961, p. 221)   |    |    | x | x |    | x |    |    | x |    |    |    |    |    |    |    |    |    |    |
point to select analogies, antonyms, number series, and arithmetical reasoning elements for the proposed test. In addition, two more elements viz., analogies and classification are also selected for a trial.

After the elements are selected, items are prepared for each of these elements. As items are to be prepared for a wide range of capacity of pupils of various ages (approximately from 11 years to 16 or 17 years), they are initially prepared and roughly classified under the three headings: easy, average and tough. Besides, the following steps are taken to avoid unnecessary errors of construction.

(a) Items are phrased in clear, understandable language so that there is no difficulty in understanding the concepts.

(b) The general directions are written plainly and adequate practice exercises are given for familiarisation with the technique of answering questions.

(c) Concepts and ideas used in items are derived from a common environment of subjects for whom the test is prepared so that there is least effect from environmental differences (formal learning experiences in different grades).

(d) Items are constructed in such a manner that they create interest among testees so that there is adequate motivation to work out problems in the test.

(e) Items are prepared in such a manner that testees can select the right answer from among several alternatives (recognition form).
(f) In all phases of item construction, the population for whom the test is meant is kept in view.

(g) Words are chosen, as far as practicable, to indicate precise meaning. Non-functional, irrelevant, ambiguous, tautologous and redundant words are avoided.

(h) The direct question type is used.

(i) Distractors in an item are made as plausible as possible so that a testee, not knowing the answer, is attracted equally by all alternatives of an item.

(j) No logical order is followed (excepting in the number series items) in arranging the alternative answers of an item.

(k) Separate directions are written for separate test booklets (one for each element) including practice exercises befitting the special nature of an element.

2.1. Analogies Subtest and Item Construction

Analogies are one of the most frequently used elements in general ability tests and has proved to be 'one of the most valuable' (Pintner, 1931, p.184). In this test, the testee is given a set of three terms by studying the relationship of which he has to discover the fourth term. The first and the second terms are related in some way and this relationship is applied to discover the correlate of the third term. It is considered as one of the 'association tests' with restrictions imposed upon the subject although, '...... the kind of restriction varies from one stimulus to
another with the series of terms. The kind of restriction, moreover, is not indicated to the S. in the instructions, but is supplied to him by the test material itself, and must be apprehended by him for that material' (Whipple, 1915, p. 90).

According to Burt (1947, p. 287), it involves implicit or explicit perception of a relation and the reconstruction of an analogous relation by what Stout has called 'relative' or 'relational suggestion'. Spearman (1937, pp. 126-129) applies his noegenetic laws that demand education of relations (first two terms) and education of correlates (last two terms) and says it to be a very efficient material for the measurement of general mental ability.

The analogies test is a measure of conceptualization and generalization of semantic terms in a verbal test. The constructors of the Differential Aptitude Test (Bennett, Seashore-Wesman, 1959, p. 6) call it a verbal reasoning test and say it to be, '..... a measure of ability to understand concepts formed in words. It is aimed at the evaluation of the students' ability to abstract or generalize and to think constructively, rather than in simple fluency and vocabulary recognition'.

Several well-known tests such as the Army Alpha and its revisions, ACE Psychological Examination, Lorge-Thorndike Tests, Cattell Intelligence Tests, Terman-DeNemar Tests, Differential Aptitude Tests include the analogies test in their batteries. In the Lorge-Thorndike Test
(Levels 4 and 5), the median correlation between verbal analogies subtest and the test shows coefficients of .50 and .52 for Form A and .52 and .47 for Form B (1957a,p.4). The analogies test in the School and College Ability Tests (1957, p.19) shows coefficients as .43, .53, .61 when the subtest is correlated with total grade average in High, Medium and Low groups respectively. The verbal-linguistic score of SCAT (Form 2A) shows a coefficient of .89 when correlated with the ACE Psychological Examination, High School edition. The DAT verbal reasoning test is an analogies test and its correlation as reported in the Manual (Bennett etc., 1959,p.72) with various intelligence tests is high and in the range from .59 to .86. The Personnel Classification Test (Wesman, 1951,p.15) shows an average correlation between Verbal Analogies and Numerical Computation to be .44 (.26 to .57). Burt (1947, p.277) reports an average coefficient of .746 and .755 between written analogies and general intelligence.

The above observations point to the usefulness of the analogies test in measuring general mental ability, and therefore, a subtest with such items is considered fit to be included in the proposed test. Although a test of this nature is prepared to be administered for the first time in Assamese, the slightly shorter mode of presentation with signs of proportion is selected with several practice exercises to precede actual testing. An item is set in one line with three terms on the extreme left. Four alternative
answers are then given on the same line toward the right of which the correct answer is to be underlined by the testee. The fourth term should bear the same relationship to the third just as the second bears to the first. The following illustrative example is given of an item:

कमः विधा : रूपाः (ि)चा (ि)नाव (ि)धीर (ि)वाचि
or,
pen : to write : axe : (ि)to cut (ि)handle (ि)steel (ि)fire-wood

A large number of such items are constructed of which 40 are finally selected for inclusion in the first draft as shown in Appendix F. As mentioned earlier, every item is constructed with terms that represent a common environment from the testees' point of view with the exception of few difficult items like धृति (orderliness), उमंग (praise) etc. The items are then subjectively rated for difficulty and then are arranged in order from the easiest to the most difficult. The total time of performance is then roughly fixed at 20 minutes.

2.2. Opposites Subtest and Item Construction

The opposites are a simple form of vocabulary test where the testees are required to give the opposite term of a given word. In a verbal test of general mental ability, synonym (same) and antonym (opposite) tests are frequently used because mastery in the manipulation of semantic material in the acquiring of intellectual keenness plays an important role in the complex of an extremely intricate adjustment process. Whipple
(1910, p.308) long back before the boom of group verbal test of intelligence was on, stated in clear terms the importance of the vocabulary test (of which the opposites test is a form) in intelligence testing: 'Since nearly all thought and expression is couched in linguistic form, and since the intellectual progress of the child at school is, in a sense, a process of augmentation of his vocabulary and of refinement of its use, it seems not unreasonable to assume that the determination of the size of this vocabulary will be of significance and value in estimating his general intellectual status'. It does not require much effort to see the logic of this plain truth considering how much dependent a modern man is upon his attaining a standard through the verbal learning process and how much humanity has to depend on this process of truth-seeking in every phase of this civilised existence.

In Table 2.1, we observe the highest frequency for synonym-antonym tests and are as popular as the arithmetical reasoning test. The Word Knowledge Test, which is a similarities test in Level 4 of the Lorge-Thorndike series (1957a, p.4), shows a correlation of .63 and .61 with the total test at the same level. The Vocabulary Test (a synonym test) in the SRA Test of Educational Ability, Grades 9-12 (1958, p.5), correlates to the extent of .77 with the Kuhlmann-Anderson Test, and .72 with the V score of the Primary Mental Abilities Test. Burt (1947, p.277) reports a coefficient of .631 between opposites test and general intelligence. All these coefficients
show a marked relationship and justify our position as to
include the element in the battery.

In preparing items for this subtest, a simple form of presentation is aimed at. The given word is placed on the extreme left and after a colon four alternative answers are written as shown in the following example:

बच्चा : (1) पुत्र (2) बच्चा (3) किशोरी (4) कला

or,

boy : (1) naughty (2) male (3) girl (4) pupil

In the constructional stage an authoritative Assamese dictionary (Chandrakanta Abhidhan, 1933) has been used to select appropriate terms for different items. Finally, from among a large number of originally prepared items, 40 are selected and arranged in order of difficulty for inclusion in the first draft as shown in Appendix F. The total time for the subtest is tentatively fixed at 20 minutes.

2.3. Number Series Subtest and Item Construction

The number series test is another kind of reasoning test where reasoning is carried out through numbers or numerical material. The series in an item presents a sequence of numbers and a principle is employed in the formulation of the sequence. The testee is to examine the relationship between the numbers in a series and discover the principle and then by applying the same principle he is to state what number or numbers should follow a particular series. This kind of
relational thinking fits in with the noogenetic principles of Spearman (1937, pp. 125-129), particularly the second (education of relations) and the third (education of correlates), and therefore, has been found to be of great service in the measurement of general mental ability. It is a test of abstract intelligence and the demonstration of such intelligence through numbers has already been recognized.

Freeman in his book Mental Tests (1939, p. 124) writes, 'It is probably more nearly a pure intelligence test than are some of the others'. It may be called a measure of ingenuity in handling numbers. The frequent employment of this element in verbal general ability tests is another evidence in support of the above statement, although it is open to discussion as to why such a test is employed to assess verbal ability. One reason is that it shows a higher associational value with tests normally used to measure verbal ability.

Returning to Table 2.1, we find that this element is employed in more than half the number of tests and its employment in tests like the Army Alpha, Henmon-Nelson, Lorge-Thorndike is noteworthy. Holzinger and Harman (1941, p. 144) worked out the general factor component of the number series test to be .734 and Rimoldi (Fruchter, 1954, p. 173) observed a g-loading of .62 in separate studies of factor analysis. In the Army Alpha Test (Kelley, 1928, p. 216), its correlation with the Synonym-Antonym test and the Analogies test is obtained respectively as .681 and .704. Thus, its high
relationship with general ability tests and frequent employment by authors favoured positively to try it in the present series.

Construction of test items on this element is a simple procedure with five or more than five numbers written in some order along a line and a blank left at the end for marking the recalled answer. Each item in the subtest is constituted of five numbers and the recall form is employed to let the testee write the correct number on the blank left at the end of a line. The recall form is used only in this subtest as there is the least chance for subjective marking of an answer which is a number. The following is an illustrative example of an item:

8 9 7 4 6 ... or,
4 5 6 7 8 ...

Finally, a large list of such items is assessed subjectively for difficulty and forty suitable items are taken in order to form the subtest for the first draft as shown in Appendix P. The total time for the subtest is roughly fixed at 20 minutes.

2.4. **Arithmetical Reasoning Subtest and Item Construction**

Arithmetical reasoning is another popular element used in many general mental ability tests as may be seen in Table 2.1. It is implied in this type of test that the testees have had some instruction in this field and are at ease in
handling problem solving situations involving numbers. In the 21st Year Book of Education (Whipple, 1923, p. 37), we find the following observation made by Colvin, 'One of the common group tests now used is an exercise in the fundamentals of arithmetic or in simple arithmetical problems. The test involves concentrated attention, mental alertness and a fair degree of rational ability in some instances. The scores obtained show a fair degree of relationship to general intelligence'. In an important paper on the nature of the general reasoning factor, several authors including Guilford (1967, pp. 434-437) have recalled some factorial work in which the arithmetical reasoning test shows the largest loading of a factor which has been termed as 'general reasoning'. This general reasoning has been conjectured as a general ability to formulate complex conceptions of many kind. In an analysis of inter-correlations of the Army Alpha Test (Kelley, 1928, p. 216), this element shows substantial relationship with all the preceding elements taken in to consideration. Thus, the coefficients appear to be,

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<td>.791</td>
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The Arithmetical Reasoning Test in the Lorge-Thorndike intelligence Test (1957a, p. 4) corresponds with the total test to the extent of .56(FormA) in Level 4, and .55(FormA) in Level 5.

An arithmetical reasoning test item is essentially a computational problem where the testees have to glean from the verbal dressing the operational procedure to arrive at the
solution. In forming such items, care is taken to apply such language that may be easily followed by testees. Unnecessary and ambiguous words and phrases are avoided and questions are made as straight as possible. The correct answer in an item is required to be selected from among five alternatives given just below a question. Thus, for example,

If 4 pupils can sit in a bench, and if there are 8 benches in a class, how many pupils can sit in the class?

30  32  28  12  44

or,

The items in the original list are first subjectively valued for difficulty and then a total of 30 items are selected and arranged in order for inclusion in the first draft as shown in Appendix F. The testees are allowed 25 minutes tentatively for solving these items.

2.5. Verbal Reasoning Subtest and Item Construction

In addition to the above four subtests, two more elements are considered for inclusion in the battery to introduce greater variety in the proposed test. The two subtests are the verbal reasoning and classification tests -- two familiar elements in many general ability tests. The verbal reasoning test is highly spoken of by Burt (1947, p. 249) and
he considers it to be one of the best tests of intelligence: 'Empirically it is found that reasoning test of this character form the best tests of intelligence ..... it is particularly useful for older and brighter children'. The materials used in this subtest are verbal statements in which certain facts leading to a problematic situation are given; by considering which in their totality, the testee is to find out the correct answer. Obviously, logical principles are involved in such situations, and therefore, require a higher degree of intellectual work with semantic material.

In our discussion on the arithmetical reasoning test, mention has been made of the general reasoning factor, and this factor is conceived of as a broad ability to grasp all kinds of systems that are conceived in terms of verbal concepts not necessarily involving problems of an arithmetical type (Guilford, 1959, p. 425). Therefore, these two tests of arithmetical reasoning and verbal reasoning, one dependent on a language environment and schooling to a particular standard, and other dependent on the language environment alone serve to measure reasoning ability which is a basic constituent of intellectual behaviour. Burt (1947, p. 277) correlated this test with general intelligence and obtained the coefficient to be .807.

For the construction of items on verbal reasoning, ideas are taken from Burt's Reasoning Test, Cattell's Intelligence Test, and Spearman's Intelligence Test. The wording of the items are made as simple as possible and unnecessary and
ambiguous terms are avoided. Recognition type alternatives are provided for each item and the testee is required to select the right answer from the choices given just below a question. Thus, as an illustrative example:

If 7 ' or ' 15

or,

Pha is bigger than Pa. Ba and Bha are smaller than Pha. Who among them is the biggest?

Pa    Pha    Ba    Bha

A collection of such items is then graded for difficulty on a subjective basis and finally 30 items are selected and arranged in order for inclusion in the first draft as shown in Appendix P. The total time for the test is roughly fixed at 25 minutes.

2.6. Classification Subtest and Item Construction

The classification test is a form of 'similarity-difference' test in which the testee is to select in an item one word from among five or six which is not similar and therefore cannot be classified with the rest. In this, the examinee has to see the relation among a number of words that can be adjudged as belonging to one class and then differentiate the one that does not show such relationship. In a classification problem the testee's capacity to work out a problem will depend
on how well he can cognize various concepts and how well he can generalise them into a class and at the same time differentiating the one that does not belong to the rest.

This element has been used in some well known tests of general mental ability like the Henmon-Nelson Test, Lorge-Thorndike Test, ACER Higher Test, Terman-McNemar Test etc. as may be seen in Table 2.1. It is therefore, thought to be reasonable to include the classification test also in the proposed battery.

Common words denoting mostly objects in the natural environment are taken to construct items of this subtest. Five words are taken to make an item framed in a line, one of which is the answer required to be underlined by the testee. The following example illustrates items used in this subtest:

Or,

Cow buffalo horse duck sheep

From a large collection of such items, 40 are selected as shown in Appendix F for the battery and this selection is again made on the basis of subjective judgment of difficulty of items. A total time of 20 minutes approximately is fixed for this subtest.

2.7. Construction of the Battery

In constructing the six subtests for the battery to be used for the first tryout and item-analysis, the following steps are taken. The battery of subtests is demonstrated
in Appendix F.

(a) Each subtest is to represent only one element.

(b) Items in a subtest are subjectively graded according to difficulty and these are then arranged from the easiest to the most difficult.

(c) The front or cover page of every subtest is provided with blanks for writing of personal data. Because every subtest is to be independently administered, relevant instructions and practice exercises are given separately with every subtest on the front page.

(d) Items of the actual subtest occur inside a booklet and testees are given repeated instructions not to turn the pages until they are asked to do so.

(e) Multiple choice type of items are provided for each subtest excepting the number series subtest where recall type of items are given.

(f) Consumable subtest booklets in the size, 32.8 cm X 21 cm, are mimeographed from stencils cut out in an Assamese type-writer (Remington Rand). This introduces a problem of spelling some new combination of letters as in भ, ज, झ, ञ, ट ती. etc., and therefore, it is considered necessary to give verbal instructions (Direction 5A/GUA/67) at the time of administration of the subtests. Although these combinations are not used in the school text-books, they are being used by the press in publishing newspapers and news magazines.
(g) Pages are numbered properly and the top and bottom of every page containing test items are provided with appropriate instructions to follow items in their order.

(h) Adequate margins are provided for the arithmetical reasoning and the number series subtests for testees to do rough work, if necessary.

(i) Instructions are also provided as to how they should correct a wrongly written or underlined answer.

(j) The total number of items in the battery of subtests are 220 distributed over the elements as shown below:

- Analogies: 40 items
- Opposites: 40 items
- Number Series: 40 items
- Arithmetical Reasoning: 30 items
- Verbal Reasoning: 30 items
- Classification: 40 items
- Total in six subtests: 220 items

(k) The battery is called GUA/67, and therefore, any reference by this code name will mean the battery of subtests as described in this chapter and shown in Appendix P.
SUMMARY

In this chapter, an analysis of elements used in some well known tests is made and a decision is taken to include the following elements in the battery of subtests to be used in the preliminary tryout.

1. Analogies
2. Opposites
3. Number Series
4. Arithmetical Reasoning
5. Verbal Reasoning
6. Classification

In sections from 1 to 6, some references are drawn to justify the inclusion of a particular subtest and the mode of construction of items and preparation of a subtest is explained. In the last section, steps taken in the final preparation of the battery are set forth.