CHAPTER- IV
DESCRIPTION OF TOOLS

For every research, we require certain instruments to collect factual information for exploring new fields for research. The instruments thus used as means are called tools. To select a suitable tool is of very important to complete the research successfully. Tools are the means for collection of data and for interpretation of data and to explore new research fields. The selection of a tool is a difficult task in research and depends on various factors such as the objectives, the choice and availability of the tools, competency of the investigator to administer the tests and the like.

According to J. W. Best, “Like the tools in a carpenter’s box, each research tool is appropriate in a given situation to accomplish a particular purpose”.

The choice of tools in a research piece has, therefore, to be proper and immediate to realize the set objectives and allied major consideration.

In the present research, the following tools were accordingly chosen or self – developed as per the requirement of the research:

A. Standardized Test
1. Group Test of Intelligence (GGTI) by Dr. G.C. Ahuja (1990)

B. Self developed Tools
3. Mathematics Achievement Test (To be developed by investigator)

4.1 Group Test of Intelligence (GGTI) (13 to 17+ years)

4.1.1 The Construction of the Test

A psychological test is an objective, organized and statistically refined instrument or method to measure some specific skills, behavior or set of characteristics under standardized conditions. The construction and standardization of such a test is largely a creative undertaking which is constructed in accordance with definite principles. The present test was devised in order to meet the pressing demand for a group test of intelligence in English. The test is meant for assessing the general mental ability of pupils
of age group 13 to 17 years studying in classes VIII to XI through English Medium Secondary Schools of Greater Bombay.

4.1.2 Construction

In devising a new test, the main advantage is that the environmental factors, local atmosphere and aptness of language can be effectively maintained. This is done by selecting such type of sub-tests and items, as may seem justifiable according to the requirements of the measure. In such a test, three important features: (i) brevity of pupil responses, (ii) extensive sampling, and (iii) absence of subjective element in the scoring of the test has got to be maintained. Accordingly, the preliminary draft of the test was prepared and it contained 261 items covered under eight different sub-tests. The instructions and explanations for practice examples were carefully worded. A separate answer sheet was also introduced. After some preliminary administrations, the tryout of the test was undertaken on a sample of 370 pupils drawn from four randomly selected English Medium Schools. The various purposes to be achieved were: (a) to obtain objective information concerning each and every item. (b) to make a judicious selection of the items to be retained in the final form, (c) to arrange the selected items in ascending order of difficulty, (d) to fix up the time limit for each sub-test (e) to produce the finished form of the test booklet and that of the answer sheet.

The item-validity was studied by the application of the following five methods:

(1) Symond’s Method,
(2) 27 Per cent Upper and Lower Groups,
(3) Lawshe’s Nomograph,
(4) Flanagan’s Product Moment ‘r’ coefficient, and
(5) Kelly’s Method.

If more methods are used, obviously the chances of error are reduced. These methods were selected from the point of view of their effectiveness and ease of computation. The item-difficulty was determined by taking into account the number
right, or the proportion of the group which could solve an item correctly. The sample of
370 testees was bifurcated into two groups of 100 each on the basis of upper and lower
27 percent tails. The difficulty value for each item was obtained by applying the formula:
\[100 - \frac{U + L}{2}\].

The quality and merit of any test depend upon the individual items of which it is
composed. The object is to make the most useful selection of test types and test items
from among those available. A two-way plot of difficulty and discrimination values for
all the 261 items was made, out of which the selection could be made. Thus 126 best
possible items were selected and retained in the beginning of the battery as a practice test.
The main purpose of including the additional test is to enable the pupils to get acquainted
with the nature and working of the test. It is expected that it will serve the purpose of
building morale in the students and thus develop confidence in them. The performance on
this test is not to be considered.

The average validity of the battery of seven tests by the application of five
different methods was found as follows: (1) Symond’s Method 11.187, (2) 27 percent
Upper and Lower Groups …. 39.80, (3) Lawshe’s Nomograph… 1.59, (4) Flanagan’s
Product-Moment ‘r’ Coefficient… .543, and (5) Kelly’s Method… 1.555. The validity
indices are fairly high.

For the sake of uniformity, in all the sub-tests, the numbers of items have been
selected in such a way that these are in conformity with the average time of 4 minutes.
This time allotment is set so that most of the individuals tested have an opportunity to
attempt all or nearly all the test items. That is, for each item he gets 13.33 seconds, which
is quite sufficient for a normal child to finish the work at his normal pace.

Table presents the number of items retained in each sub-test. The time limit fixed
for each sub-test has also been shown.
### TABLE

**Total Items and Total Time Required for each Sub-Test**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sub -Test</th>
<th>Number of Items</th>
<th>Time Limit</th>
<th>Remarks (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Following Directions</td>
<td>9</td>
<td>04 Minutes</td>
<td>Additional Test</td>
</tr>
<tr>
<td>2</td>
<td>Classification</td>
<td>20</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Analogies</td>
<td>06</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Arithmetic Reasoning</td>
<td>06</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Vocabulary</td>
<td>40</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Comprehension</td>
<td>08</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Series</td>
<td>12</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Best Answers</td>
<td>20</td>
<td>04 Minutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>126</strong></td>
<td><strong>28 Minutes</strong></td>
<td>(Excluding Test 1)</td>
</tr>
</tbody>
</table>

#### 4.1.2 The Test Booklet and the Answer Sheet

The test booklet contains eight sub-tests. Test 1 is an additional sub-test which is meant for practice only. The remaining seven sub-tests from II to VIII are the tests proper. For every sub-test, the first page is provided for instructions and practice examples.

A sub-test requiring two pages is placed in such a way that it does not involve the turning of the page. A sub-test requiring one page is followed by a blank sheet. It makes the students to face the relevant test- material and hence to concentrate on that matter only.

A few main directions are given on the title page of the test booklet and the remaining general instructions are on the reverse side of the title page. Eight pages are utilized for instructions and practice examples. Eleven pages are meant for all the test items of eight sub-tests.
There are 135 test items and 24 practice examples (9 test items and 2 practice examples contained in the first additional sub-test have also been included in the total figures.)

The answer sheet is of four pages. At the space meant for each sub-test, the first column is for practice examples where identical page number of the test booklet is printed to facilitate its location. The subject has to mark the practice examples there only.

The test problems are to be marked in the second and third columns adjacent to that of first column. There also, the page number of the test booklet is printed. The columns are placed with sufficient spacing and in symmetrical order. After each sub-test, a straight horizontal line has been drawn which enables the subjects to distinguish easily where one sub-test ends and the other beings. Thus the process of marking the answers on the answer sheet is very smoothly and elegantly handled by the subjects.

The total testing time for all the eight sub-tests is 32 minutes. The time required for instructions and practice is approximately 35 minutes. Thus the battery of eight tests can be very conveniently administered within two school periods of 35 minutes each.

4.1.4 Directions for Administering and Scoring the Test

Administering the test

The test is meant for measuring the intelligence of pupils studying in class-Group VIII to XI through English Medium Secondary Schools of Greater Bombay.

There are eight sub-tests in the test booklet. The first one is an additional test of very easy items. The purpose of first page is to build morale in the subjects. It helps them to develop confidence and as a result they get adjusted with the nature of work. The performance of this additional test is not to be taken into account. This fact (that performance on the first test is immaterial) is not to be revealed to the pupils. While administering the tests, the value of this additional test is not to be under-estimated. The remaining seven sub-tests from II to VIII are the tests proper.

Answers are to be marked on the separate answer sheet provided. Test booklets are reusable. After each use the booklets must be inspected since some pupils will mark in them despite directions to the contrary. Erase all writing and marks. If any answer is indicated and cannot be thoroughly obliterated, discard the booklet.
The test booklets and answer sheets should be counted in advance. After the test is over, the test booklets and answer sheets, both used and unused, should again be counted to see that all have been collected.

For every test, first page has been provided for instructions and examples for practice. Directions for taking the test are printed on the test booklet. They are to be read silently by the pupils while the examiner reads them aloud.

The tester should take the test himself before giving it to a group or he may give the test for practice to some pupils who will not be included later in the test properly. Such an experience would equip the tester to administer the test without difficulties.

The test may be administered in regular class-room. Students being tested should be seated apart. The space provided to them should be so large that booklets and answer sheets can be used without inconvenience.

It is advisable for pupils to take the test with pencils. Some extra pencils should be kept at hand and supplied to any examinee that needs.

The time limit for each sub-test should be strictly adhered to. For this, a stop watch should be used.

Before the start of the test, the students should be allowed to meet their physical needs.

First of all, the following orientation address should be delivered to establish the rapport:

Today I am going to give you very interesting and simple work to do. For class test you prepare and study hard, but here for these tests, no advance preparation is needed. Also there is less of writing business. You have simply to mark the answers and it will be fully explained with examples how you have to do the work.’ For administering the test, the following steps should be observed:

1. Distribute the answer sheets and instruct the pupils to fill in the requested information in the proper spaces. (When the testing is over, verify the date of birth entries from the school record.)

2. Before distributing test booklets, make the following announcement so that it is clearly understood: ‘Do not open these booklets until I tell you to do so.

3. Read the Main Directions on the cover page of the test booklet.
4. Read general instructions on the reverse of the title page of the test booklet.
5. Read Practice Examples and Instructions relating to Test I given on page 3 of the test booklet.
6. Show the space on the answer sheet for marking answers to the test problems.
7. Ask the pupils to get their doubts cleared (if any). For this, repeat appropriate sections of the directions, or review the examples given, rather than employ new explanations or examples.
8. Tell the pupils to revise the answers if they finish the test before time.
9. Tell them to turn the page of the test booklet and say “Start”. Start the stop-watch and after four minutes, say “Stop”. Tell them to turn the page of the test booklet.
10. Go around seeing that each student is marking properly. Follow the above procedure for the remaining seven sub-tests.

4.1.5 Scoring the Test

A set of scoring stencils has been provided. Put the related stencil of key on each page of the answer sheet. It should be so adjusted that the page numbers are visible enough through the circular holes of the scoring stencil. The correctly marked answers (cross marks) will be visible through the holes. Count the number of right answers and write in the left margin against each sub-test of the page.

It is also necessary to inspect the answer sheets to determine whether a student marked more than one answer. If in the same item, more than one answer is marked, score it as wrong.

The same procedure is to be followed for all the sub-tests except for Test VIII. In that case, the correct answers are the alternatives that correspond with the numbers given on the stencil key. Take a red or blue coloured pencil and mark the question numbers that are answered wrong, or are left unattempted. Now count the number or items marked above (both wrong as well as unattempted), and then deduct that from 12 (total number or items contained in test VII), to balance is the correct score for the said sub-score.

Transfer the scores from the different pages of the answer sheet in the table towards the top of the front page of the answer sheet, and find out the total score.
4.1.6 NORMS

In the case of an intelligence test like present one, the norms are generally worked out for the different age-groups and class-groups. To study the sex-differences, separate norms are provided for both the sexes. This, on comparison with the table of norms enables to rank an individual pupil’s performance and indicate the level reached by the pupil relative to his own and other age or class-group. To express the results in more meaningful forms, the individual scores are represented in one or more of the indices of brightness. In intelligence tests, the DIQ (deviation intelligence quotient) as one of the units of brightness holds a strong bearing.

Age Norms

A norm with reference to age is the normal score of the average or middle-most child of the age under consideration. The age norms were established by considering the different age-wise distributions of test scores made by the samples of boys as well as those of girls. The irregularities in the mean-scores for age-groups 12 to 18+ were smoothed to show regularity.

Interpretation of the Age-Norms

The deviation of a score from the corresponding age-norm can be used as a measure of acceleration or retardation. For example, a boy aged 15 years with a test-score of 70 turns out to be the retarded one by 5 point than the average of his age. In other words, the deviation of his score from the corresponding age-norm is -5. Similarly, another boy age 17 years with a test-score of 90, turns out to be the accelerated one by 12 point than the average of his age. That is, the deviation of his score from the corresponding age-norm is +12.

It is obvious that the (+) sign attached with the deviation of a score from the corresponding age-norm indicates acceleration. Whereas (-) sign indicates retardation. If the deviation of a score from the corresponding age-norm is 0, it indicates that the pupil is exactly at the normal level.
Separate norms have been provided for boys and girls. From the relevant column of Table 12, the deviation of a score from the corresponding age-norm can be obtained easily. By this way, a rough comparison or a simple gradation of pupils can readily be made.

**Some More Procedures of Expressing the Individual Scores in Units of Brightness (With Reference to Age-Groups)**

The provision for further interpretations based on the deviation of a score from the corresponding age-norm in the form of Percentile Ranks, Sigma Scores and Standard Scores (Tables 14 and 15) has also been made. Side by side with these above-referred to indices, the process of converting the test-scores into T-scores (Tables 16 and 17), and that of Deviation Intelligence Quotients (Tables 20 and 21) has also been formulated.

**Class Norms**

Class norms are related to the performance of any individual to that of the average students at each class (also known as Standard or Grade) level. It is in relation to class placement that a pupil’s performance is likely to be interpreted. The class norms are to be established by taking into account the various class-wise distributions of test-scores (Tables 7 and 8) made by the samples of boys as well as that of girls. Class-norms are given in Table 13.

**Interpretation of the Class-norms**

The deviation of a score from the corresponding class-norms can be used as a measure of acceleration or retardation for boys and girls respectively with reference to the class-group concerned. For example, a IX class boy with a test-score of 80 turns out to be the accelerated one by 8 points than the average of his class. In other words, the deviation of the score form the corresponding class-norm is +8.

Similarly, a class X girl with a test-score of 90 turns out to be the accelerated one by 11 points than the average of her class. In other words, the deviation of the score from the corresponding class-norms is +11.
It is obvious that the (+) sign attached with the deviation of a score from the corresponding class-norm indicates acceleration, whereas (-) sign indicates retardation. If the deviation of a score from the corresponding class-norm is 0, it indicates that the pupil is exactly at the normal level.

The norms with reference to class-groups have been provided separately for boys and girls. From the relevant column of Table 13, the deviation of a score from the corresponding class-norm can be obtained easily. By this way, a rough comparison or a simple gradation of pupils with reference to class-group (Standard or Grade) can readily be made.

**Some more procedures of expressing the Individual Scores in Units of Brightness (With Reference to class-groups)**

The provision for interpretations based on the deviation of a score from the corresponding class-norm in the form of Percentile Ranks, sigma Scores and Standard Scores (Tables 14 and 15) has also been made. Side by side with these above-referred to indices, the process of converting the test-scores into T-scores has also been formulated.

**4.1.7 Percentile Ranks**

The easiest way to make comparisons is to rank the scores from highest to the lowest. The percentile ranks are expressed in terms of the percentage of persons in the standardization sample which falls below a given raw score. These provide a direct statement of the individual’s relative position in the group under reference. For example, a person having a percentile rank of 40 (P40) is situated above forty-per cent of the group fall below this person’s rank and so on, for any percentile rank in the scale.

**Tables of Percentile Ranks**

The deviation of a score from the corresponding age-norm/class-norm can readily be obtained. For all possible deviations, the percentile ranks have been worked out separately for boys and girls.
The deviations were first expressed in Sigma Score. The values of these Sigma Scores were taken from Garrett’s Table A3 of areas under the Normal Probability Curve. Thus the percent deviation from the mean was obtained. The percentile ranks were then established by adding 50 to these (Percent Deviation) values. Table 14 and 15 serve as the ready reckoners for obtaining the percentile ranks of boys and girls respectively. These can be obtained with reference to the deviation of a score from the corresponding age-norm/class-norm.

4.1.8 Sigma Scores

Deviations from the mean expressed in SD units are called sigma scores. These are also known as Z-scores or Reduced Scores. The mean of a set of sigma scores is always 0 (the reference point) and the sigma is always unity or 1.00. Above half of the sigma scores turn out to be positive and half negative. The sigma score indicates, in terms of standard deviation, how far a particular score is removed from the mean of the distribution.

Tables of Sigma Scores

The deviation of a score from the corresponding age-norm/class-norm can readily be obtained. For all possible deviations, the sigma scores have been worked out separately for boys and girls.

For establishing the sigma score table of boys, the deviations from the corresponding norms were divided by the standard deviation of the entire sample of boys (SD =21.88)

For the corresponding Table of Girls, the deviation from the corresponding norms were divided by the standard deviation of the entire sample of girls (SD=22.25 vide).

Tables were thus prepared for boys and girls respectively. These tables serve as ready reckoners for obtaining the sigma scores of boys and girls. These can readily be obtained with reference to the deviation of a score from the corresponding age-norm/class-norm.
4.1.9 Standard Scores

The standard scores are another form of sigma scores usually converted into a new distribution with Mean and Standard Deviation selected in such a way as to make all scores positive and relatively easy to handle. Such scores are called standard scores. For establishing the standard scores, any convenient values can be arbitrarily chosen for the new mean and standard deviation.

Tables of Standard scores

The tables of standard scores were prepared by making the transformation similar to that of AGCT (Army General Classification Test) Scores. The Sigma scores were adjusted to a mean of 100 and an SD of 20. To convert a sigma score to the new scale, it was simply necessary to multiply the sigma score by the desired SD (20) and add it to the desired mean 100. Tables 14 and 15 serve as ready reckoners for obtaining the Standard Scores (adjusted to a Mean=100 and SD-20) of boys and girls respectively. These can be obtained with reference to the deviation of a score from the corresponding age-norm/class-norm.

4.1.10 T-Scores

T-Scores are normalized standard scores converted into a distribution with a mean of 50 and standard deviation of 10. The formula for the T-score is as follows:

\[ T\text{-Score}=54+10 \times \frac{X}{SD \text{ dist.}} \]

(Where, X is the difference between the individual’s score and the average score of the group to which he belongs divided by the SD of the distribution of the scores.)

Guilford writes, “The T-Scale is probably the most widely used of all derived scales. Its advantages are many, and its disadvantages few.”

Garett writes, “T-Scores have general applicability, a convenient unit, and they cover a wide range of talent”.

122
4.1.11 Tables of T-Scores

The method of calculation of T-Scores was followed as illustrated by Garrett. The analysis of the scores of the sample revealed that in certain categories at the extremes of each of the distribution (Tables 5 to 8), none of the cases happened to fall. Therefore T-scores for these blanks have also been provided by taking into account the trend of the curve. Tables 16 and 17 serve as ready reckoners with reference to different age-groups of boys and girls respectively. The corresponding Tables 18 and 19 are meant for different class-groups of boys and girls respectively. An individual’s test-scores can readily be converted into its corresponding T-score with reference to age-group/class-group. For this purpose, the relevant Table and its relevant column need to be referred to.

4.1.12 Deviation Intelligence Quotients

The deviation IQ is a recently developed concept. The deviation IQs are not ratios of mental and chronological ages. There are certain practical advantages in the use of a derived scale which corresponding to the familiar distribution in the use of a derived scale which corresponding to the familiar distribution of Stanford-Binet IQ’s. Such relationship can easily be achieved by the selection of numerical vales for the mean and SD which agree closely with those in the Standford-Binet distribution. Anastasi1 writes,” A number of current group tests also use deviation IQ’s.” Freeman writes, “The deviation IQ, furthermore, is especially useful at age levels above 16 or 18 years. For these and older persons, the use of mental age and the formula for the ratio IQ (MA/CA) have been regarded as inappropriate and questionable by many psychologists.”

The deviation IQs unlike regular IQs are based entirely upon the performance of the children of similar chronological ages and experience.

4.1.13 Tables of Deviation Intelligence Quotients

The deviation IQs were worked out by applying the following formula:

\[
\text{Deviation IQ} = 1.64 \times (\text{T-score}) + 18.
\]
The test-scores can readily be converted into deviation IQs. Tables 20 and 21 are meant for converting the test-scores into Deviation IQs with reference to age groups (12 to 18+) for boys and girls respectively. By using the relevant Table and its relevant column, for any test-score, deviation IQs can readily be read out. The deviation IQs thus obtained maintain the property of the constancy of the IQs, i.e., the mean and the standard deviation at each age-group is uniform, which have close correspondence with that of Standford-Binet, 1960 Revision and that of 1937 Revision having Standard Score IQs.

The deviation IQ thus obtained is a measure which decidedly defines the relative brightness or intellectual capacity for an individual more or less permanently. Also under normal conditions, it manages to maintain an individual’s IQ, the same at least throughout the age limits covered (12 to 18+) by the test.

4.1.14 Distribution of Deviation IQs of the Sample

Table 9 presents the age-wise distribution of deviation IQs for the entire sample of 10,132 pupils. It is observed that the mean of every age-group is very close to 100. Besides it, the standard deviation of every age-group is very close to 16.4.

The mean and SD for the entire group of 10,132 pupils are 100.14 and 16.47 respectively.

A set of uniform mean and SD at every age-levels well as of the entire group of 10,132 pupils lead to the conclusion that the standardization process adopted in the present study is quite satisfactory.

4.1.15 Reliability of Test

Reliability means the extent to which a test is consistent and stable in what it measures and gives dependable and steady results. Reliability has been studied by two methods: one which concerns the stability of the measure in terms of time, and the other involves the internal consistency of the test.
a. The Test Retest Method. The retesting was undertaken after an interval of six months on a sample of 599 pupils (309 boys and 290 girls). The sample was drawn from four randomly selected English Medium Secondary Schools. The reliability coefficient by this method was found to be .84+.021 which represents a high correlation, a marked relationship.

b. The Split-Half Method. To apply this method, a sample of 518 pupils (303 boys and 215 girls) was taken from four randomly selected English Medium Secondary Schools. The scores of all these subjects were split into two parts each, one containing odd and the other even items. The coefficient of correlation between scores and the other even items. The coefficient of correlation between scores on odd and even items was found to be .951+.004. To obtain the reliability coefficient of the whole test, spearman-Brown Prophecy Formula was applied, and the coefficient of correlation was found to be .974+.003, which is a very high correlation and hence a very dependable relationship.

Reliability in Terms of True Scores and Measurement Errors

The following aspects connected with the reliability of test-scores were also studied.

I. The Index of Reliability was found to be .9854.

II. The Standard Error of Measurement was found to be 3.52 (for boys) and 3.58 (for girls).

III. The Probable Error of the Obtained Scores was found to be 2.38 (for boys) and 2.42 (for girls).

Reliability of the Sample Tested

To study the representative character of the standardization sample, the distributions of tested-scores and that of deviation IQs checked statistically. The distributions did not deviate significantly from the normal probability curve.
4.1.16 Validity of the Test

Validity concerns the degree to which a test measure what it claims to measure. The item validity has already been reported. The practical or empirical validity of the test was studied by the following methods.

(I) Scholastic Marks; to apply this method. First terminal examination marks of 244 pupils (133 boys and 111 girls) were obtained from two English Medium Secondary Schools. The percentage of total marks obtained in all the subjects were correlated with the total score obtained one of the present tests. The coefficient of correlation was found to be .57+.043. The coefficient of correlation for individual school subjects was also computed. These are as follows:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>.31 (N=244)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.52 (N=244)</td>
</tr>
<tr>
<td>General Science</td>
<td>.49 (N=244)</td>
</tr>
<tr>
<td>Social Studies</td>
<td>.59 (N=244)</td>
</tr>
<tr>
<td>Hindi</td>
<td>.48 (N=244)</td>
</tr>
<tr>
<td>Second Language</td>
<td>.20 (N=244)</td>
</tr>
<tr>
<td>French, Latin, Sanskrit and Persian</td>
<td>.35 (N=189)</td>
</tr>
<tr>
<td>Marathi</td>
<td>.35 (N=189)</td>
</tr>
<tr>
<td>Drawing</td>
<td>.24 (N=80)</td>
</tr>
<tr>
<td>Needle Work</td>
<td>.15 (N=49)</td>
</tr>
</tbody>
</table>

The annual examination results of the Secondary School Examination Board, Maharashtra State, Poona, for 90 students (59 boys and 31 girls) studying in class XI were obtained from two randomly selected English Medium Schools. The coefficient of correlation was found to be .53+.075.

(3) Teacher’s Judgments. Teacher’s Judgments were obtained on a seven point scale as shown below:

<table>
<thead>
<tr>
<th>Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very Inferior</td>
</tr>
<tr>
<td>2</td>
<td>Inferior Below</td>
</tr>
<tr>
<td>3</td>
<td>Slightly Inferior</td>
</tr>
<tr>
<td>4</td>
<td>Average</td>
</tr>
<tr>
<td>5</td>
<td>Slightly Superior</td>
</tr>
<tr>
<td>6</td>
<td>Superior</td>
</tr>
<tr>
<td>7</td>
<td>Very Superior</td>
</tr>
</tbody>
</table>

126
For every individual student, teacher’s judgments were obtained from four different teachers. A sample of 247 pupils (147 boys and 100 girls) was drawn from four randomly selected English Medium Secondary Schools. The Sum of the four ratings for each student was computed. The coefficient of correlation between the test scores and the sum of the four ratings was found to be .61+.040.

(3) With Other Tests. (a) Dr. G.H. Nafde’s Non-Verbal Test of Intelligence was administered on a sample of 278 Pupils (135 boys and 143 girls) drawn from three randomly selected English Medium Secondary Schools. The coefficient of correlation between the two sets of test-scores was found to be .50+.44.

(b) Parsi Panchyet’s Vocational Guidance Bureau constructed and standardized a group test of general intelligence in English which is meant for student of Class XI. To obtain the validity coefficient, the test was administered on a sample of 124 students (66 boys and 58 girls) of Class XI drawn from three randomly selected English Medium Secondary Schools. The coefficient of correlation between the two sets of scores was found to be .69+.047.

4.1.17 Internal Validity and Factorial Validity of the test

To study the internal validity and the factorial validity, a random sample of 487 students (304 boys and 183 girls) was drawn from 53 English Medium Schools. The Internal consistency correlations between the sub-tests and the total test score were computed. The factorial validity was then studied by Thurstone’s Centroid method and verified by Spearman’s formula of ‘g’ saturation. It came out to be a uni-factor test.

4.1.18 Conclusion

The reliability and validity of the test was studied from different standpoints. The results were obtained by using different methods and they were confirmed by each other. The degrees of reliability and validity coefficients were found to be fairly high. Hence, it is concluded that the present test is reliable and valid.
4.1.19 Allied Studies
Mother Tongue and Intelligence

The purpose of this investigation was to compare the variations in performance on a group test of intelligence that were attributable to different mother tongues and to know the relative frequency of the gifted children in each language-group. The findings revealed that the mean of deviation IQs for all the eleven language-groups (English, Gujarati, Hindi, Kannada, Konkani, Malayalam, Marathi, Punjabi, Sindhi, Tamil and Urdu) were very close to 100. The SDs for all these language-groups were also equal. Almost equal percentage of children who could be termed as gifted, were found in all these language-groups.

Constancy of Ration IQ versus Deviation IQ

The purpose of this investigation was to find out the mean differences and the extent of variability between IQs at different age-levels. The results were found to be as follows:

1. The Mean IQs show considerable variability, differing as much as 7.14 percent in the case of boys and 2.60 percent for that of girls. Similar is the case with the SDs at different age-levels. These differ by as much as 5.17 units in the case of boys and 3.05 units in the case of girls.
2. It is observed that the deviation IQs do not show considerable variability. The differences in the case of boys and that of girls are .97 percent and 0.91 percent respectively. The differences between the SDs are 0.92 unit and 0.80 unit respectively in the case of boys and that of girls.
3. It is also clearly observed that the IQs do maintain their constancy whereas the deviation IQs do maintain it to a great extent.

4.1.20 A Study into the Occupations of the Parents of Gifted Children

The objectives of the present study were (i) to ascertain occupations of the fathers of the gifted children, (ii) to study the percentage of the gifted children in different occupational groups, and (iii) to compare the mean IQs of the different occupational categories. The results revealed that the occupations of the fathers of the gifted have influence upon the intelligence of their children. Though gifted children are found in
almost all occupational categories, and no category has monopoly on giftedness yet intellectually gifted children come, in relatively high proportions from parents who have good educational background and fathers who have a high prestige occupation. Gifted percentage is high among professional and managerial groups when compared to other groups. The gifted children and managerial groups when compared to other groups, the gifted children belonging to the parental occupations of very high intelligence show an increase in mean IQ when compared with the mean IQ of the overall gifted group.

4.1.21 Sex and Intelligence

The study of sex differences in intelligence revealed that boys show a slight improvement over girls. These differences were found to be statistically significant at .01 level of significance. To remedy this slight sex difference, the standardization of the present test has been done separately for boys and girls.

4.2 Socio-Economic-Status Scale (SESS-UR), by Ashok K. Kalia and Sudhir Sahu (2011)

4.2.1 Introduction

Social changes are determined with the help of social positions, with time, region, culture and paying capacity of people. Growing economy of India, implementation of New Pay Scales as recommended by the Sixth Pay commission (2008), technological explosion, impact of electronic media, print media and education has changed many parameters of social position in last few years. In these days, number of followers of person in social network in last few years. In these days, the ability of the person to influence mass and so is his/her level of social status. This is the era of globalization, liberalization and privatization. Today modernity is regarded as more important than money. Hence, Social status of a person cannot be measured only with financial and occupational status. The level of education, modern life styles, health status and kind of
gadgets, facilities and services that a person is enjoying must be taken into consideration while determining his/her social position.

The available literature on SES indicates change in the concept of social position from time to time. Power (1981) focused only on occupation while measuring socio economic position. U.S. Department of Defence (1986) identified some traditional components of socio-economic-status viz.- education, occupation, income, employment status, possession of materials and presence of reading materials. Australian Bureau of Statistics (19994) identified education, health, contact with criminal justice system, employment, housing, access to services, water, sewerage, etc. as social position and income, ownership, assets level, holdings etc as economic position of a person. Williams and Moss (1997) in their study assessed socio-economic-status at three level i.e. (i) individual level, (ii) house hold level and (iii) community level. Social class, caste and race were also identified as indicators of socio-economic position (Piko and Fitzpatrick, 2001). Income, wealth, social standing/ prestige and social deprivation were used as common factors in measurement of social position (2002). Tello et all. (2005) developed an ecological index of socio-economic-status through factor analysis of 1991 Census (Italy) data. Three significant factors reflected the domains of (i) educational-employment sector, (ii) relational network and (iii) material conditions.

Singh, Shyam and Kumar (2006) developed a scale to measure socio-economic-status. Caste, family, education (of self), occupation, income, possession (material and monetary), land (agricultural/residential), participation in social, political, religious and academic activities, house (own or rented), size of house, etc. were the areas they identified to measure socio-economic-position.

A number of socio-economic-status scales have been developed by various researchers in the past few years, but most of them are not able to meet the parameters of current changes in the society in term of economic and technological advancement. Review of some of SES Scales being used currently, throw light on efforts of various experts in measuring socio-economic-status in the past viz. Kuppuswami (1960), Verma (1962), Pareek and Trivedi (1964), pandey (1966), Kulshrestha and De(1970), Singh and Sexena (1981), Shah (1986), Kapoor and Singh (1998), Singh, Shyam and Kumar (2006)
etc. Most of SES Scales are out dated and need a through modification and revision. Even during the developmental period of this scale (from 2007 to 2011), it has faced many modifications due to introduction of New Pay Scales by Sixth Pay Commission and emerging technical products in the market. While some years before Mobile Phone was a Luxurious item of aristocrat families now it has become a necessity of a layman. Now people are concerned about branded items irrespective of tag of high price level. Because of this, new way of thinking has emerged to define social position of an individual. Though Indian society is still struggling with some traditional social diversification of caste, class, race and power, yet in recent years emerging awareness through electronic and print media has developed a new social pattern in India. Now caste is not considered as important factor in determining status of an individual as once it was considered. Education, modern life styles, socio-cultural participation, ability to influence mass, future possibilities of person, health status, enjoyment of modern facilities including modern technology, various servicers and leisure/enjoyment has become more than unfolded wealth of a person.

4.2.2 Development of SES Scale

SES Scale is designed to measure social position of a person in Urban and Rural areas according to the lifestyle prevailing in both the regions. Socio-economic-status of a person in this scale refers to the “status of his/her family in relation to their level of socio-cultural participation, ability to influence mass, level of education, kind of occupation, financial position, health-wellbeing, lifestyle, level of aspiration, kind of gadgets, services and leisure facilities that the family enjoys”. This scale is an endeavor to ascertain the SES of an individual based on current social structure with a new thinking.

This scale has been developed both in English and Hindi languages for Urban/Rural households. It is easy to be administered and acknowledges the social position of an individual in the society. Scoring process of the SES Scale is easy, and objective. To get the total SES scores, the researcher is required to count the SES scores of the answer/options mentioned in the square box, which has been ticked by the respondent. In this way it saves time, money and labour. It also minimize possibility of error of counting of total score by the researcher.
4.3.3 Items and Components of SES Scale

The scale comprised of 40 statements in all based on five different dimensions of socio-economic parameters. Distribution of items and components of SES Scale is given below:

<table>
<thead>
<tr>
<th>Part</th>
<th>Dimensions of SES Scale</th>
<th>Items</th>
<th>Total Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part-I</td>
<td>SOCIO-CULTURAL COMPONENT</td>
<td>1 TO 15 (+ information on caste)</td>
<td>15+1</td>
</tr>
<tr>
<td>Part-II</td>
<td>ECONOMIC COMPONENT</td>
<td>16 TO 20</td>
<td>05</td>
</tr>
<tr>
<td>Part-III</td>
<td>POSSESSION OF GOODS AND SERVICES</td>
<td>21 TO 30</td>
<td>10</td>
</tr>
<tr>
<td>Part-IV</td>
<td>HEALTH COMPONENT</td>
<td>31 TO 35</td>
<td>05</td>
</tr>
<tr>
<td>Part-V</td>
<td>EDUCATIONAL COMPONENT</td>
<td>36 TO 40 (+ information on Stream)</td>
<td>05+1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>40+2=42</td>
</tr>
</tbody>
</table>

4.2.4 Reliability of SES Scale

Reliability of the scale has been measured by Split-half and test-retest method. Results given below indicate that the scale is highly reliable.

<table>
<thead>
<tr>
<th></th>
<th>English Version</th>
<th>Hindi Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split-half Method</td>
<td>.68</td>
<td>.71</td>
</tr>
<tr>
<td>Test-retest Method</td>
<td>.86</td>
<td>.89</td>
</tr>
</tbody>
</table>
4.2.5 Validity of SES Scale

All the 40 items of socio-economic-status has been evaluated by the various experts. The investigator has established content validity while preparing the preliminary draft of SESS. Expert opinion of teacher educators and language specialists with regard to relevance of each item was sought. For this, a copy of the final draft of SESS was given to nine experts who have been directly or indirectly involved in research. The expert opinion came out to be favourable in terms of the relevance of each item in the scale. This scale has already been used in various research works at Post Graduate, M.Phil. and Ph.D. level in Maharishi Dayanand University, Rohtak and its affiliated institutions and proved as most appropriate and useful for determining SES. The criterion validity was measured by correlating it with Socio-Economic-Status Scale by Prof. Rajbir Singh, Dr. Radhey Shyam and Dr. S. Kumar (2006) and it came out to be 0.85 which is highly significant.

All 42 items (including caste and academic steam) were analysed to measure internal consistency of the SESS through Pearson’s Product Moment, Kendall’s taub and Spearman’s rho correlation method. Coefficient of correlation is highly significant in most of the dimensions except only in one dimension i.e. Health Component due to presence of some items with negative scores.

Factorial Validity

With the help of PSS, Principal Component Analysis Method along with Varimax Rotation and Kaiser Normalization was employed on 1200 respondents to restrict in five factors. All the five factors along with its items which are found significantly loaded.

All the five factors explained have eigen value greater than unity. Type of family, importance to casteism in family, monthly income of the family, monthly savings of the family, no. of income tax payers in family, kind of home, reading materials and place of holidays are loaded significantly on first factor. Donation, kind of profession of the father, level of profession of the mother, total wealth of the family, type of vehicles in the family, modern recreational habits, type of servant and occupational aspiration of the respondent are significantly loaded on second factor. Factor third is significantly loaded
with involvement in local/street activities, donation, monthly savings of the family, pocket money, total wealth of the family, reading materials and kind of school, involvement in socio-cultural organization is loaded significantly on fourth factor. Fifth factor is significantly loaded with importance to casteism in family, criminal cases on the family members, kind of profession of the mother, income tax payers in family, kind of home, household amenities and place of holidays. The factorial structure explained above indicates the factorial validity of SES Scale.

4.2.6 Limitations of the Scale

This scale is not suitable for small children (below 8 years) who do not possess adequate knowledge of their family and family members. It is a verbal test and only literate persons are able to respond. In case of illiterate respondent, it may disturb privacy as another person is required to fill information on behalf of illiterate respondent in the answer sheet.

4.2.7 Administration of Socio-Economic-Status Scale

This scale comprised of 40 items on five different areas/dimensions of socio-economic status viz. - (i) Socio-Cultural Component, (ii) Economic Component (iii) Possession of Goods and Services (iv) Health Component and (v) Educational Component. There is no time limit for filling this scale. But it takes approximately 20-25 minutes for completing it. While administering SES scale following precautions should be kept in mind:

1. A proper seating arrangement should be made for the respondents in a peaceful environment.
2. A minimum facility of writing material should be arranged for respondents.
3. All instructions mentioned in the test booklet should be loudly read out by the test administrator.
4. Respondents should be instructed to give their responses only on consumable test booklet.
5. Test administrator should motivate the respondents for free and frank responses by establishing proper rapport with them.
6. All doubts should be clarified before the start of the test.
7. Before collecting the response sheets, the test administrator should ensure that all the test items have been answered by the respondents.

4.2.8 Scoring of Socio-Economic-Status Scale

The scoring of SES Scale is easy and objective. To find out the total score in Socio-Economic-Status Scale the examiner should add the scores where the respondents has put a check (”) as his/her response. A separate scoring key has been developed to facilitate the scoring of Socio-Economic-Status Scale. Total scores for Socio-Economic-Status Scale are obtained after adding scores from information given by the respondent to Part-A and the responses/answers given to the all items (1-40) of the Part-B of the test booklet.

4.3 Achievement Test

Achievement tests are well suited to provide educators with objective feedback as to how much students are learning and understanding. Teachers teach and help the learners to learn. The learning that takes place is assessed or evaluated not only for the learners’ benefit but also for the teacher to evaluate his/her own work. At the end of a lesson or a group of lessons, the teacher needs to get feedback on what the learner has achieved, as a result of the teachers’ efforts and also indirectly to assess his /her own achievement as a teacher. This feedback comes with the help of a tool, known as “Achievement Test”.

Gronlund (1977) defined an achievement test as “a systematic procedure for determining, the amount a student has learned through instruction”.

In the words of Wiersman, W. and Jurs, S.G. (1990), “An achievement test is a measure of knowledge and skills in a content area”.

Since no specific achievement test in the selected topic was available to test the effectiveness of Educomp Smartclass on VIII grade mathematics students, so, an achievement test in mathematics for VIII class on the topic “Algebraic Expressions and
Identities & Understanding Quadrilaterals” was prepared by the investigator herself to evaluate the pupils’ Knowledge, Comprehension, and Application.

Achievement tests were prepared, for all the seven sub-units of the two units’ selected; consisting of 100 multiple choice questions in total and after try out the final draft had 60 questions. Achievement tests covered all the important aspects of the two units taught (Algebraic Expressions & identities and Understanding Quadrilaterals) in the class by the teacher to both the control group and the experimental group. Four options were given for every question and only one option was correct. The students were asked to mark the correct option on the answer sheets provided separately. This was used for the pre-test, post-test and retention test. The test items were prepared based on a blueprint.

The following steps were followed for developing the tests:

4.3.1 Planning of the test

While going to construct a building, an engineer prepares a plan. Similarly, planning is necessary in constructing an objective based test for evaluation. Planning stage of the test tries to answer what content area is to be included in the test and what are the objectives that are going to be tested? The planning stage of a test should include the nature of the test items and the statement of conditions under which it will be administered. The Achievement Test was planned with the objective of measuring Achievement in Mathematics of VIII grade students on selected topics. For planning of the Achievement Test, the following points were taken into account:

- Determining the purpose of a test;
- Identification and defining the intended learning outcomes;
- Preparing the test specifications; and
- Constructing relevant test items;

So, the Achievement Test was planned in mathematics of VIII class students on topic “Algebraic Expressions & Identities and Understanding Quadrilaterals”.

4.3.2 Preparing the Achievement Test

For the preparing of Achievement Test the following points were taken into account:
Objectives of the Test

For the purpose of constructing Achievement Test, objectives were defined in behavioural terms from selected units of Mathematics textbook of class VIII prescribed by CBSE. Since the major concern here was to test the academic achievement and retention of Mathematics of class VIII students, it was accordingly, decided to test the three major areas of cognitive domain, i.e., Knowledge, Understanding and Application. After determining objectives, the learning outcomes were stated as observable terminal performance. In order to make sure that Achievement Test measures a desirable behaviour, test specifications were developed covering the objectives and subject -matter selected to be taught during the experiment.

The test covered the content of the following units.

**Unit 1 - Algebraic Expressions and Identities**

1.1 Algebraic Expressions
1.2 Addition of Algebraic Expressions
1.3 Multiplication of Algebraic Expressions
1.4 Standard Identities

**Unit 2 – Understanding Quadrilaterals**

2.1 Polygons
2.2 Kinds of Quadrilaterals
2.3 Some Special Parallelogram

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Algebraic Expressions and Identities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Algebraic Expressions</td>
</tr>
<tr>
<td>1.2</td>
<td>Addition of Algebraic Expressions</td>
</tr>
<tr>
<td>1.3</td>
<td>Multiplication of Algebraic Expressions</td>
</tr>
<tr>
<td>1.4</td>
<td>Standard Identities</td>
</tr>
</tbody>
</table>

Table 4.1 The Test Covered the Content of the Following Units/Sub-Units
To decide the weightage to be given to different content areas, objectives and different forms of questions, expert opinions of the concerned teachers were taken into consideration.

- **Preparation of the Blue - print**

Preparation of the blue - print helped the investigator to have an objective based Achievement Test giving due weightage to objectives, content and forms of questions. More than the required number of items was included in the test under each objective and content sub-unit. This was done to get enough items for the final test.

### Table 4.2 Numbers of Items in the First Draft of Achievement Test at Different Cognitive Levels of Objectives

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Sub-unit</th>
<th>Cognitive Levels of Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebric Expressions and Identities</td>
<td>Algebraic Expressions</td>
<td>Q₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1, 3, 6, 32, 33, 35, 36</td>
</tr>
<tr>
<td></td>
<td>Addition of Algebraic Expressions</td>
<td>Q₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2, 4, 5, 14, 37</td>
</tr>
<tr>
<td></td>
<td>Multiplication of Algebraic Expressions</td>
<td>Q₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13, 42</td>
</tr>
<tr>
<td></td>
<td>Standard Identities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7, 23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9, 10, 16, 39, 40, 48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18, 27, 28, 44</td>
</tr>
<tr>
<td>Understanding Quadrilaterals</td>
<td>Polygons</td>
<td>Kinds of Quadrilaterals</td>
</tr>
</tbody>
</table>

**Table 4.3 Blue Print of First draft of Achievement Test**

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Sub-unit</th>
<th>Cognitive Levels of Objectives</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units ↓</td>
<td>↓</td>
<td>Q₁, Q₂, Q₃</td>
<td></td>
</tr>
<tr>
<td>Algebric Expressions and Identities</td>
<td>Algebraic Expressions</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Addition of Algebraic Expressions</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Multiplication of Algebraic Expressions</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Standard Identities</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Understanding Quadrilaterals</td>
<td>Polygons</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Kinds of</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
Quadrilaterals

<table>
<thead>
<tr>
<th>Quadrilaterals</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some Special</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Parallelograms</td>
<td>Total 36</td>
<td>33</td>
<td>31</td>
</tr>
</tbody>
</table>

Q1=Knowledge Q2= Comprehension Q3=Application

□ Preparation of the test Items

Keeping in mind the above “Rules and Suggestions”, a total of 100 objective type items with a wide range of difficulty were constructed from ten sub-units of mathematics syllabus prescribed by Central Board of Secondary Education for class VIII. Items were prepared in conformity with the Blue-print. While constructing items, it was ensured that no objective remained untested and language of the test items was understandable and unambiguous and the instructions very clear. The test items were arranged properly and assembled in the order of difficulty into the test. Easy items were given a place in the beginning and difficult items towards the end. The preliminary draft in Achievement Test was given to experts in education and experienced Mathematics teachers for their opinion about the language and appropriateness of the items. Only those items were selected which were having 0% unanimity. Items in difficult language were modified to simple language. Finally, 60 items constituted the Achievement Test, containing multiple choice type items prepared in conformity with the Blue-print.

□ Preparation of Directions to Test Items

Appropriate directions to test items were prepared, in a clear and concise way so that the students could understand them easily. As test was divided into Multiple Choice Questions, clear instructions were given at the beginning of the test. The students were asked to write the correct response in the answer sheet.

□ Preparation of Directions for Scoring

To facilitate objectivity in scoring, scoring keys were prepared. Scoring Keys were prepared for Multiple Choice Questions.

□ Practicability

Practicability of the test is maintained by means of the ease of administration, readiness of interpretation, economy in initial cost, practicability of securing materials, time required for scoring and analyzing the results. The prepared achievement test was easy to
administer. It was economical, as were as reusable as the answer sheets were provided separately. Time needed for scoring was limited. Hence the test had good practicability.

4.3.3 First Try-Out

The first draft of the achievement test was administered on a group of 40 students of class VIII of Vivekananda Public School, Sonipat. At the time of administering the first draft of the achievement test, all due efforts were made to maintain a normal environment. The time limit of one hour was also observed on the subjects and they were given as much time as they required. The answer-sheets of achievement test were collected from the students for scoring purposes. The marking scheme used was: correct answers of students were given one mark and wrong answers were given zero marks after scoring the test items, the Achievement Test scores were organized in an ascending order. An analysis was made to find out their difficulty value (D.V.) and discriminative power (D.P).

Difficulty Value

“The difficulty value of an item may be defined as the proportion of certain sample of subjects who actually know the answer of item”. (Frank S. Freeman) The index of difficulty (D.V) of each item of the test was calculated using the following formula:

\[ D.V = \frac{P_h + P_l}{2} \]

\[ P_h = \text{Proportion of the right response of the upper group} \]
\[ P_l = \text{Proportion of the right response of the lower group} \]

The difficulty indices were analyzed using the Henning (1987) guidelines as Shown in the Table 4.4

Table 4.4: Henning’s Guidelines (Difficulty Value)

<table>
<thead>
<tr>
<th>High Difficult (≤0.33)</th>
<th>Medium (0.34-0.66)</th>
<th>Low (≥0.67)</th>
</tr>
</thead>
</table>

Based on the Henning’s Guidelines in the above Table, the 100 test items categorized in Table 4.5
Table 4.5 Distribution of Difficulty Value (D.V) of Items of First Draft of Achievement Test

<table>
<thead>
<tr>
<th>Level of difficulty</th>
<th>Items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High(≤.33)</td>
<td>06, 14, 26, 31, 39, 42, 74, 91</td>
<td>08</td>
</tr>
<tr>
<td>Medium(.34-.66)</td>
<td>01, 02, 03, 04, 05, 07, 08, 09, 10, 11, 13, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 40, 41, 43, 44, 45, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 71, 72, 73, 75, 76, 78, 79, 80, 81, 82, 83, 84, 85, 86, 88, 89, 90, 92, 93, 94, 95, 96, 97, 98, 99, 99, 100</td>
<td>86</td>
</tr>
<tr>
<td>Low(≥0.67)</td>
<td>12, 22, 46, 70, 77, 87</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

**Discriminative Power (D.P)**

Discriminative Power of an item may be defined as the extent to which success and failure on that item indicates the possession of the trait or achievement being measured (Marshall and Hales, 1972). Bean (1953) defined it as: “The degree to which the single item separates the superior from the inferior individual student in the trait or group of traits being measured”. The index of discrimination (DP) is the difference between the proportion of the upper group who answered an item correctly and the proportion of the lower group who answered an item correctly.

Distribution of discriminating powers of items was calculated by formula

\[
DP = \frac{(R_U - R_L)}{0.5N}
\]

- \(R_U\) = Number of correct responses in the upper group
- \(R_L\) = Number of wrong responses in the lower group
- \(N\) = Total Number of correct responses.

Ebel’s (1979) criteria and guidelines for categorizing discriminating indices is a widely quoted set of guidelines and, therefore, was used in this test analysis.
Table 4.6: Ebel’s Guidelines (Discriminating powers)

<table>
<thead>
<tr>
<th>Discriminating powers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40 and above</td>
<td>The item is functioning quite satisfactorily</td>
</tr>
<tr>
<td>Between 0.30-0.39</td>
<td>Little or no revision is required</td>
</tr>
<tr>
<td>Between 0.20-0.29</td>
<td>The item is marginal and needs revision</td>
</tr>
<tr>
<td>&lt; 0.19</td>
<td>The item should be eliminated or completely revised</td>
</tr>
</tbody>
</table>

Based on the Ebel’s guidelines in the above Table’ the 100 test items categorized as in Tables 4.7 to 4.10.

Table 4.7 Distribution of Discriminating Powers (D.P) of Items of First Draft of Achievement Test

<table>
<thead>
<tr>
<th>Discriminating Powers</th>
<th>Items</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>.40 and above</td>
<td>02, 03, 10, 11, 15, 17, 18, 19, 23, 25, 27, 28, 30, 32, 33, 34, 49, 50, 52, 53, 54, 62, 63, 66, 67, 68, 71, 75, 76, 80, 83, 86, 97, 98, 99</td>
<td>35</td>
</tr>
<tr>
<td>Between 0.30-0.39</td>
<td>01, 04, 07, 08, 13, 20, 21, 29, 35, 37, 38, 48, 51, 55, 56, 57, 69, 72, 73, 79, 84, 85, 94, 95, 96</td>
<td>25</td>
</tr>
<tr>
<td>Between 0.20-0.29</td>
<td>09, 12, 14, 16, 22, 26, 36, 39, 41, 48, 59, 60, 61, 64, 70, 78, 81, 82, 88, 89, 91, 92, 93</td>
<td>23</td>
</tr>
<tr>
<td>≤0.19</td>
<td>05, 06, 24, 31, 42, 43, 44, 45, 46, 47, 58, 65, 74, 77, 87, 90, 100</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8 Distribution of Discriminating Powers (D.P) of Terms of First Draft of Achievement Test

<table>
<thead>
<tr>
<th>Discriminating powers</th>
<th>frequency</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>.40 and above</td>
<td>35</td>
<td>Very Good Items</td>
</tr>
<tr>
<td>Between 0.30-0.39</td>
<td>25</td>
<td>Reasonably Good Items</td>
</tr>
</tbody>
</table>
### Table 4.9 ITEM ANALYSIS CHART (FIRST TRY-OUT)

<table>
<thead>
<tr>
<th>Level of Difficulty → Discriminating Powers ↓</th>
<th>High Difficult (≤.33)</th>
<th>Moderate (.34-.66)</th>
<th>Low (≥0.67) Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤0.19 (Bad)</td>
<td>06, 31, 42, 74</td>
<td>05, 24, 43, 44, 45, 47, 58, 65, 90, 100</td>
<td>46, 77, 87</td>
<td>17</td>
</tr>
<tr>
<td>Between 0.20-0.29</td>
<td>14, 26, 39, 91</td>
<td>09, 16, 36, 41, 48, 59, 60, 61, 64, 78, 81, 82, 88, 89, 92, 93</td>
<td>12, 22, 70</td>
<td>23</td>
</tr>
<tr>
<td>Between 0.30-0.39</td>
<td>-----</td>
<td>01, 04, 07, 08, 13, 20, 21, 29, 35, 37, 38, 48, 51, 55, 56, 57, 69, 72, 73, 79, 84, 85, 94, 95, 96</td>
<td>-----</td>
<td>25</td>
</tr>
<tr>
<td>.40 and above</td>
<td>-----</td>
<td>02, 03, 10, 11, 15, 17, 18, 19, 23, 25, 27, 28, 30, 32, 33, 34, 49, 50, 52, 53, 54, 62, 63, 66, 67, 68, 71, 75, 76, 80, 83, 86, 97, 98, 99</td>
<td>-----</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>08</td>
<td>86</td>
<td>06</td>
<td>100</td>
</tr>
</tbody>
</table>

Out of 100 items, **60** were selected having difficulty index between .34 and .66 and discriminating power above .30 for the test. These items were improved with respect to language and destructors.
4.3.4 Second Try–Out

The revised version of the Achievement Test was administered on another group of 48 students of class VIII of Shiva Shiksha Sadan, Sonipat. Again difficulty value and discriminating power of 60 items were computed. The distribution of discriminating powers and difficulty value can be seen in Table (4.10), Table (4.11), and the final draft in Table (4.12).

**Table 4.10 Distribution of Discriminating Powers (D.P) and Difficulty Values of Items of Final Draft of Achievement Test**

<table>
<thead>
<tr>
<th>Level of Difficulty → Discriminating Index ↓</th>
<th>Moderate (.34-.66)</th>
<th>Remarks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 0.30-0.39</td>
<td>01, 04, 07, 08, 10, 13, 18, 20, 21, 29, 35, 37, 48, 51, 55, 56, 57, 69, 72, 73, 79, 84, 85, 86, 94, 95, 96</td>
<td>Reasonably Good</td>
<td>27</td>
</tr>
<tr>
<td>.40 and above</td>
<td>02, 03, 11, 15, 17, 19, 23, 25, 27, 28, 30, 32, 33, 34, 38, 49, 50, 52, 53, 54, 62, 63, 66, 67, 68, 71, 75, 76, 80, 83, 97, 98, 99</td>
<td>Very Good Items</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

**Table 4.11 Number of Items Retained in the Final Draft of Achievement Test at Different Cognitive Levels**

<table>
<thead>
<tr>
<th>Cognitive levels of objectives</th>
<th>Serial Number of items retained</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Level (Q₁)</td>
<td>01, 03, 08, 20, 21, 29, 32, 33, 34, 35, 38, 50, 51, 52, 56, 57, 62, 72, 73, 75, 76, 80, 85,</td>
<td>23</td>
</tr>
<tr>
<td>Understanding Level (Q₂)</td>
<td>02, 04, 11, 15, 17, 19, 25, 30, 37, 49, 54, 66, 68, 69, 79, 83, 84, 94, 95, 96,</td>
<td>20</td>
</tr>
<tr>
<td>Application Level (Q₃)</td>
<td>07, 10, 13, 18, 23, 27, 28, 48, 53, 55, 63, 67, 71, 86, 97, 98, 99</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>
4.3.5 Standardization of Achievement Test

60 items constituted the final form of the Achievement Test. The Achievement Test was further standardized by experimental validation of the test that included establishing reliability and validity.

□ Reliability of the test

Reliability is one of the important characteristics of any test and measuring instrument. “Reliability means consistency of scores obtained by same individual when re-examined with test on different sets of equivalent items or under other variable examining conditions”. Anastasi (1968).

In the present study the reliability of the test was measured by split-half method. In this method the score obtained from each individual was divided in to two groups by pooling the odd number items and even number items. Their scores were tabulated and reliability was determined by using the Spearman-Brown Prophecy formula. The reliability co-efficient of the present test was 0.76. This shows that achievement test has high reliability.

□ Validity of the test

“Validity refers to the extent to which a test or a set of operations measures what it is supposed to measure” (E.E.Ghiselli).

Achievement Test constructed for the study was taken for granted because this is in accordance with Guilford (1971) who said, “There are some measures whose validity is taken for granted, for example, Achievement Test scores”.

The test was validated against the criterion of content validity. Content validity is an important criterion for the usefulness of the test, especially of an achievement test. It is a measure of the match between the content of the test and the content of “teaching” that precede it. It was observed that the items of the Achievement Test were distributed over all the units of the instructional objectives. For ascertaining the content validity of the Achievement Test, the help of the subject-matter experts was also solicited. A copy of the list of the behavioural objectives and Achievement Test was given to the subject-matter experts in mathematics. They were asked to give their judgments with regard to the congruence between each objective and the relative test item.
Final form of the test

The final form of the Mathematics Achievement Test contained 60 items, along with a scoring key (Appendix- 3).

The final form of pre-and post-test consisted of 60 multiple choice type questions. Where each question was provided with four options as answers (one correct and three distracters). Two sets of marking scheme were used: (1) correct answers of students were given one mark and wrong answers were given zero mark.