METHODOLOGY

The present chapter gives a detailed account of the research methods used in executing this study. It includes the description of sample, test used, administration and scoring of the test and statistical analyses of the obtained data.

SAMPLE

The study was conducted on a sample of 250 (115 female and 135 male) students of 11th and 12th grade. The sample was drawn from four senior secondary school in Sirsa. The participants were recruited from different areas of study in order to cover all variety of school students in arts, commerce, medical and nonmedical streams. Sampling of the subjects was accomplished through cluster sampling technique. The age of selected participants ranged from 15 to 18 years with a mean age of 16.5 years. Socio-economic status of the participants varied from lower middle to high and all belonged urban areas of Sirsa city. Initially, 270 participants were drawn; some of them were dropped from the final sample due to absentees, incomplete responses or lack of interest in testing.

The school and classwise split of the sample

<table>
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<th>Name of School</th>
<th>X1th Class</th>
<th>X11th Class</th>
<th>Total</th>
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<td>M.A.G S.S SCHOOL</td>
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<td>_</td>
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Measuring Instruments

Following psychological tests were used to measure the variables included in the study:

1. Working Memory Test
   (a) Operation Span Test (Turner & Engel, 1989)
   (b) Reading span test (Daneman & Carpenter, 1980)

2. Fan Manipulation Task for LTM Activation (Whitlon, 1984)

3. Culture Fair Intelligence Test (Cattell, 1961)

4. Hundal General Mental Ability Test (Singh, 1973)

Brief description of these tests is as under:

1. **Culture Fair Intelligence Test- Scale 3**

   The Culture Fair Test Intelligence (Cattell, 1961) is a paper pencil test. It is a perceptual or spatial test consisting of abstract geometrical form having certain relationship to each other, which must be educed before each item or sequence can satisfactory completed. It depend minimally on past learned knowledge and skills. This test is available in three levels: Scale 1, for ages 4 to 8 and mentally retarded adults; scale 2 for ages 8 to 13 and average adults, and scale 3, for grades 10 to 16 and superior adults. Each scale is available in two parallel forms, A and B. Scale 2 and 3 may be given either individually or as group tests. Culture fair test consists of abstract geometrical forms having certain relationship to each other performance on this test is not influenced by past experiences, school learning and culture. As contended by Cattell (1963) and Horn (1965) culture fair tests are measures of fluid intelligence (gf). These scales are alike, except for difficulty level. Each consists of the following four subtests: 1. Series: Select item that completes the series. 2. Classification: Mark the one item in each row
that does not belong with others. 3. Matrices: Mark the item that correctly completes the given matrix or pattern. 4. Conditions: Insert a dot in one of the alternative designs so as to meet the same conditions indicated in sample design.

The scores on scale 2 and scale 3 can be converted into deviation IQ’s with an SD of 16 points. These scales have been standardized on larger samples. Fairly verbal instructions are required but the author asserts that giving these instructions in any language will not affect the difficulty of the test. Scale 3 has been designed for grades 10 to 16 and for superior adults. The test comprises four subtests namely-series, classification, matrices and topology. The numbers of items in these subtests are 13, 14, 13 and 10 respectively. In arrangement of the subtests an easy to grasp subtest has been chosen to start the subject off. In all, the test items are arranged in order of increasing difficulty order. The test is administered with a time limit of 12.5 minutes 3, 4, 3 and 2 ½ minutes being for subtests 1, 2, 3 and 4, respectively.

Internal consistency and alternate form reliability co-efficient fall mostly between .50 s and .80 s in American sample. The test reliability has been evaluated both in terms of dependability co-efficient and the consistency co-efficient. The dependability co-efficient on the full test for 200 American high school freshmen was .82 and on 450 eleven year old British secondary school entrants .85. Approximately the same values have come from small samples in France and Italy. The consistency co-efficient has come out at .70, .36, .87 and .92 on four different groups. Validity of the test has been assessed chiefly in terms of saturation with a general intellectual factor (g), having been investigated largely through a correlation with other tests and through factor analysis.
Cattell’s CFIT scales have been used in several European countries, North America and in certain African and Asian cultures. Norms tended to remain unchanged in cultures moderately similar to that in which tests were developed. Studies conducted in India (Rao, 1965; Singh, A., 1970; Singh, R., 1986; Kharb, 1987; Kajal, 1990; Jyotsna, 2006; Monika, 2011) also demonstrated its utility as a measure of intelligence.

2 Hundal General Mental Ability Test (GMAT):

Hundal General Mental Ability Test (Hundal, 1962) is a group test designed to measure the general mental ability of Punjabi speaking students of 13 to 17 years of age. It consists of 7 subtests: Number Series (NS), Analogies (An), Classification (C), Inference (In), Following Directions (FD), Opposites (Opp) and Synonyms (Sy). In total there are 100 items arranged spirally in ascending order of difficulty value.

The Hindi version of this test was developed by translating it into Hindi and replacing the vocabulary items with comparable Hindi items (Singh 1967). The split-half reliability coefficients for 7th to 11th graders range from .85 to .88. The overall test-retest reliability coefficient with a time gap of about three months for the students of 11th grade was found to be .71. The split-half reliability coefficients for different subtests ranged between .43 and .84.

The validity of the test has been established in terms of construct validity, which also includes factorial validity. The factorial structure for different grade groups show that the contribution of common factors, at each level, virtually accounts for the total variance. The test is thus a fair measure of ‘general mental ability’. A few other studies (Jalodia, 1995; Jyotsna, 2006; Sharma, 1990) have also demonstrated the usefulness of this test as a measure of general mental ability.
It is pertinent to mention that the test material has direct association with school education and as such the performance on this test is influenced by formal and informal learning in school and society. Cattell (1963) has pointed out that tests of this sort are predominantly the measures of crystallized intelligence (gc).

3. Working Memory Tests

(i) Operation Span Test:

The operation span task is a subtest of working memory designed by Turner and Engle (1989). In operation span task the processing and verification of arithmetic problems were conducted in which subject receives a series of simple arithmetic problems (in printed form) one by one, each followed by a lower case word. The subjects read aloud and solve the problem and then read the word given after each problem i.e., post-fixed word. At the end of operation-word string, on a signal, they are to write down the words that followed the operation strings in the correct order. The string size recalled correctly by the subject is the operation span score.

For example, in the following set size of three operation-word string, the subject would read aloud “is (3×8)-3=21? The subject would answer “yes” if the equation was correct or “no” if the equation was incorrect and then would read aloud the word “kite”. On hearing the word "kite" the experimenter would present the next string. This procedure allows adequate time for each individual to process the operation and word but serves to reduce the time for rehearsal. After the last operation-word string in the set, in this case the third string, the participant would see a set of three question marks centered on the paper sheet. The question marks cued participants to write down the words that followed the operation strings in correct serial order.
For example:

(a) is \((3 \times 8) - 3 = 21\)? KITE

(b) is \((2 + 8) - 1 = 9\)? MOUSE

(c) is \((4 \div 2) \times 6 = 11\)? CODE

? ? ?

The number of operation-word strings (set size) presented before the recall cue varied from two to five, with two trials of each set size. Set size varied in the same randomly chosen order for each participant. Thus the participant could not know the number of words to be recalled until the question marks appeared. The operation span score was the cumulative number of words recalled from perfectly recalled trials. That is the score on this and other tasks discussed latter consisted of an accumulation of the number of items from those trials on which the participant recalled all the items in the correct order.

(ii) Reading Span Test:

The reading span test developed by Daneman and Carpenter (1980), is a measure of working memory. This test presents sentence-word strings of different sizes. The subjects read aloud the sentence and then read aloud the word in capital letters. At the end they are to write the words that followed the sentences the same way. Subject is to remember unrelated words printed at the end of the sentence.

For example, in the following set of three sentences, subjects were shown one sentence at a time on the card. They read the sentence aloud and then read aloud the word in capital letters. At that point, the experimenter presents the next sentence. After the last sentence in each set, the participant saw the question marks, which served as a cue that the participant should write down the capitalized words in the correct serial order.
(a) Amit has to cut a pipe into pieces.

(b) For a sportsman, the only thing that matters is the game.

(c) This was another sweet memory.

The number of sentence-word combinations (set size) presented before the recall cue varied from three to eight, with two trials of each set size. Set size varied in the same randomly chosen order for each participant. After recalling the words, participants were asked a comprehension question about one of the sentences. Chosen at random, such as “which thing is important for sportsman?” The comprehension questions were used to ensure that participants attended to the sentence. The reading span score was the cumulative number of words recalled from perfectly recalled trials.

4. Fan Manipulation Task for LTM Activation:

A task developed by Andersons (1974, 1976) called Fan Manipulation Task was used in fan–effect studies (Anderson, 1974, 1983; Myers et al., 1984; Whitlow, 1984). Sixteen target sentences, were generated that all took the form “the SUBJECT is in the PLACE” or “The LAWYER is in the BOAT”. These sentences are schematically represented in the top half of the screen. Each PLACE term was associated with two SUBJECT terms. Each SUBJECT term was associated with one, three, or four PLACE terms. Thus, propositional fan size was 1,3, or 4. As can be seen in Figure, two sets of target sentences were created. The corresponding foil sentences are shown in the bottom half of the screen. They were generated by switching SUBJECT terms between sets of target
sentences so that they still reflect the same propositional fan size. For example, subjects studied the target sentence “The LAWYER is in the BOAT.” The foil for this sentence was “The LAWYER is in the HOUSE.”

The procedure for the fan task occurred in two phases. In the first phase, subjects were presented with groups of target sentences for study. Once they had learned these sentences they were given the second phase of the task, which was speeded verification of targets and foils. The test was desiged to suit MS power point presentation on through computer. The LTM activation task was administered in two phases. These phases are:

**Learning Phase:** The to-be-learned sentences (targets) were presented in groups so that all of the target sentences associated with a single SUBJECT term was presented together. For example,” The PLUMBER is in the PARK”, The PLUMBER is in the CHURCH “and “The PLUMBER is in the BANK” were all presented in the same display. The algorithm n(10s)+10s, where n equaled the number of sentences to be displayed, determined how long each group remain on the screen.(Myres et al., 1984; Anderson, 1980). After each of the groups of sentences had been presented for study, subjects were tested so that we could determine whether they had learned the material. A SUBJECT term was displayed on the screen, and subjects were told to orally recall all of sentences associated with that term.

A group of sentences was scored as correct only if all of the appropriate sentences were recalled and if no additional incorrect sentences were generated. After the subjects had been tested on all of the groups of sentences, the sentences were presented again individually for study. The order of presentation was randomized and was not the same as any other study order. The subjects were then
tested again for learning. Any group of sentences that had been correctly recalled on three consecutive study-test cycles was then dropped from further study and test. When all of the groups met the criterion, each was presented once more for study, and the learning phase of this task was terminated. At this point, we assumed that all of the material had been learned and the subjects had established LTM propositional networks like those described by Anderson (1983).

**Verification Phase:** For this phase, target and foil sentences were presented one at a time. Subjects pressed one of two keys to indicate whether the sentence presented had also been studied. The “1” and “3” keys on the numeric keypad were used for yes and no response, respectively. Each target and foil was randomly tested three times. RT was measured from the onset of a sentence to the time of the subject’s response.

**Testing Procedure**

In order to collect data for the present study the selected subjects were contacted in their respective schools. For engaging the subjects Principles of the concerned schools were approached and their permission was sought for the study. It is imperative to mention here that no academics records were taken into account and no information about the academic performance was collected regarding any of the subject.

The subjects were taken into confidence for their participation in the study and their consent was sought. They were made clear that it is a scientific activity and their performance on the tests will not affect the classroom evaluation or examination result. They were also informed that their scores will be kept confidential and were instructed to take the tests without any fear or hesitation. If any subject had any doubt points were made clear to him or her.
To assist the test administration help was sought from in charge of concerned class. The tests were conducted in two sessions. Working memory and long term memory tests were administered in first session individually to each subject. All the other tests were administered in small groups in second session. Directions for the test were clearly and thoroughly explained to the subjects and feedback from the subjects was taken to ensure that the directions are understood properly by them.

Properly ventilated rooms, benches and desks were arranged and efforts were made to ensure minimum disturbance to the subjects during tests. Proper spacing was maintained so that no subject takes advantage of the answer sheet of other subjects and any unwanted discussion were ensured to be minimum.

The tests were administered in accordance with the procedure described in respective test manuals. In case of working memory test and long term memory test subjects were given detailed instructions to make them acquainted with the nature of the task and how they were to perform. They were also given practice traits to ensure that they understood what to do.

The general testing conditions were quite satisfactory and procedures were uniform all through. However, efforts were made to get maximum cooperation from the subjects but a few could not respond well on one or the other tests, such cases were dropped at the time of scoring or tabulation.

**Scoring of the Tests**

All the tests namely Working Memory tests, long term memory activation test and intelligence test were scored following the procedure prescribed in their respective test manuals or as described by the test
authors. The scoring of the two subtest scores of WM, 3 subtest scores LTM, 7 subtest of GMAT and 4 subtests of CFIT was accomplished separately.

(a) **Working Memory**: The operation span score was the cumulative number of words recalled from perfectly recalled trials. The number of sentence word combinations presented before the recall cue varied from three to eight, with two trials of each set size. The scores of Reading Span Working Memory test lie between 3 and 8. The maximum number of capitalized words recalled perfectly is the score of the subject. Two trials were taken of each card.

(b) **Culture Fair Intelligence Test (CFIT)**: Culture Fair test was scored for 4 variables: Series, Classification, Matrices, and Topology. Scoring of these variables was made strictly according to scoring procedure mentioned in the manual. One score was assigned for each correct response and subtest scores were obtained by adding up individual item scores. Culture four subtest scores may range 0-12, 0-14, 0-12 and 0-8 for series, classification, matrices and topology.

(c) **Hundal General Mental Ability Test (GMAT)**: Separate scoring keys or scoring guides were used for the scoring of tests. GMAT was scored by assigning a score of one to each correct answer and was scored for seven categories. The total score of a subject on this test can range from 0 to 100. Seven categories are Number Series (NS), Analogies (An), Classification (CV), Inference (Inf), Following Directions (FD), Opposites (Opp) and Synonyms (Sy) and they contain 20, 20, 15, 14, 11, 10, 10 items, respectively.

(d) **Long Term Memory Activation (Fan Manipulation Task)**: For the scoring of Fan Manipulation Task target and foil sentences were presented one at a time. Subjects pressed one of two keys to indicate
whether the sentence presented had also been studied. The “1” and “3” keys on the numeric keypad were used for yes and no response, respectively. Each target and foil was randomly tested three times. RT was measured from the onset of a sentence to the time of the subject’s response.

**Statistical Analyses:**

The obtained data were analyzed for descriptive statistics i.e., Mean, Standard Deviation, Skewness and Kurtosis, Pearson n correlations and Principle Components analysis. The original factor solution was rotated to accomplish simple structure and positive manifold by Varimax criterion of orthogonal rotation.