Chapter 3

Method and Procedure
METHOD AND PROCEDURE

Methodology of research includes the plans, techniques and strategies to be followed in carrying out a research study, i.e., selecting appropriate research design, identifying and defining the nature of the population, techniques used to select a representative sample from that population, tools used for the data collection, and the statistical techniques used in the data analysis. These steps require immense care on the part of the researcher.

RESEARCH DESIGN:

Research design is the plan, structure, and strategy of investigation conceived so as to obtain answers to research questions and to control variance, Kerlinger (2002). Basically research design serves two functions. First, it enables the researcher to answer research questions as validly, objectively, accurately, and economically as possible. Secondly it also acts as a control mechanism enabling the researcher to control unwanted variance.

As far the nature of the design of the present study is concerned, it is an exploratory one. According to Kerlinger (2002), exploratory research has three functions:

i. To discover significant variables in the field situation

ii. To discover relations among variables

iii. To lay the groundwork for latter, more systemic and rigorous testing of hypotheses.
The present study has been undertaken:

- To identify the significant predictors of attitude towards science and their extent of predictability for the different samples.
- To identify the significant predictors of science achievement and their extent of predictability for the different samples.

**POPULATION:**

Population in the present study refers to all the students of Aligarh district studying in class X during the academic session 2002-03 in any institution located in urban area and affiliated to any board.

There are 411 Secondary/High Schools (including Senior Secondary schools and Intermediate Colleges where Secondary/High School sections are attached) in the district Aligarh as per the records obtained from websites of Uttar Pradesh Board (UPB), Council for Indian School Certificate Examination (CISCE), Central Board of Secondary Education (CBSE) and Aligarh Muslim University (AMU). Total 82 schools are situated in urban areas. These schools are categorized into subgroups as follows:

<table>
<thead>
<tr>
<th>Type of Institutions</th>
<th>Muslim Majority</th>
<th>Non-Muslim Majority</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>03</td>
<td>38</td>
<td>41</td>
</tr>
<tr>
<td>Girls</td>
<td>03</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Co-education</td>
<td>07</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Grand Total</td>
<td>13</td>
<td>69</td>
<td>82</td>
</tr>
</tbody>
</table>

Table 3.1

*Distribution of the Secondary/High Schools in Aligarh city*
SAMPLE:

Keeping in view the feasibility and other resource conditions, nineteen schools are selected by stratified random sampling procedure in such a way that Muslims, Non-Muslims, males and females may get equal representation. From each selected school, the sections of class 10th are identified through random sampling. Finally, the adolescent students of class 10th are taken from the selected sections by the cluster sampling technique.

The diagram showing distribution of the sample is given below:

![Diagram of sample distribution]

The detail of the sample is given in the Table 3.2:
### Table 3.2
School wise distribution of the sample

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the Schools</th>
<th>Muslim</th>
<th>Non-Muslim</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>1.</td>
<td>A.B.K. Union High School (Boys)</td>
<td>37</td>
<td>00</td>
<td>02</td>
</tr>
<tr>
<td>2.</td>
<td>A.B.K. Union High School (Girls)</td>
<td>00</td>
<td>39</td>
<td>00</td>
</tr>
<tr>
<td>3.</td>
<td>Aligarh Modern School</td>
<td>23</td>
<td>17</td>
<td>03</td>
</tr>
<tr>
<td>4.</td>
<td>City Girls School</td>
<td>00</td>
<td>45</td>
<td>00</td>
</tr>
<tr>
<td>5.</td>
<td>City High School</td>
<td>25</td>
<td>00</td>
<td>19</td>
</tr>
<tr>
<td>6.</td>
<td>G.D. Public School</td>
<td>03</td>
<td>03</td>
<td>17</td>
</tr>
<tr>
<td>7.</td>
<td>Girls High School</td>
<td>00</td>
<td>34</td>
<td>00</td>
</tr>
<tr>
<td>8.</td>
<td>Gopilal Paliwal Inter College</td>
<td>04</td>
<td>00</td>
<td>31</td>
</tr>
<tr>
<td>9.</td>
<td>Government Girls Inter College</td>
<td>00</td>
<td>05</td>
<td>00</td>
</tr>
<tr>
<td>10.</td>
<td>Hindu Inter College</td>
<td>07</td>
<td>00</td>
<td>29</td>
</tr>
<tr>
<td>11.</td>
<td>Lt. Nahar Singh Inter College</td>
<td>03</td>
<td>00</td>
<td>32</td>
</tr>
<tr>
<td>12.</td>
<td>Lutfia Higher Secondary School</td>
<td>19</td>
<td>14</td>
<td>02</td>
</tr>
<tr>
<td>13.</td>
<td>Maharshi Gautam Higher Secondary School</td>
<td>04</td>
<td>02</td>
<td>19</td>
</tr>
<tr>
<td>14.</td>
<td>Neehar Meera National high School</td>
<td>10</td>
<td>05</td>
<td>16</td>
</tr>
<tr>
<td>15.</td>
<td>Ram Katori Girls Inter College</td>
<td>00</td>
<td>03</td>
<td>00</td>
</tr>
<tr>
<td>16.</td>
<td>S.T.S. High School</td>
<td>41</td>
<td>00</td>
<td>04</td>
</tr>
<tr>
<td>17.</td>
<td>Tikaram Girls Inter College</td>
<td>00</td>
<td>08</td>
<td>00</td>
</tr>
<tr>
<td>18.</td>
<td>Vasudev Higher Secondary School</td>
<td>05</td>
<td>00</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>199</td>
<td>190</td>
<td>210</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>389</td>
<td>415</td>
<td></td>
</tr>
</tbody>
</table>
TOOLS USED:

For the purpose of data collection, the following standardized tools were used:

1. Intelligence Test: Culture Fair (Scale 2, Form A) by Cattell, and Cattell.
2. Verbal Test of Creative Thinking (TCW) by Mehdi.
6. Science Achievement Scores (taken from final examination school records and converted into T-scores).

The descriptions of the above tests are given below:

1. **INTELLIGENCE TEST: CULTURE FAIR (SCALE 2, FORM A)**

Intelligence Test: Culture Fair (Scale 2, Form A) is developed by Cattell and Cattell (1973). This test measures individual intelligence in a manner designed to reduce, as much as possible, the influence of verbal fluency, cultural climate and educational level. The test is non-verbal in nature and requires only that examinees be able to perceive relationships in shapes and figures. The scale contains four subsets, involving different perceptual tasks, so that the composite intelligence
measure avoids spurious reliance on a single skill. The descriptions of the subsets are as follows:

- **Series Test**
  This subtest contains 12 items for which the allotted time is 3 minutes. In it, the individual is presented with an incomplete progressive series. His task is to select, from among the choices provided, the answer which best continues the series.

- **Classification Test**
  This subtest contains 14 items for which the allotted time is 4 minutes. In it, the individual is presented with five figures and he or she has to select one which is different from the other four.

- **Matrices Test**
  This subtest contains 12 items for which the allotted time is 3 minutes. In it, the task is to correctly complete the design or matrix presented at the left of each row.

- **Conditions (Topology) Test**
  This subtest contains 8 items for which the allotted time is 2 and 1/2 minutes. It requires the individual to select, from the five choices provided, the one which duplicates the conditions given in the far left box.

**Reliability of the test**

The reliability of the test is established by three separate methods. The first method evaluates consistency over items, calculated through
various methods including Split-half and appropriate internal consistency formulae which is found to be 0.76 (N=3909 males and females). The second method evaluates consistency over parts by inter form correlations corrected to appropriate length which is found to be 0.67 (N=832 males and females). The third method evaluates consistency over time by immediate test-retest correlations, and which is found to be 0.73 (N=650 males and females). All coefficients are quite respectably high and have been evaluated across large and widely diverse sample.

**Validity of the test**

The validity of the test is also established through various methods. The concept validity (how well the test measures the pure intelligence factor ‘g’ which it is designated to measure) by direct correlations with pure intelligence factor is found to be 0.81 (N=660 males and females) across independent factor analysis and across cultures. The concrete validity (correlations with other methods of general intelligence, some non-verbal, others substantially verbal in content like GATB, WAIS, Progressive Matrices, DAT, Stanford-Binet and WISC) is found to be 0.70 (N=523 males and females).

In relation to test design itself, another important avenue of validity to explore is the extent to which the effects of cultural learning and social climate have been removed from test cores. Various researchers like Cattell (1951), Fowler (1955), Rodd (1958), MacArthur and Elley (1963) and Weiss (1971) have demonstrated no significant differences in intelligence over cross sectional sample.
2. **VERBAL TEST OF CREATIVE THINKING (TCW)**

Verbal Test of Creative Thinking is developed by Mehdi (1997). The test includes four subsets, namely consequences test, unusual uses test, similarity test and product improvement test. The numbers of relevant responses on these subtests measure one's ideational fluency, the number of thought categories measure flexibility and the number of uncommon or novel responses indicates originality of the subject.

- **Consequences Test**

  The basis of the consequences test is Guilford's consequences test or Torrance's just suppose activity. The activity includes the tasks which are very familiar but confront the subject with a situation which he can think of with a large number of possibilities to a hypothetical happening. It consists of three tasks or hypothetical situations:

  a. What would happen if man could fly like bird?
  b. What would happen if our school had wheels?
  c. What would happen if man does not have any need for food?

- **Unusual Uses Test**

  The idea of unusual uses test is based on Guilford's brick uses test or Torrance's tin-can uses test or cardboard boxes uses test. In this test, the subjects are asked to write as many novel, interesting and unusual uses of the three objects, namely:

  a. a piece of stone
  b. a wooden stick
  c. water
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- **New Relationship Test**
  The idea of new relationship has come from Mendrick’s association. In this subtest, the subjects are asked to think and write as many novel relationships as possible between the two object of each pair in the space provided. The pairs of the words are:
  a. tree and house
  b. chair and ladder
  c. air and water

- **Product Improvement Test**
  In this part, the verbal imaginations are similar to the Torrance’s product improvement activity. Torrance used a picture of a monkey but in this sub-test the subjects are asked to think of a simple wooden toy of horse and suggest changes to make it more interesting and unusual for the child to play.

  The allotted time for the above subsets are 15, 12, 15, and 6 minutes respectively, thus, the total time required for administration of the test is 48 minutes in addition to the time necessary for instructions.

Reliability of the test

The test–retest reliabilities of the factor scores and also the total scores have been obtained on “small sample” (N=31). The reliability for fluency, flexibility, originality and total creativity scores are 0.945, 0.921, 0.896 and 0.959 respectively. Inter scorer reliability for the factor scores in a study is found to vary from 0.653 to 0.981.
Validity of the test

The validity coefficient against the teacher ratings for each, fluency, flexibility and originality are found to be 0.40, 0.32 and 0.34 respectively, all being significant beyond 0.01 level. The validity of the total creativity score is found to be 0.39 which is also significant beyond 0.01 level (N=300). Higher correlations with teachers' ratings are usually not found due to the unreliability of the ratings.

3. SOCIO-ECONOMIC STATUS SCALE (SESS-U) (URBAN)

Socio-Economic Status Scale is developed by Srivastava (1997). It seeks information about education, occupation, income cultural living and social participation. The SES scale is developed and standardized in the year 1991. Therefore, it is to be rationalized and updated keeping in view the then inflation rate. Thus, the income of different slabs of the scale is revised keeping in mind the price increase so as to take into account in inflation during this period (National Statistical Organization, New Delhi).

Reliability of the scale

The internal consistency reliability of the final form of the scale is established and the value of the reliability coefficients are found to be 0.79, 0.72, 0.66, 0.60 and 0.70 of education with occupation, income, cultural living, social participation and the whole test respectively; 0.86, 0.77, 0.56 and 0.91 of occupation with income, cultural living, social participation and the whole test respectively; 0.77, 0.60 and 0.94 of income with cultural living, social participation and the whole test respectively; 0.63 and 0.92 of cultural living with social participation.
and the whole test respectively; and 0.71 of social participation with the whole test (N=100). The test-retest reliability is found to be 0.94 (N=100 and time gap=4 weeks). All the values are very satisfactory.

**Validity of the scale**

- The scale possesses high content validity as the universe of the concept is covered widely and sampled through the perusal of Indian and foreign studies, each item of the scale is judged by the experts.

- The concurrent validity of the scale is also found to be very satisfactory as estimated by different methods. The total score on the Socio-Economic Status Scale with teacher’s rating on high school students yields high correlation (r=0.82, N=50). The concurrent validity of the scale is also established by testing identifiable groups (one having the students who had their primary education in ordinary schools and the other those who had primary education in public schools) which differs significantly beyond 0.01 level (N=100).

- Construct validity of the scale is tested by applying the test of normal probability. The variable socio-economic status is found to be nearly normally distributed as it is slightly positively skewed. However, the test of significance has showed that the symmetry of the curve has not deviated significantly from normality.

**4. ADJUSTMENT INVENTORY FOR SCHOOL STUDENTS (AISS)**

This inventory has been prepared and standardized by Sinha and Singh (1998). It is suitable for Hindi knowing students and seeks to
segregate between well adjusted and poor adjusted secondary school students (age group 14-18 years) in three areas of adjustment-emotional, social and educational.

A set of 100 questions based on the problems of the students in the aforesaid areas of adjustment are prepared and the responses are recorded in 'yes' or 'no'. The final form of the test consists of 60 items, 20 in each areas of adjustment and has been standardized on randomly selected representative sample of 1950 (1200 boys and 750 girls) from class IX to XI grade pupils of 40 schools of Bihar.

Reliability of the inventory

The reliability coefficients of the total test and of sub-tests are calculated by different methods. For emotional dimension of the test, the reliability coefficients are found to be 0.94 by Split-half method, 0.96 by Test-retest method and 0.92 by KR-20 formula. For social dimension of the test, the reliability coefficients are found to be 0.93 by Split-half method, 0.90 by Test-retest method and 0.92 by KR-20 formula. For educational dimension of the test, the reliability coefficients are found to be 0.96 by Split-half method, 0.93 by Test-retest method and 0.96 by KR-20 formula. For the total test, the reliability coefficients are found to be 0.95 by Split-half method, 0.93 by Test-retest method and 0.94 by KR-20 formula.

Validity of the inventory

The validity coefficients are determined for each item by biserial correlation method with both the total score and the area score. The correlation between emotional and social dimension of adjustment is
found to be 0.20, between emotional and educational dimensions 0.19 and between social and educational dimension as 0.24. The inventory is also validated by correlating inventory scores with rating by the Hostel Superintendent and found to be 0.51 (N=60).

5. **SCIENCE ATTITUDE SCALE (SAS)**

Science Attitude Scale (SAS) has been prepared and standardized by Grewal (2000). It is a self reporting inventory consisting of 20 items and comprising four categories from the universe of content ‘science attitude’ (positive intellectual, negative intellectual, positive emotional and negative emotional attitudes) designed to assess the attitude of individuals towards science. Likert method and Scale discrimination techniques are used in the construction of SAS. Initially the universe of content for the attitude scale constitutes 41 statements about science collected from various relevant sources dealing with the world of science. The final form of the scale consists of 20 items (10 positive and 10 negative) standardized on 515 higher secondary students drawn from 6 schools of Bhopal.

**Reliability of the scale**

The reliability of the scale established through Split-half (odd-even) method is found to be 0.87, through Test-retest method (time gap 3 months) as 0.77 whereas the same is 0.96 when established by Likert - Thurstone (Technique of Scoring). The reliability of the test established by various methods is found to be very satisfactory.
Validity of the scale

The scale appears to have content validity and the method of selecting items support this supposition. In addition, differences in mean scores are found among the selected groups of known preferences for science, i.e., Arts students (Mean=46.41) and Science students (Mean=50.58) which is significant at 0.01 level (t=60.62).

6. SCIENCE ACHIEVEMENT SCORES

The marks obtained by the students in Science subject (including Physics, Chemistry, and Biology with practical) in the board examination (Class 10th) are taken as the measure of Science Achievement Scores. To reduce the inter-board discrepancies in marking, the science achievement scores are converted into standard scores (T-scores) to make them comparable.

COLLECTION OF DATA:

After the getting the letter of reference from the Chairman, Department of Education, A.M.U., for collection of data, the researcher sought the help of principals and staff of the selected schools. The importance of the honest and frank responses of the students was discussed and the students were motivated to act sincerely. The respondents were ensured that the data would be used only for the research purposes. All the five tests namely intelligence, creativity, socio-economic status, adjustment and attitude towards science were administered by the investigator himself adhering strictly the instructions given in the manual of the tests. Each data sheet was
scrutinized for correction, if any. The data for Science Achievement were the marks obtained by the respondents in the Annual Examination (10th class) noted from the office records.

**SCORING OF THE TESTS:**

All the tests employed for the present investigation are standardized. The scoring of the tests (intelligence, creativity, socio-economic status, adjustment and attitude towards science) was done strictly according to the guidelines and instructions provided by the author (s) in the manuals and keys of the respective tests.

**DATA PROCESSING:**

Keeping in view the objectives and hypotheses of the study, the nature of the data required the use of advance statistical techniques. So, the collected data were processed by computer using statistical software package SPSS (Statistical Package for Social Sciences). A comprehensive data sheet was prepared with proper coding of the dependent and independent variables taking care of the need of the package. After that the data was fed in the software worksheet and also crosschecked to weed out mistakes.

**STATISTICAL TECHNIQUES:**

The main statistical technique used for the treatment of data is stepwise multiple regression analysis. In this technique, according to Kerlinger (2002), "The computer first selects the independent variable, X_a that has the highest correlation with the dependent variable, Y, and calculates regression statistics. It then selects the variable X_b that, after
the first variable will contribute most to the variance of Y. It then stops to evaluate what it has done. That is, it examines the contribution the first variable would have made had it been entered second. If this contribution turns out to be statistically significant, the variable is dropped. The process is continued until a statistical test of significant strikes a variable, \( X_m \) that does not contribute significantly to \( R^2 \)."

A brief description of the statistical techniques used in the analysis of the data is given below:

1. Pearson Product Moment correlation coefficient (\( r \)) to find out the correlations between the paired variables

\[
r_{xy} = \frac{N\Sigma XY - \Sigma X \Sigma Y}{\sqrt{[N\Sigma X - (\Sigma X)^2][N\Sigma Y - (\Sigma Y)^2]}}
\]

2. t-test to see the significance of \( r \)

\[
t_r = \frac{r\sqrt{N - 2}}{\sqrt{1 - r}}
\]

3. Mean

\[
M = \frac{\Sigma X}{N}
\]

4. Standard Deviation

\[
\sigma = \sqrt{\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2}
\]

5. t-test to see the significance of difference between two means

\[
t = \frac{|M_1 - M_2|}{\sqrt{\frac{N_1 \sigma_1^2 + N_2 \sigma_2^2}{N_1 + N_2 - 2} \left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}
\]
6. z-test to see the significance of difference between two proportions or percentages

\[ z = \frac{|P_1 - P_2|}{\sqrt{P_1 q_1 \left( \frac{1}{N_1} + \frac{1}{N_2} \right)}}, \]

7. Multiple correlation (R) in terms of partial coefficients of correlation for n variables

\[ R_{1(234...n)} = \sqrt{1 - [(1-r_{12}^2)(1-r_{13,2}^2)\ldots(1-r_{1n,234...,(n-1)}^2)]} \]

8. Partial r in terms of the coefficients of lower order -n variables

\[ r_{i34...n} = \frac{r_{12,34...,(n-1)} - r_{i1n,34...,(n-1)} r_{2n,34...,(n-1)}}{\sqrt{1-r_{i1n,34...,(n-1)}^2} \sqrt{1-r_{2n,34...,(n-1)}^2}} \]

9. Partial σ for n variables

\[ \sigma_{1234...n} = \sigma_1 \sqrt{1-r_{12}^2} \sqrt{1-r_{13,2}^2} \sqrt{1-r_{14,23}^2} \sqrt{1-r_{1n,234...,(n-1)}^2} \]

10. Partial (unstandardized) regression coefficients in terms of partial coefficient of correlation and standard errors of estimates-n variables

\[ b_{i234...n} = r_{i234...n} \frac{\sigma_{1234...n}}{\sigma_{2,34...n}} \]

11. Beta coefficients (standardized regression coefficient or β-weight) calculated from partial regression coefficients

\[ \beta_{i234...n} = b_{i234...n} \frac{\sigma_2}{\sigma_1} \]
12. F-test to check the statistical significance of $R^2$ with $n$ independent variables

$$F = \frac{R^2 / k}{(1-R^2) / (N-k-1)}$$

13. F-test to see the significance of difference between multiple $R's$

$$F = \frac{(R_1^2 - R_2^2) (N-m_1-1)}{(1-R_1^2) (m_1-m_2)}$$

14. F-test to see the significance of variance attributed by the prediction model due to the regression

$$F = \frac{SS_{reg}/df_1}{SS_{res}/df_2}$$

15. SE of a multiple regression coefficient, $b$

$$\sigma_{b1,2,3,\ldots,m} = \frac{\sigma_{1,2,3,\ldots,m}}{\sqrt{N-m}}$$

16. Multiple Regression equation in score from for $n$ variables

The criterion variable is expressed as weighted linear combination of the predictive variables. The mathematical model can be expressed as follows:

$$X_1 = b_{1,2,3,\ldots,n} X_2 + b_{1,2,3,\ldots,8} X_3 + \ldots + b_{1,2,3,\ldots,(n-1)} X_n + K$$

The formulae which are mentioned above are inbuilt in the software SPSS, only necessary commands are given to do the calculations.

The next chapter deals with analysis and interpretation.