CHAPTER - IV

DESIGN AND METHODOLOGY

Research is a systematic effort in the direction of solution of a problem having direct or indirect bearing on human welfare. It is 'systematic' because it involves certain steps to be taken in a definite order. There may be more than one approaches to solve a problem, some of them being better than others. Which approach or methodology is followed largely determines the dependability of research findings. So, the success of a researcher lies in his choice of methodology to be followed. Methodology includes all the plans techniques and strategies follow in carrying out a research study. From the very beginning the investigator has been very particular to see that no loop-hole is left in the methodology followed in the present investigation. This chapter reports the details of the design of the study including technique of sample selection, development of research tools, techniques followed in data collection and analysis.

4.1 SAMPLE:

Generally it is not possible to study the entire population in a single research study. There are two reasons for this: (i) when the population is very large it
is not possible to contact every individual unit; (ii) when dependable results can be obtained by studying a small portion of the population, there is no use of wasting time and money.

One very important use of inferential statistics is in drawing of inferences about larger populations on the basis of informations obtained from smaller groups selected from the population. To state in other words, we wish to make statements or generalizations about the population on the basis of informations obtained from the study of one or more samples. The extent to which we can do this with reasonable accuracy depends on the adequacy or representativeness of the sample.

To study the whole population is rather impracticable; a statistical process called sampling makes it possible to draw useful inferences or generalizations on the basis of careful observations or manipulation of variables, within a relatively small proportion of the population. The process of sampling generally refers to the method of selecting a small part or specimen of a large Universe of subjects, in order to study some quality or characteristic of the whole. So, sampling is one of the most fundamental aspects of the total methodology followed in particular research study. It is an act of determining
how many elements in a population are to be sampled, and how they are to be selected. A single member of the population is referred to as a population unit or element. The statistical values which refer to samples are called "statistics". On the basis of statistics, we can estimate the corresponding population values called parameters. So, a statistical inquiry involves estimating an unknown "parameter", on the basis of statistics obtained from a sample. This process is known as statistical inference (Best, 1977).

Since the present study has been conducted on class VIII students, all the students studying in class VIII constitute the population of the study. The age range of the members of the population is 14-15 years. This study was carried out in Intermediate colleges of Aligarh city. Keeping in view the practical feasibility and other conditions the investigator used cluster sampling. In cluster sampling the population is viewed as a collection of groups that are much the same. That is, strata are internally homogeneous and clusters are internally heterogeneous. In cluster sampling, it is the clusters themselves which are selected at random. The investigator used this technique because schools provide the whole class for test administration. It is not possible to select a simple random sample in educational institutions.
To start with, a sample of 800 class VIII students was drawn from 11 different Intermediate Colleges located in Aligarh city. Later on some of the cases were dropped because of nonavailability of adequate informations. Due to the occasional absence of the students on the days of test administration, the number of cases were also reduced. As it was necessary to administer all the tests to the same subjects, those who had taken few tests and left others were not included in the sample for final analysis. So the final size of the sample was 489 which consisted of 263 boys and 226 girls. The details of sample are presented in the table 4.1.

4.2 **TOOLS USED:**

The dependability of research findings are not only determined by planning, methodology, data analysis and interpretation but also on tools that are used to collect informations or data. In a research study, while selecting research tools many considerations have to be kept in mind - such as objectives of the study, the amount of time to be devoted for the study, availability of suitable tests, their statistical characteristics etc. Since the study involves identification of over-and underachievement in science and gathering informations about their sociocultural and familial background the investigator used three different research tools:
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the Institution</th>
<th>Number of cases selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Raghuvi Sahai Inter College, Aligarh</td>
<td>55</td>
</tr>
<tr>
<td>2.</td>
<td>Rajkiya Balika Inter College, Aligarh</td>
<td>52</td>
</tr>
<tr>
<td>3.</td>
<td>Dharam Samaj Inter College, Aligarh</td>
<td>47</td>
</tr>
<tr>
<td>4.</td>
<td>Hindu Uchhattar Madhyamic Vidyalaya, Aligarh</td>
<td>50</td>
</tr>
<tr>
<td>5.</td>
<td>Naurangi Lal Govt. Inter College, Aligarh</td>
<td>27</td>
</tr>
<tr>
<td>6.</td>
<td>Shrimad Brahmanand Inter College, Aligarh</td>
<td>84</td>
</tr>
<tr>
<td>7.</td>
<td>Shri Tikaram Girls Inter College, Aligarh</td>
<td>53</td>
</tr>
<tr>
<td>8.</td>
<td>Ratan Prem D.A.V. College, Aligarh</td>
<td>05</td>
</tr>
<tr>
<td>9.</td>
<td>Shri Maheshwari Girls Inter College, Aligarh</td>
<td>40</td>
</tr>
<tr>
<td>10.</td>
<td>Shri Chiranjlal Kanya Inter College, Aligarh</td>
<td>36</td>
</tr>
<tr>
<td>11.</td>
<td>Shri Uday Singh Jain Kanya Inter College, Aligarh</td>
<td>40</td>
</tr>
</tbody>
</table>

Total 489
(i) An intelligence test was used as a predictor test.
(ii) An achievement test in science for class VIII students was used as a criterion variable.
(iii) A sociocultural and familial background assessment scale was used to gather informations regarding these variables.

In the pages to follow these tools are described in detail, the details including, types of items, statistical characteristics scoring methods and techniques of score interpretation.

4.2.1 Achievement test in science:

The achievement test in science for class VIII students that was used in the present study was constructed by the investigator herself as part of her M.Phil. degree. This test had been printed in Hindi because it was to be used on Hindi medium students. This was a very comprehensive test composed of three subtests one each in Physics, Chemistry and Biology. The final form of the test had 20 items in Physics, 25 items in Chemistry and 30 items in Biology. Thus the test had 75 items in all. All the items in the achievement test were multiple choice type with four alternative options each. Although the achievement test was composed of three subtests, the total score on the test as a whole was used as a measure of achievement in science. The statistical
characteristics of the whole test were available with the investigator. The test covered all the important topics in science taught at class VIII level. All the 75 items in the test were arranged in order of difficulty, the easy items being placed in the beginning. This was done to motivate the students. The difficulty values (p-values) of items in the test fell between the range of 0.25 to 0.75. Similarly, each item had a discrimination power greater than 0.30. A copy of the test booklet is appended at the end of this report.

The test was based on the latest syllabus prescribed by the Directorate of Education, U.P. This test had a fairly high content validity and its reliability coefficients were computed by using several methods. The values obtained were found out to be fairly satisfactory. The details are provided in Table 4.2.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Methods used</th>
<th>Reliability Coefficients obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>KR-20 formula</td>
<td>0.86</td>
</tr>
<tr>
<td>2.</td>
<td>Rulon formula</td>
<td>0.82</td>
</tr>
<tr>
<td>3.</td>
<td>Flanagan formula</td>
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</tr>
<tr>
<td>4.</td>
<td>Split half method</td>
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</tr>
<tr>
<td>5.</td>
<td>KR-21 formula</td>
<td>0.79</td>
</tr>
</tbody>
</table>
4.2.2 **Intelligence test:**

The investigator employed 'Culture Fair' test of general mental ability constructed by Cattell & Cattell (Test of 'g': Culture Fair, Scale 2, Form A) for measuring intelligence of the subjects. This test was chosen in preference to some other available tests primarily because it is a culture fair test. Unlike other widely used tests it is less affected by the vagaries of place and time. The constructor of the test claims that the test measures "individual intelligence" in a manner designed to reduce, as much as possible, the influence of verbal fluency, cultural climate, and educational level. (Measuring Intelligence with the Culture Fair Tests, Manual for scale 2 and 3, 1973, p. 5). Scale 2 of the test could profitably be employed for the present study as it is usable on children beyond the age of 8 years, and the subjects of the study were school pupils of class VIII with a mean age of 15 years.

The facility in the administration of the test was also one of the positive consideration. The test is so designed that it can be conveniently administered in a group situation, and no special training on the part of the administrator is required. The test items or tasks in this test are so structured that the subjects are required 'Only to perceive relationships in shapes and figures'. Their
verbal ability or lack of it is supposed to have no affect on the results. Hence, the test is called "culture fair". Scale-2, Form-A of this test consists of four subtests. The first subtest has 12 series of figure items and the time allotted for it is 3 minutes. The second subtest contains 14 items based on 'classification' and the time allotted for it is 4 minutes. The third subtest is composed of 12 items based on figure matrices and the allotted time is 3 minutes. The fourth subtest has 8 items based on topology and the time allotted for it is $2\frac{1}{2}$ minutes. Thus in all there are 46 items in the entire test divided into four subtests. It is important to mention here that both in the arrangement of the four subtests, and the order of items within each subtest the psychological principle of moving from easy to difficult operations is adhered to.

Each subtest is accompanied by examples so that the task requirements are clearly understood by the subjects who take the test. The total effective time for completing the test is twelve and a half minutes. Fortunately, sufficient number of copies of this test were available in the library of the Department of Education, Aligarh Muslim University. The investigator used these copies while administering the test.

For a test of intelligence or general mental ability, construct validity is the most important type of
validity. A construct is a basic psychological trait measured by a test. For instance, a test of intelligence must measure intelligence; a test of creativity must measure creativity and the like. The author of the test has determined construct validities for each subtest as well as for the whole test. These validity coefficients were determined by the internal consistency method, and termed them as 'direct construct validities'. For scale-2 these have been calculated for each of the four subtests separately and reported in the Technical Supplement published in 1973. For the first subtest, the direct construct validity coefficient was reported to be 0.76; for the second subtest the coefficient was 0.54, for the third subtest it was 0.76; and for the fourth subtest 0.51. For the total test consisting of 46 items, the direct construct validity coefficient has been reported to be 0.85 (Technical Supplement, 1973). For determining concurrent validity of scale 2, the author correlated the performance on it with that on other intelligence tests. It is reported in the Manual that the concurrent validity coefficients for the test used by the investigator, against four tests of intelligence, namely 'Wechsler Adult, Revised Beta, Otis Group Test, and Coloured Progressive Matrices', were found to be 0.74, 0.76, 0.71 and 0.68 respectively (Technical Supplement, 1973, p. 18). The average coefficient of concurrent validity as determined against these tests
Reliability is a very important characteristic of a psychological test. Before using the said test the investigator wanted to be sure that the test had adequate degree of reliability. In order to determine the reliability of the said test the test-retest agreement method and the split half method were employed by the original authors of the test for obtaining dependability coefficient and internal consistency coefficient respectively. The test-retest dependability coefficients, ranged from 0.82 to 0.85 while the odd even split half 'consistency' coefficients correlated by spearman Brown formula for full length ranged from 0.95 to 0.97 (Technical Supplement, 1973, p. 2). Test reliability has been evaluated both in terms of the dependability coefficient and the consistency coefficient. The Dependability Coefficients (immediate test-retest agreement) on the full test were 0.82 and 0.85 for two different groups. The consistency coefficient (split half, corrected to full length A and B forms) were reported to be 0.70, 0.86, 0.87 and 0.92 for the four different groups.

The reports in connection with validity and reliability of the test indicated that the said test was properly developed and was appropriate for use in the present study. A copy of the test booklet is attached at the end of this report.
4.2.3 Sociocultural and Familial Background Assessment Scale:

Since the main purpose of the present study was to study the effect of sociocultural and familial variables on academic achievement of children, a scale to assess these variables was needed. The investigator searched for such a scale in the market and libraries, but no such scale had been constructed by anybody which could be used on class VIII students. So, the investigator had no option but to develop the scale herself for the purpose of her own study. So, the investigator developed the scale herself. The scale was named Sociocultural and Familial Background Assessment Scale (SFBA - Scale). This scale was developed by the investigator to measure the sociocultural and familial factors which influence the achievement of the subjects.

The scale had 11 items in all which were divided into two parts. First, five questions (from 1 to 5) sought informations about the sociocultural background and the second part consisting of 6 items (from 6 to 11) sought informations regarding familial variables. The items were numbered from 1 to 11 in that order.

Question 1 in the scale sought informations about rural/urban location of the residences of the subjects; question 2 asked their religious affiliation, question three enquired about caste; question 4 sought information about
type of schooling and question 5 enquired about the medium of instruction. Question 2 and 5 did not provide useful informations because all the students belonged to the same religious group and studied through the same medium of instruction. So there was no variation. Question 6 enquired about family environment and sought information about size of the family, type of the family, number of brothers and sisters, the type of house. Question 7 sought information regarding the size of house in which the subjects lived. Question 8 and 9 sought informations about the education of parents and Questions 10 and 11 enquired about family occupation and income respectively. In all there were seven variables that were assessed by this scale.

4.3 DATA COLLECTION:

Fortunately, the three tests administered were not very technical as far as their administration is concerned. So, the investigator decided to visit the schools herself for data collection. The basic requirement of the study is that all the tests must be administered to the same subjects. If a subject takes one of the tests, it is a must for him to take other two tests also. The administration of the three tests, namely Achievement test in science, Cattell's Culture Fair Intelligence Test & Sociocultural and Familial Background Assessment Scale was conducted on
the consecutive days in a particular school. All the tests were administered to the same sections of class VIII and strict adherence to the instructions given by the authors of the tests was maintained. The investigator visited and collected the data from different Intermediate Colleges personally.

To seek cooperation of principals and teachers of these Intermediate Colleges, the investigator received introduction letters from her supervisor and chairman of the Department of Education, A.M.U. in which they had requested the concerned principals to cooperate in this task. Consequently, the principals and the teachers of the schools visited for data collection cooperated fully in the process of test administration. The entire data collection business was completed during the period from Sept. 1991 to March 1992. The students of the said colleges also cooperated satisfactorily. The investigator is thankful to all of them.

4.4 SCORING:

Both the intelligence test and achievement test were objective type with multiple choice test items. The method of scoring for the intelligence test was given in the test manual. The investigator strictly followed the guidelines provided in the manual for the purpose of scoring. The achievement test, which was developed by the investigator
herself, also included multiple choice test items. In both the cases, the process of scoring was the same. Cattell's Culture Fair Intelligence test and Achievement test in science were scored by the investigator herself with the help of scoring keys available with the test manuals. A right answer was scored as 1 and a wrong one was scored as 0. The score of a candidate on a particular test was the number of items he did right.

A number of different standards have been suggested in the literature for obtaining differential weights for items. A more sensible approach is to obtain differential weights for items by a method that will tend to maximize the reliability of total test scores. Such a method would fit well with the procedures for selecting items in terms of items-total correlations. An appropriate method for obtaining such differential weights is to weight each item by its item total correlation. The crucial question in seeking differential weights for items is how much difference it makes to use differential weights. It would make a difference if the weighted and unweighted scores on the whole tests did not correlate highly and if the reliability of the weighted test were considerably higher than that of the unweighted test. However, there is overwhelming evidence to show that the use of differential weights seldom makes an
important difference. Also, the slight increase in reliability or predictive validity obtained by weighting items can be matched in nearly all instances by adding several items to the unweighted test. Since it is much easier to develop new test items than to go through the labours of determining and using differential weights for items, seeking differential weights is almost never worth the trouble (Nunnally, 1981).

Differential weighting of items is most effective in short tests and usually pays little dividends when there are more than 10 to 20 items. In a long test it matters little what set of weights is used, provided they are of appropriate algebraic sign. Thus weights of 1 for all items in long tests of ability are quite appropriate. Therefore, the investigator did not proper to use the differential weighting approach in scoring the intelligence and achievement test and the simple method of providing 1 for a right answer and 0 for a wrong one was applied. Although, argument in favour of differential weighting, sometimes, sound reasonable but their effect on reliability and other test characteristics is only marginal.

However, the Sociocultural and Familial Background Scale, that was developed by the investigator herself, was not so simple as far as scoring is concerned. As mentioned
earlier the scale had 11 items or questions which sought
different informations. Each information practically formed
a different variable. Through this scale, the investigator
intends to measure seven different variables, namely,
sociocultural background, family size; home environment,
ordinal position, parent education, occupation and income.
Therefore, the decisions regarding scoring was taken by the
investigator herself. All the items in this scale were
multiple choice type with a few exceptions which had only
two options. The subjects were instructed to put a tick mark
(✔) against the alternative which suits them, and indicates
their own sociocultural background. Item No. 1 had two
alternatives (rural/urban) which have been given weightages
of 1 and 2 respectively. Since urban location indicated a
superior sociocultural background to rural location, it was
given a larger weightage. Item 2 did not function because
all the subjects belonged to the same religious community.
So there was no variation. Item 3 enquired about the caste
of the subjects; the responses were arranged from higher
castes to lower castes in the social hierarchy. So, these
responses were also weighted from highest to lowest. The
highest weight (4) was given for a high caste and lowest (1)
for other backward castes. The scoring weights were 1, 2, 3,
4. respectively for the given options. It is to be noted
that superior level in a particular variable was associated with higher weightage irrespective of its order of occurrence. Likewise item 4 has three alternatives (type of schooling), their weightages are 1, 2, 3 respectively depending on the quality of schooling. Item 5 which sought information about the medium of Instruction had four options but two of them (Urdu and others) did not function because all the students came from either Hindi or English medium schools. English medium indicating superior sociocultural background was given higher weightage. So, the weightages were 2 for English and 1 for Hindi medium.

Under the second main component of the scale which measured familial background item 6 had five different information to seek. There were size of the family, type of the family, number of brothers and sisters, order of birth and type of house (Kuchcha or Pucca). Here the scoring was done very carefully following certain principles. Larger family, joint family and Kuchcha house were associated with lower sociocultural background. The weighting of the responses were made accordingly. The first component of item 6 assessed the variable 'family size'. Similarly the second component of item 6 and item 7 together assess another important variables namely 'home environment'. The weights of these components were added to obtain the score
on the variable assessed by them. For example scores on type of family & size of the house were combined to obtain the score on house environment. Although these measures are crude, but sufficient in Indian conditions to give dependable results. Item 6(3) is of fill in the blank type, which asks about the family size. Items 6(4) and 6(5) together enquire about the ordinal position in birth, of the subjects. Item 8 which seeks information about father's education has seven alternatives which were given weightages of 1, 2, 3, 4, 5, 6, 7 respectively, since the level of education was arranged in increasing order. Item 9 was provided to seek informations about the education of the mother and had similar format. Hence its scoring procedure was the same as that of item 8. Item 10 sought information regarding the level of occupation of the family. The options indicated five different occupational level in order of superiority. These were weighted as 1, 2, 3, 4, 5 respectively. Item 11 which sought information about income level, had five options indicated different income levels in increasing order. These were also scored with weightages 1, 2, 3, 4, 5 respectively.

As mentioned earlier, the Sociocultural and Familial Background Assessment Scale was developed to obtain measures on seven different variables. The investigator does not hesitate to state that some of the item options in this scale could not be utilized.
because some of the respondents gave incomplete or partial responses which could not be used for data analysis. It should be clarified here that the said scale is very simple because it was to be used on younger children aged around 14 years. It is not expected from these children to work with a more complicated scale. However, the investigator feels the information on the items in the scale are sufficiently dependable and hence could be used for research purposes. A copy of the scale is attached at the end of this chapter.

4.5 DATA ANALYSIS:

The objectives of this study indicate that the data analysis would be carried out in two phases: (1) as a first step over and underachievers would be identified (ii) secondly, a stepwise multiple regression analysis would be conducted with over and underachievement scores as dependent variables and sociocultural and familial variables as independent variables. The theoretical discussion of the techniques of identifying over-underachievers has been presented in chapter II. Here the actual technique used in this study has been given. For the purpose of statistically identifying over- and underachievers in science 'regression
The formula for working out the regression equation is as follows:

$$\bar{Y} = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$ (Garrett, 1981, p. 158)

in which:

- $\bar{Y}$ = the predicted value of criterion score (achievement)
- $r$ = the coefficient of correlation between the predictor (intelligence) and the criterion (achievement) variables.
- $\sigma_y$ = Standard deviation of the criterion (Achievement) scores.
- $\sigma_x$ = Standard deviation of the predictor (Intelligence) scores.
- $X$ = individual predictor score.
- $Y$ = individual criterion score.
- $M_x$ = mean of the predictor (Intelligence) scores.
- $M_y$ = mean of the criterion (Achievement) scores.
- $r \frac{\sigma_y}{\sigma_x}$ = regression coefficient.

Since the prediction equation required means and standard deviations of the predictor and criterion variables as well as correlation coefficient between Intelligence and achievement scores, these were also worked out for boys and girls separately and utilized in working out the regression equation. The value thus obtained represented the predicted
achievement score for the individual concerned as predicted on the basis of intelligence.

After obtaining the predicted scores, the discrepancies between the actual achievement scores and the predicted scores were worked out for each individual in science. The scores were worked out for boys, girls and combined sample separately. These quantities namely, $M_X$, $\sum X'$, $M_Y$, $\sum Y'$ are were computed by using electronic computer. The values on $X$ and $Y$ were available on the original data sheet prepared by the investigator. This equation was used to compute predicted ($\tilde{Y}$) achievement score for every individual subject. His actual score on achievement in science ($Y$) was already known. The discrepancy, $d = Y - \tilde{Y}$ was computed for each individual. For identifying the overachievers and underachievers, more precisely, i.e., unaffected by the statistical errors of estimate, cases one unit standard error of estimate above their predicted achievement scores were designated as overachievers and those one $SD_e$ below as underachievers. The formula for computing standard error of estimate is given below:

$$S.D_e = S.D. \sqrt{1 - r^2}$$ (Garrett, 1981, p. 161)

where $S.D.$ stand for standard deviation of criterion scores.
On the basis of above mentioned procedure, the girls, boys and combined sample were divided into underachievers, average achievers and overachievers. The second phase of data analysis was conducted on overachievers and underachievers only. The average achievers were excluded. Now the following 6 groups were isolated.

1. Underachiever girls  
2. Overachiever girls  
3. Underachiever boys  
4. Overachiever boys  
5. Underachiever combined  
6. Overachiever combined.

These six groups were used for multiple regression analysis. The techniques was used with the scores of each group independently. This means that, in all six different regression analyses were carried out.

Regression analysis is a statistical technique which analyses the variance of these dependent variable and assigns to each component of variance an independent variable which accounts for it. There are several approaches to regression analysis. The present study uses the 'step-wise' regression analysis method. This method first identifies the best predictor from amongst the predictor variables and includes it in the regression equation. In the second step, the method identifies the second best predictor which has high validity coefficient but low correlation with
the first predictor. At the third step, next best predictor is identified with higher validity coefficient but low correlation with both of the existing predictors already selected. This process continues until further addition of variable makes insignificant contribution to the prediction power of the predictors. In this approach, it is not necessary to use all the predictor variables in the regression equation. Only those predictors are taken which make significant contribution to the prediction process. The significance of the variance explained by a predictor is judged by using F-test. The detailed results of these procedures are presented in the next chapter. Here we have given only a brief outline.