THE EXPERIMENTAL DESIGN

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First half of the planning has been discussed in detail in the preceding chapter. The second half which is experimental in nature, is proposed to be discussed in this chapter under the heading of the 'Experimental Design.' Any meaningful study requires a great deal of thought for setting a design. More so, when it happens to be experimental in nature. Setting of Experimental Design demands the formulation of sound hypotheses and formulation of sound hypotheses needs intensive scrutiny of the objectives of study. The bases of scrutiny become the pre-requisites of formulation of hypotheses.

5.1 PRE-REQUISITES OF THE FORMULATION OF HYPOTHESES:

The scrutiny of the objectives resulted into the following interrogatory which helped in the formulation of the hypotheses:

(i) What is the effect on the reading comprehension scores in social-studies when the textual material re-written to a lower level of readability is read by pupils having low I.Q.?
(ii) What is the effect on the reading comprehension scores in social studies when the textual material re-written to a lower level of readability is read by pupils having high I.Q.?

(iii) What is the effect on the reading comprehension scores in social studies when the textual material re-written to a lower-level of readability is read by pupils having low reading ability?

(iv) What is the effect on the reading comprehension scores in social studies when the textual material re-written to a lower level of readability is read by pupils having high reading ability?

5.2 FORMULATION OF HYPOTHESES:

A sound research must make use of the carefully formulated hypotheses. Hence, the following operational null-hypotheses were formulated with a view to verifying the hypotheses satisfactorily with the help of statistical techniques:

\[ H_1 : \text{There is significant difference between the mean score on reading comprehension test in Social Studies of Experimental and Control groups.} \]
$H_2$ : There is no significant difference between the mean scores on reading comprehension test in social studies of Boys and Girls.

$H_3$ : There is no significant difference between the mean scores on reading comprehension test in social studies of low I.Q. Group and High I.Q. group.

$H_4$ : There is no significant difference between the mean scores on reading comprehension test in social studies of poor and good readers.

$H_5$ : There is no significant effect of the interaction of treatment and sex on the Reading Comprehension.

$H_6$ : There is no significant effect of the interaction of treatment and I.Q. on the Reading Comprehension.

$H_7$ : There is no significant effect of the interaction of treatment and Reading ability on the reading comprehension.

$H_8$ : There is no significant effect of the interaction of sex and I.Q. on the reading comprehension.

$H_9$ : There is no significant effect of the interaction of sex and Reading ability on the reading comprehension.
There is no significant effect of the interaction of I.Q. and Reading ability on the reading comprehension.

There is no significant effect of the interaction of treatment, Sex and I.Q. on the reading comprehension.

There is no significant effect of the interaction of treatment, sex and Reading ability on the reading comprehension.

There is no significant effect of the interaction of treatment, I.Q. and Reading ability on the reading comprehension.

There is no significant effect of the interaction of sex, I.Q. and Reading ability on the reading comprehension.

There is no significant effect of the interaction of treatment, sex, I.Q. and Reading ability on the reading comprehension.

The formulation of hypotheses leads the investigator, eventually to the selection of a method appropriate to the present study. There are three methods which are
usually in use in educational experimentation. They are:

1. One group method
2. Parallel or equivalent group method
3. Rotational group method.

The investigator thought it worthwhile to use parallel or equivalent group method for the present study because it is through this method that certain variables could be controlled effectively.

After deciding the method of experimentation, it is very essential on the part of the investigator to inquire about the pre-requisites of the experiment with a view to ensuring clarity of steps of design and to test the hypotheses. The pre-requisites of the experiment are enlisted hereafter.

5.3 PRE-REQUISITES OF THE EXPERIMENT:

(i) Original textual material of Social Studies having high level of readability, re-written to a lower level of readability.

(ii) A valid and reliable test for measuring reading comprehension in Social Studies based on the reading material included in the chapters under study.
(iii) Reading ability test scores of the sample.
(iv) I.Q. scores of the sample.
(v) A teacher made test, based on the textual materials in Social Studies of the previous Std. i.e., VIII Std.
(vi) A sample that represents the population.
(vii) A suitable experimental design.

The original and re-written material, test for reading comprehension, Reading ability test and non-verbal group test of intelligence have been described at length in the preceding chapter. The description of the remaining requirements, namely, the sample and experimental design is given here after.

5.4 THE SAMPLE:

The generalizability of the conclusions by and large depends upon the representative sample of the population. The difficult task confronting the investigator now was, to select schools in such a way that the pupils studying in those schools could be termed as representative of the total population of Std. IX of Gujarat State. In order to obtain a representative sample, the investigator thraished certain but important points with the guide and other
learned professors. The points that were considered useful for selecting the schools, are given here below:

(i) Total strength of the school.

(ii) The area of its situation - rural or urban.

(iii) Type of school - girl-school, boy-school or a mixed school.

(iv) Its achievement at the S.S.C. Examination.

Keeping in view these criteria, nine schools were randomly selected from urban area of Gujarat State. The students studying in Std. IX of these schools are included in the sample. Sample, thus selected, could be considered as representative one for the reasons enlisted hereafter:

(i) The formation of divisions of IX is not done on the basis of any set criteria. So, there is randomization of pupils in forming classes too.

(ii) In Gujarat, as in the whole of India, primary education is free and compulsory and secondary education is free in Gujarat. Hence, it is within the reach of even the poorest to join Std. IX.
(iii) These schools do not impart education of any particular religions, communities and of both sexes join the schools. Hence, it is very safe and natural to say that the sample, chosen for the study is quite representative of the total population desiring education through English of Std. IX in the state.

5.5 FORMULATION OF EQUIVALENT GROUPS:

The hypotheses of the present study lead to the selection of equivalent group method to carry on the study. But as it is difficult to form equivalent groups, it was decided to match the groups for means and standard deviations. For this, 16 Divisions of Std. IX, having a total number of 738 were selected from nine schools. A teacher-made test, based on the teaching points of syllabus in social studies for Std. VIII was administered to the pupils of the sixteen divisions. A copy of the teacher-made test is given in Appendix G. The mean and S.D. of pre-test scores in social studies was calculated for each of the sixteen divisions. In matching the divisions for mean and S.D. scores a few students were rejected. Hence the students whose scores were rejected, were not considered as subjects for experimentation.

Thus divisions were matched for means and standard deviations on the basis of the scores on pre-test.
As a result of this four divisions were discarded since they revealed significant differences between the means on the pre-test. On the basis of these twelve divisions, six pairs of matched groups were formed. Eventually, one group from each pair was treated as experimental group and the other as control group. As a result, there were 6 experimental and 6 control groups in all. Putting it in other words, there were six replications. The mean scores and S.D.'s and their respective critical ratios are given in Table: 5.1

<table>
<thead>
<tr>
<th>Replication No.</th>
<th>No. of pupils</th>
<th>Mean</th>
<th>S.D.</th>
<th>Mean Diff.</th>
<th>C.R.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>46*</td>
<td>52.71</td>
<td>20.55</td>
<td>1.193</td>
<td>0.3173</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>53.91</td>
<td>14.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>52*</td>
<td>56.13</td>
<td>11.24</td>
<td>2.56</td>
<td>1.2905</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>58.69</td>
<td>10.65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>48*</td>
<td>53.94</td>
<td>13.91</td>
<td>4.52</td>
<td>1.7056</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>49.42</td>
<td>12.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>52*</td>
<td>63.52</td>
<td>15.07</td>
<td>3.88</td>
<td>1.1616</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>53</td>
<td>59.64</td>
<td>19.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>37*</td>
<td>57.89</td>
<td>18.98</td>
<td>2.47</td>
<td>0.6068</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>55.42</td>
<td>16.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>51*</td>
<td>47.94</td>
<td>17.48</td>
<td>2.73</td>
<td>0.8531</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td></td>
<td>54</td>
<td>50.67</td>
<td>15.15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This replication study shows that the two matched groups are really equivalent.

5.6 **STATISTICAL TECHNIQUES : EXPERIMENTAL DESIGN**

For testing the hypotheses, an experimental design is needed. In an experimental design the investigator manipulates and controls one or more independent variables and observes the dependent variable for corresponding changes.

The designs are classified into two groups or categories:

1. Inadequate designs or quasi experimental design
2. General experimental designs.

<table>
<thead>
<tr>
<th>Replication No.</th>
<th>No. of pupils</th>
<th>Mean</th>
<th>S.D.</th>
<th>Mean Diff.</th>
<th>C.R.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole</td>
<td>286*</td>
<td>55.36</td>
<td>17.33</td>
<td>0.75</td>
<td>0.1637</td>
<td>Insignificant at 0.1 level</td>
</tr>
<tr>
<td>groups</td>
<td>270</td>
<td>54.61</td>
<td>15.73</td>
<td>0.75</td>
<td>0.1637</td>
<td></td>
</tr>
</tbody>
</table>

(N.B. Numbers marked with asterick (*) are of experimental group).
5.6.1. **Quasi-experimental design:**

The one group designs come under the first category. It is also known as one-shot case study. Case studies fall under this group and hence the name. In this design a group is exposed to some treatment and after a period the effect is measured. For example if a school wants to introduce a new curriculum and study its effects, after an year the student achievement is studied and found to be same or better. Symbolically it is denoted by

\[ X \quad Y \]

Here the dependent variable Y is studied while the independent variable X is assumed or imagined. Sometimes conclusions could be misleading.

Another form of one-group design is the pre-test post-test type. This is an improvement over the previous method. The important characteristic of this design is that a group is compared with itself. This is theoretically sound since all the independent variables associated with the subject's characteristics are controlled. The group is measured on the dependent variable Y before the experiment. It is called pre-test. After the experimental manipulation again Y is measured. The differences in scores or \( Y_a - Y_b \) are studied symbolically. It can be shown as

\[ Y_b \quad X \quad Y_a \]
Though this appears to be sound it is not that simple. The difference might have been caused by variables like history on maturity.

5.6.2. General Designs:

(i) The experimental - control group design is one of the best designs for many experimental purposes in Education and Psychology. The paradigm is

\[
\begin{array}{c|cc}
R & X & Y \\
\hline
X & Y \\
\end{array}
\]

(experimental) 
(control)

The R placed before the design shows that subjects are to be randomly assigned to the experimental group and the control group.

There are two merits of this method:

(1) The presence of a control group gives the comparability required by Science and (2) Randomization provides assurance that the two groups are approximately equal on variables that may be related to the dependent variable.

(ii) The two group-method subjects design is another. Here instead of randomization the subjects are matched on one or more attributes.
This shows that after matching the members of each pair must be assigned to the two groups randomly. This can be done by using random numbers. Odd numbered subjects go into one group and the even numbered subjects go into another group.

(iii) Three group before - after

\[
\begin{array}{c c c c c}
Y_b & X & Y_a & \text{(Experimental)} \\
Y_b & X & Y_a & \text{(Control - 1)} \\
X & Y_a & \text{(Control - 2)} \\
\end{array}
\]

This is an improvement over the previous design. It avoids the possible interactive effects of the pre-test. This is done by the second control group. If the treatment is effective then the means of experimental group and control group 2 will be significantly higher than the mean of control group 1.

(iv) Four - group, before - after (Solomon)

This design was proposed by Solomon

\[
\begin{array}{c c c c c}
Y_b & X & X_a & \text{(experimental)} \\
Y_b & X & Y_a & \text{(control - 1)} \\
X & Y_a & \text{(control - 2)} \\
X & Y_a & \text{(control - 3)} \\
\end{array}
\]
This design has powerful controls. The salient features of the previous designs are included in this one design. It is widely used by social scientists.

5.6.3. **Choice of the Design:**

In deciding an approach, the researcher has to take into consideration several factors like available setting, nature of objectives, and time.

Two separate and independent dimensions can help the researcher in the choice of approach. Fox (1969) had suggested the following table:

**TABLE: 5.2**

INTERACTION OF TIME AND INTENT DIMENSIONS

<table>
<thead>
<tr>
<th>Dimension - 2</th>
<th>Dimension - 1</th>
<th>Time in which interest lies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent of Research</td>
<td>Past</td>
<td>Present</td>
</tr>
<tr>
<td>Historical</td>
<td>Simple historical</td>
<td>Simple survey</td>
</tr>
<tr>
<td>Survey</td>
<td>case study</td>
<td>Multiple group survey</td>
</tr>
<tr>
<td>Comparison</td>
<td>parallel historical</td>
<td>Multiple group survey</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Historical and criterion measure</td>
<td>Single-group or multiple group survey</td>
</tr>
<tr>
<td>meanure</td>
<td>meanure</td>
<td>meanure</td>
</tr>
</tbody>
</table>
The use of the table in the present case leads to the choice of multiple group experimental design. Since there are four independent variables each of two levels a factorial design is called for.

5.6.4. ANOVA: Factorial Design:

According to Kerlinger (1970) "Factorial Design is the structure of research in which two or more independent variables are juxtaposed in order to study their independent and interactive effects on a dependent variable."

In the present experiment the Independent Variables are treatment (A), Sex (B), I.Q. (C), Reading Ability (D). Each is at 2 levels. Hence it is a $2^4$ Factorial Experiment.

Factorial Analysis of variance has several advantages. It enables the researcher to manipulate and control or more variables. Secondly variables like sex, that cannot be manipulated can also be controlled. A third advantage is that factorial analysis is more precise than the one-way analysis. Finally the interactive effects could be studied. This is important from the scientific point of view.

5.6.5. Statistical technique in ANOVA:

Here treatment (A), Sex (B), I.Q. (C), Reading Ability (D) are the independent variables each at 2 levels.
In all there are 16 cells that would include the students of various strata. They are shown in table 5.3.

The F test is based on the following assumptions:
(i) an equal unit scale is assumed for the measurement of the dependent variable.
(ii) Homogeneity of variance.

The ANOVA summary helps in testing whether the group means differ or not.

TABLE 5.4
ANOVA SUMMARY: Between the Group and Within the Groups

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean SS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between the groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within the groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The 0.05, 0.01 confidence levels were taken to test for significance.
<table>
<thead>
<tr>
<th>d₁</th>
<th>d₂</th>
<th>d₃</th>
<th>d₄</th>
<th>d₅</th>
<th>d₆</th>
<th>d₇</th>
<th>d₈</th>
<th>d₉</th>
<th>d₁₀</th>
<th>d₁₁</th>
<th>d₁₂</th>
<th>d₁₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>c₁</td>
<td>c₂</td>
<td>c₃</td>
<td>c₄</td>
<td>c₅</td>
<td>c₆</td>
<td>c₇</td>
<td>c₈</td>
<td>c₉</td>
<td>c₁₀</td>
<td>c₁₁</td>
<td>c₁₂</td>
<td>c₁₃</td>
</tr>
<tr>
<td>b₁</td>
<td>b₂</td>
<td>b₃</td>
<td>b₄</td>
<td>b₅</td>
<td>b₆</td>
<td>b₇</td>
<td>b₈</td>
<td>b₉</td>
<td>b₁₀</td>
<td>b₁₁</td>
<td>b₁₂</td>
<td>b₁₃</td>
</tr>
<tr>
<td>a₁</td>
<td>a₂</td>
<td>a₃</td>
<td>a₄</td>
<td>a₅</td>
<td>a₆</td>
<td>a₇</td>
<td>a₈</td>
<td>a₉</td>
<td>a₁₀</td>
<td>a₁₁</td>
<td>a₁₂</td>
<td>a₁₃</td>
</tr>
</tbody>
</table>

Table 5.3: \textit{Factorial Design for Data Analysis}
5.7 NAMING THE GROUPS:

This experimental design involved two types of treatment, namely, the use of original textual material and the use of re-written textual material to lower level of readability. Therefore, both the groups received either of the two types of treatment. Theoretically, therefore, the control group was conspicuous by its absence in the present experiment. But the group that read original textual material having higher level of readability is named as 'control group' and hereafter wherever control group is mentioned would convey the same meaning. Similarly, the group that read the re-written material having lower level of readability is named as experimental group and hereafter wherever experimental group is mentioned it would convey the same meaning.

5.8 REQUIREMENTS TO BE SATISFIED BY THE SUBJECTS OF THE GROUPS:

It was seen that each pupil of both the groups satisfied the following conditions:

-- He/She was a student of IX Std.
-- He/She took the teacher-made test based on social-studies for Std. VIII.
-- He/She was not taught the content of reading material included in the treatment.
-- He/She took the intelligence test.
-- He/She took the reading ability test.

5.9 THE TIME ALLOWANCE FOR READING THE TEXTUAL MATERIAL AND ANSWERING THE TEST:

As a pre-requisite to start, the final phase of experimentation, it was necessary to determine the amount of time to be given to subjects for reading the textual material chapterwise and answering the test based on each chapter. A division of Std. IX that consisted of 50 boys and girls was selected from the local school for the purpose of determining the time allowance. The students were given the following instructions:

-- "With the signal, start reading."
-- You have to start reading the first chapter.
-- "As soon as you finish reading it, raise your hand."
-- They were instructed to start reading only after a fixed signal. They were also instructed to raise their hands as soon as they finished reading the material of the concerned chapter.

The investigator noted down the time taken by each student for reading the chapter. The time taken by 45th student was noted. The criterion of 90% was selected for the purpose of reading the textual material.
Similarly, the re-written material was also given to read and the time taken by the 45th student was noted. From this data the average time of reading chapter was calculated. This procedure was followed for other two chapters too. Thus the time to be given to read each chapter was determined. Now, the next task was to determine the time to be allowed for answering the questions based on each chapter.

The time limit for answering the three sub-tests of reading comprehension was also determined in the same way. The only thing that differed was the criterion of 90% was changed to 75%. Accordingly, the time required by the 37th student for completing the test was taken as the time limit for answering the test. This was done by following suggestion made by Lindquist who observes "In general achievement tests, the time allowance should be so adjusted that at least 75% of the pupils will have time to consider all items in each section." Following this criteria, the time limits for answering the three sub-tests were determined. The table No. 5.5 shows the time to be given to students to read the chapter and to answer the test based on it.

---

TABLE 5.5
TIMINGS FOR CHAPTERS READING AND ANSWERING THE TEST

<table>
<thead>
<tr>
<th>Chapter No.</th>
<th>Time taken for Reading in mts.</th>
<th>Av. time in mts.</th>
<th>Time taken for answering the test in mts.</th>
<th>Total time required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original Material</td>
<td>Re-written material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>22</td>
<td>23.5</td>
<td>13</td>
</tr>
<tr>
<td>9</td>
<td>28</td>
<td>25</td>
<td>26.5</td>
<td>15</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>18</td>
<td>19</td>
<td>14</td>
</tr>
</tbody>
</table>

5.10 EXECUTION OF THE EXPERIMENT:

The investigator carried out the experiment on students of experimental and control groups in the month of August and September, 1989. The experiment was carried out with the help of the teachers of social studies in the Std. IX in concerned schools. The conduction of the experiment had the following visible features:

(i) The treatment was given to both groups.
(ii) Administration of the test at the end of each treatment.
(iii) Observations were made during the conduct of experiment.
5.11 TREATMENT GIVEN TO GROUPS:

**Control group:**

This group was given to read the original textual material having high level of readability. The original material consisted of chapters No. 5, 9 and 18 of the Social Studies text book meant for Std. IX.

The subjects were asked to read only one chapter a day to avoid boredom, fatigue and disinterestedness. The reading was closely followed by the administration of the sub-test based on that chapter. This process was continued for three continuous days. The pupils were allowed the stipulated time set for reading the material and answering the test based on the same chapter. The time limit was strictly observed.

**Experimental Group:**

The experimental group was given to read the re-written textual material in social studies having low level of readability. This material also had the same content as that of original textual material given to the control group.
The subjects were given to read only one chapter a day and the test was administered soon after the reading was over.

The stipulated time for reading the material and answering the test was allowed and the time limit was strictly observed. Data, thus collected were analysed and subjected to statistical treatment.