CHAPTER V

THE EXPERIMENTAL DESIGN

"The greatest invention of the nineteenth century was the invention of the method of invention."

- A. N. Whitehead

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In the previous chapter, the planning for determining the impediments, selection of the readability formula, the test of its reliability and validity together with the steps of construction of the test for measuring reading comprehension in Science have been described in detail. In this second part, that is, the second phase of the investigation, the planning has been dealt with in detail. It is mentioned earlier in this report that the second phase of the present investigation is by and large an experimental study. Therefore, to prepare a well conceived design of an experiment, the investigator first aimed at formulating the hypotheses. This is done keeping in view the objectives and the questions arising therefrom. This served as the prerequisite to the formulation of hypotheses.

3.1 Prerequisite to the Formulation of Hypotheses:

The following questions have been raised to serve as prerequisite to the formulation of hypotheses:

1. What happens to the scores of comprehension test in science when pupils having low reading ability read the textual material which is rewritten to a low level of readability?
ii. What happens to the scores of Comprehension test in science when pupils having high reading ability read the textual material which is rewritten to a low level of readability?

iii. What happens to the scores of Comprehension test in science when pupils having low I.Q. read the textual material which is rewritten to a low level of readability?

iv. What happens to the scores of Comprehension test in science when pupils having high I.Q. read the textual material which is rewritten to a low level of readability?

The answers to the above questions served as prerequisite to the formulation of hypotheses for the present work.

5.2 Formulation of Hypotheses:

A sound research must make the use of carefully formulated hypotheses. No scientific undertaking can proceed effecting without well-conceived hypotheses. Without hypotheses, the research is unfocused, haphazard, and accidental.1

So it was decided to formulate the following operational forms of hypotheses for the present investigation which could be tested statistically:

1. The eighth-grade pupils falling in the first quartile \((Q_1)\) of the distribution scores of the Reading Ability Test (RAT) would score significantly higher on test of comprehension in science after reading rewritten science textual material of low readability than those pupils falling in the same quartile of the distribution scores of the RAT who would read original science textual material of high readability.

ii. The eighth-grade pupils falling in the upper quartile \((Q_3)\) of the distribution scores of the RAT would score significantly higher on test of comprehension in science after reading rewritten science textual material of low readability than those pupils falling in the same quartile of the distribution scores of the RAT who would read original science textual material of high readability.

iii. The eighth-grade pupils falling in the first quartile \((Q_1)\) of I.Q. distribution would score significantly higher on test of comprehension in science after reading rewritten science textual material of low readability than those pupils falling in the same quartile of the I.Q. distribution who would read original science textual material of high readability.
iv. The eighth-grade pupils falling in the upper quartile ($Q_3$) of the I.Q. distribution would score significantly higher on test of comprehension in science after reading rewritten science textual material of low readability than those pupils falling in the same quartile of the I.Q. distribution who would read original science textual material of high readability.

The hypotheses thus formulated have guided the investigator in selecting an appropriate method of experiment. For this, the present researcher had to go through different methods of experimentation. In the field of education the following three methods are most widely used by the educational researchers:

1. One-group method.
2. Parallel or Equivalent Group method.
3. Rotational Group method.

Out of these three methods, the second method, that is, Equivalent Group method is widely used because it is through this method that certain variables are controlled rigorously. Before describing the actual steps of the method it would be in the fitness of things to consider the basic requirements of the experiment.

5.3 Basic Requirements of the Experiment:

In order to test the hypotheses formulated earlier, the following requirements are essential:
1. Sample af the population.
2. An appropriate experimental design.
3. Original science textual material of high readability and rewritten science textual material of low readability.
4. A reliable test of reading comprehension in science based on the reading materials included under (iii)
5. Reading Ability Test Scores of the sample.
6. I.Q. scores of non-verbal intelligence test of the sample.
7. The teacher-made test in science based on the science syllabus of Std. VII.

Except requirements No. (i) and (ii) the other requirements have already been described in the previous chapter. The first two requirements are being described in the following paragraphs.

5.4 Sample of Schools:

It was decided to select schools in such a way that representative sample of pupils studying in Std. VIII of secondary schools could be procured for the purpose. It is impossible to arrive at reliable, valid and relevant conclusions without representative sample. So it was decided to have a representative sample for the study, the purpose of
which was to investigate the relationship between the two levels of readability of science textual materials and their effect on the comprehension scores of the pupils of Std. VIII in schools of Keira District only. Therefore ten schools in Keira District were selected keeping in view the following criteria:

1. The strength of the school.
2. The area in which it is located - whether rural, urban etc.
3. Type of school- whether boys', girls' or mixed school.

Ten schools were selected from Keira District in such a way that five pairs could be matched keeping in view the above criteria. The students studying these schools could be considered as representative sample as well as randomised sample because it was found from the oral talk with the principals that the pupils are generally admitted in the schools on the 'first come first served' basis. There is no selection of pupils to be admitted in the school. This condition prevails almost everywhere in the schools of Keira District. At the same time there are also no definite criteria for the formation of divisions of the Std. VIII. Therefore it could be said that the pupils are generally allotted to different divisions of the class at random. Hence it is said that there is natural randomisation of students in the group itself.
Besides this, the sample is also treated as representative of total population because of the fact that the primary and the secondary education in the State of Gujarat is free, so practically the children of all the strata of the society attend the school. The eighth standard being the first year of the secondary stage, the guardians of the lower strata of the society are also tempted to send their children to the school as a token of status. Under such circumstances the pupils of Std. VIII belong to different castes and sub-castes of all religions, of all income-groups and of both the sexes of varying abilities. From this discussion it becomes evident that the sample is quite representative and members of the groups called 'subjects' are randomly assigned to divisions of the Std. VIII.

Looking to this, it was presumed that the sample taken represented, in all respects, the population of eighth-grade pupils of the schools in Kaira District.

5.5 Formation of Equivalent Groups:

In order to test the four hypotheses of the research, an experimental method of 'Equivalent-group' was contemplated. For the formation of equivalent-groups, initially 969 pupils of 18 classes of 10 schools were tested by administering teacher-made test in science covering the teaching points of science syllabus of Std. VII. The teacher-made test in science for Std. VII is given in Appendix C. On the basis of the scores of this test, the classes were matched for
mean and SD of the groups. 14 out of 18 classes could be matched. The rest were discarded as the 't' test showed significant differences between the means of the classes. These 14 classes were divided into seven pairs of equivalent groups. In each pair of equivalent groups, one group was treated as the control group while the other as the experimental group. In all there were seven control groups and seven experimental groups. So there were seven replications of the experiment. The following Table No. 5.I shows the mean scores and S.D. of control and experimental groups with their respective critical ratio; the experimental groups in the table are shown with *.

contd...
TABLE 5.1

No. of pupils, Mean scores, S.D. and C.R. of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Replication No.</th>
<th>No. of pupils</th>
<th>Mean</th>
<th>S.D.</th>
<th>C.R.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>57*</td>
<td>12.74</td>
<td>4.62</td>
<td>0.25</td>
<td>Insignificant at .01 level</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>13.5</td>
<td>4.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>39*</td>
<td>11.84</td>
<td>2.82</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>11.80</td>
<td>3.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>39*</td>
<td>11.24</td>
<td>2.0</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>10.03</td>
<td>2.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>45*</td>
<td>11.12</td>
<td>3.52</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>11.45</td>
<td>2.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>36*</td>
<td>12.89</td>
<td>3.76</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>14.00</td>
<td>3.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>45*</td>
<td>12.12</td>
<td>3.56</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>12.40</td>
<td>3.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>34*</td>
<td>11.62</td>
<td>3.24</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>11.47</td>
<td>3.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole group</td>
<td>293*</td>
<td>12.32</td>
<td>3.57</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>293</td>
<td>11.94</td>
<td>3.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The steps that were followed after the formation of the control and experimental groups are given below:
5.6 **Steps of the Design**

To ascertain whether a low readability material would increase reading comprehension, the investigator would follow the following steps:

1. Test the groups on the dependent variable (score in science) and find the mean pre-test score for the experimental and control groups. \( T_{1E} \) for experimental and \( T_{1C} \) for control.

2. Keep all the conditions identical for the groups except for exposing the experimental subjects with rewritten textual material of low readability and the control subjects with textual material of high readability. (Independent variables)

3. Test the groups on dependent variable and find the mean post-test scores for each replication. \( T_{2E} \) and \( T_{2C} \)

4. Find the mean difference between \( T_{1E} \) and \( T_{2E} \) for each replication. \( D_{E} \) and \( D_{C} \)

5. Compare \( D_{E} \) and \( D_{C} \) to determine whether the application of \( X \) caused a significant change in the experimental group's score as compared with the control group's scores.

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vi. Apply an appropriate statistical procedure to ascertain whether the difference in the scores is sufficiently great to be a real difference, or whether it is only a chance occurrence.

All these steps may be depicted as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Treatment</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R*) Experimental</td>
<td>$T_{1E}$</td>
<td>X</td>
<td>$T_{2E}$</td>
</tr>
<tr>
<td>(R*) Control</td>
<td>$T_{1C}$</td>
<td></td>
<td>$T_{2C}$</td>
</tr>
</tbody>
</table>

* Treatment randomly assigned to groups

Experimental Group $T_{2E} - T_{1E} = D_E$

Control Group $T_{2C} - T_{1C} = D_C$

The investigator followed the above steps with all possible precautions and exactness required for conducting the experiment. With this fundamental concept of the design in mind, the study proceeded to test the hypotheses mentioned elsewhere in this chapter.

5.7 Naming the Groups:

Besides this, in the present experimental design, there were two types of treatment using original textual material and rewritten textual material—that were given to the pair of equivalent groups. Basically both the groups received either of the two types of treatment. Therefore, theoretically,
the control group was conspicuous by its absence in the present experimental design. But as the original science textual material was considered as the traditional reading material, the group reading that material was treated as control group. With this explanation, the ensuing pages of the thesis would use henceforth the "control group" in the above sense. The class reading rewritten textual material was called the "experimental group".

The two classes of the equivalent-groups had been assigned treatments randomly. This act of randomization was necessary to insure against the chance error that might creep in the experiment.

5.8 Requirements to be Fulfilled by the Members of the Groups

Before starting the experiment, the investigator made sure that the subjects (pupils) of both the groups satisfied the following requirements:

1. that each pupil belonged to the eighth-class,
2. that he/she took the reading test,
3. that he/she took the intelligence test,
4. that he/she had taken the initial teacher-made test in science for Std. VII,
5. that he/she was not taught in the class the contents of the reading material included in the treatments.
5.9 Time Allowance to Read and Answer the Test

In order to decide the time to be given to read each chapter and to answer the test based on it, one of the divisions of Std. VIII class was selected from the local school. It was a class of 40 students including boys and girls. The students were given the following instruction:

"With the signal 'Start Reading', you have to start reading the first chapter. As soon as you finish reading it, raise your hand."

The investigator noted down the time taken by each student to read the particular chapter. From this data, the time taken by the 30th student to read the chapter was taken as the time to be given to read that chapter. In the same way, the rewritten textual version of the same chapter was given to read and the time taken by the 30th student to read the chapter was noted down. From these data the average time needed to finish reading the chapter was extracted. Similar average timings for the other two chapters were also determined following the above procedure.

In the above procedure, the criterion of 75th per cent was selected from the suggestion made by Lindquist who observes that "in general achievement tests, the time allowance should be so adjusted that at least 75 per cent of the pupils will have time at least to consider all items in each section." 3

In the same way the time-limit for answering the three tests of comprehension was also determined. Accordingly, the following time limits for reading the chapters and answering the respective tests on the chapters were obtained:

**TABLE 5.II**

<table>
<thead>
<tr>
<th>Chapter No.</th>
<th>Reading time in minutes for Original material</th>
<th>Rewritten material</th>
<th>Average for 2 and 3 in minutes</th>
<th>Time taken in minutes for answering the test</th>
<th>Total minutes required</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>27</td>
<td>21</td>
<td>24</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>17</td>
<td>33</td>
<td>27</td>
<td>31</td>
<td>12</td>
<td>43</td>
</tr>
<tr>
<td>23</td>
<td>38</td>
<td>30</td>
<td>34</td>
<td>18</td>
<td>52</td>
</tr>
</tbody>
</table>

Thus, the average time fixed for reading each chapter was allowed to experimental and control groups. In the same way, the fixed time for answering the test was allowed for each test to both the groups.

### 5.10 Conduct of the Experiment:

In the month of August, 1973 the investigator carried out the experiment on the students of the control as well as experimental groups with the help of the teachers in charge of teaching science in Std. VIII of that particular school.
The conduct of the experiment consists of three main things, namely,

1. the treatment given to the groups,
2. administering the test at the end of each treatment, and
3. observation made during the period of experiment.

5.11 Treatments Given to Groups

The students of the control groups were given the original textual material in science, that is, the material having high readability. The original reading textual material is selected from the three branches of science, namely, reading material in Physics (Density), reading material in Chemistry (Water) and the reading material in Biology (Nutritional Parasitism). Each of these materials was not given to students to read on the same day because it would be psychologically unsound and at the same time it would also be taxing. This situation is likely to create aversion to reading. In order to avoid this situation the investigator decided to make them read only one chapter on a particular day. The reading of the chapter was closely followed by the test on that chapter. The stipulated time was given to read each chapter and to answer the questions of the test. Usually the third and the fourth period were utilised for this purpose. Thus three days were sufficient to give treatment to each group.
In the same way, the students of the experimental groups were given the rewritten materials of the same chapters, that is, materials having low readability. In this case also the pupils were made to read only one chapter on a particular day and it was followed by a test based on that particular chapter. The same time limits for reading the material and answering the test were observed for these groups also. Thus the time factor was strictly controlled.

The third and the fourth period were utilized with a view to controlling the factors like freshness of the mind and the room-temperature. In mid-September 1975, the investigator finished the experiment and collection of data obtained from the treatments given to experimental and control groups.