CHAPTER VI

ANALYSIS AND INTERPRETATION OF DATA

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6.7.3. Third order Interaction effect

Study-15: Interaction effect of Treatment, I.Q., Sex and Reading Ability V/s Reading Comprehension
6.1 Introduction:

The necessary data about the experimental and control groups for testing the hypotheses formulated in the beginning of the study were collected with the help of the reliable and valid tools. The procedure of collecting the data and the treatment given to both the groups, are described in detail in the foregoing chapter. Now the crux of the present research lies in the accurate and complete analysis of the data as well as in subjecting them to appropriate statistical treatment, so that dependable conclusions could be drawn by verifying the hypotheses. Therefore, data were subjected to statistical treatment, keeping in view, the hypotheses mentioned elsewhere in this report.

Before proceeding further, it would be opportuned to mention that when pre-test was conducted for the purpose of matching the groups, the number of subjects in the experimental group was 286 and in the control group, it was 290. But when post-test was administered, the number of subjects was equal for all the 16 cells according to $2 \times 2 \times 2 \times 2 (2^4)$ factorial
design. Keeping in mind the four independent variables the number of subjects was (10) ten in each cell. So out of 576 subjects only 160 subjects were selected randomly for the study.

6.2 Structural Model:

Keeping in view the various hypotheses formulated in Chapter V, there were mainly four independent variables under the study. The independent variables incorporated are:

(A) Treatment - Two levels
   (1) Low readability material (Experimental)
   (2) Text book material (Control)

(B) Sex : Two levels
   (1) Boys
   (2) Girls

(C) Intelligence: Two levels
   (1) High I.Q.
   (2) Low I.Q.

(D) Students' Reading Ability : Two levels
   (1) Good
   (2) Poor

The dependent variable was the achievement scores obtained by the students on the achievement test prepared by the investigator after administering the low readability
material to the students under study. All due care was taken while preparing the achievement (comprehension) test, administering the test, scoring and constructing the study. As described in earlier chapter, the entire study was done through factorial design.

According to the design and the main as well as the interactive effects what may be observed, a complete structural model for a score in 2 x 2 x 2 x 2 factorial design is postulated as below:

\[ Y = G + A + B + C + D + AB + AC + AD + BC + BD + CD + ABC + ABC + ACD + BCD + ABCD + E \]

Where  
\( Y \) = Dependent Variable Score  
\( G \) = Usual Grand Mean  
\( A \) = Effects due to treatment  
\( B \) = Effects due to sex  
\( C \) = Effects due to Intelligence  
\( D \) = Effects due to students' Reading Ability

The predetermined procedure for the analysis of observed data is briefed in the coming caption.

6.3 Procedure of Analysis:

The analysis of the data was done with the help of all functions calculated in the order given below:

(1) The mean and variance of 2 x 2 x 2 x 2 factorial design were computed.
(2) The test of homogeneity of variance was given prior to ANOVA to the data of factorial design.

(3) The primary ANOVA was done for 15/144 degree of freedom.

(4) Orthogonal contrast matrix was constructed to partition sum of squares for one degree of freedom for the factorial design.

(5) To locate significance among means, Newman-Kaul's sequence Range Test was given to arrive at appropriate means.

6.4 Homogeneity of Variance Test:

According to Ray Meadis the homogeneity of variance must be tested prior to carrying out ANOVA on the observed data:

"When there are three or more samples, it is necessary to test whether all groups were drawn from the population with the same variance."

Despite the fact, that there is an equal number of observations (n = 10) per cell, the investigator was eager to know whether or not the independent variables produced unusual

differences in the variability or response measures on achievement test. The descriptive data together with mean score and variances of the factorial design are computed and shown in the table 6.1.

From the Table: 6.1, the necessary statistics for analysis were briefed and displayed in the Table: 6.2.

The statistics shown in the Table: 6.2 was earlier used for two aspects:

(1) Hartely's $F_{\text{max}}$ test
(2) ANOVA

Hartley's $F_{\text{max}}$ statistics for $2 \times 2 \times 2 \times 2$ factorial design is to be used appropriately on the cell variance.

Thus

$$F_{\text{max}} = \frac{\text{High Variance}}{\text{Lowest Variance}}$$

$$= \frac{60.08}{8.289}$$

$$= 7.248$$

The value of $F_{\text{max}}$ is 7.248 which is less than 10.7 as found from the table $F_{\text{max}}^2$. The observed value is non-significant. Hence it was concluded that the variances between the groups were homogeneous. Therefore, the test of variance paved the way for the ANOVA for the study.

---

**TABLE 6.1**

**SCORES FOR 2 x 2 x 2 x 2 (Treatment x Sex x I.Q. x Reading Ability)**

**FACTORIAL DESIGN**  \( N = 10 \), \( K = 16 \)

<table>
<thead>
<tr>
<th>Treatment ( A )</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex ( B )</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>I.Q. ( C )</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Reading Ability ( D )</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>1111</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td>1211</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>1212</td>
<td>37</td>
<td>38</td>
</tr>
<tr>
<td>1121</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>1122</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>1221</td>
<td>42</td>
<td>39</td>
</tr>
<tr>
<td>1222</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>1112</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>2211</td>
<td>38</td>
<td>36</td>
</tr>
<tr>
<td>2212</td>
<td>42</td>
<td>39</td>
</tr>
</tbody>
</table>

**EX**  
408 365 335 368 372 319 366 290 349 319 304 279 232 226 275 266

**EX²**  
16992 12599 12391 15360 14056 10299 9411 8502 12857 10777 9340 7967 8016 5706 7769 6768

**\( \overline{X} \)**  
40.8 36.6 33.6 36.8 37.2 31.9 30.6 27.0 34.9 31.9 30.2 27.9 27.2 23.6 27.6 25.6

**\( \sigma \)**  
5.512 3.716 4.34 5.636 4.646 2.879 5.293 3.033 5.975 7.75 4.676 4.276 2.96 3.693 4.217 4.63

**Variance**  
### TABLE 6.2

**Sums, Sums of Squares, Means & Variances of a 2 x 3 x 2 x 2 Factorial Design**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Variance</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Mean</td>
<td>34.625</td>
<td>28.726</td>
<td></td>
</tr>
</tbody>
</table>
6.5 **Analysis of Variance:**

The ANOVA model, the primary ANOVA, orthogonal matrix and detailed ANOVA are discussed under this caption and the computed statistics are shown in the tables.

6.5.1. **ANOVA Model:**

The comprehension test score was the dependent variable, while treatment, sex, intelligence and reading ability were the independent variables. Each of the dependent variables was dichotomized into two levels. According to Allen L. Edward,³ "When the levels of factors are not randomly selected, the ANOVA model is referred to as a fixed effect model, when the levels of each factor have been randomly selected from the large population, the ANOVA model is referred to as a random effect model. If the levels of some factors have been randomly selected and those of others have not been the ANOVA model is referred to as a mixed effect model."

In this factorial design, the sex cannot be dichotomized randomly, while the levels of treatment, intelligence and reading ability have been randomly selected. Thus the ANOVA model is a mixed effect model.

Before proceeding with the ANOVA, it would be useful to look into the assumption underlying the ANOVA technique. They are parametric assumptions:

(i) An equal unit scale is assumed for the measurement of the dependent variable.

(ii) Homogeneity of variance is the basic assumption.

Both the assumptions for the ANOVA are satisfied as the scores on comprehension test were continuous and $F_{\text{max}}$ being non-significant. Therefore, the primary ANOVA was carried on to the next caption.

6.5.2. Primary ANOVA:

The total sum of squares (SST), between sum of squares (SSB) and within the sum of squares (SSW) were computed with the help of calculator and were shown in Table: 6.3.

<table>
<thead>
<tr>
<th>Variance</th>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>$\frac{\sum x_i^2 - (\bar{x})^2}{N}$</td>
<td>6801.1</td>
</tr>
<tr>
<td>SSB</td>
<td>$\frac{\sum x_i^2}{n_k} - (\frac{\sum x_i^2}{N})$</td>
<td>3349.1</td>
</tr>
<tr>
<td>SSW</td>
<td>SST - SSB</td>
<td>3452</td>
</tr>
</tbody>
</table>
The analysis of variance resulted into participating of the total sum of squares and the degree of freedom into two parts. One part was associated with the differences among 16 groups and means and was based on \( K - 1 = 15 \) degree of freedom. The other part was associated with the variation within each of the 16 groups, and had \( k = (n - 1) = 144 \) degree of freedom. This analysis is shown in table: 6.4.

**TABLE: 6.4**

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean sum of squares</th>
<th>F</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between the groups SSB</td>
<td>3349.1</td>
<td>15</td>
<td>223.273</td>
<td>9.3139</td>
<td>Significant</td>
</tr>
<tr>
<td>Within the groups SSW</td>
<td>3452</td>
<td>144</td>
<td>23.972</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6801.1</td>
<td>159</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table No. 6.4, the F was found to be significant for \( 15/144 \) degree of freedom at df. Hence it was concluded that the group-means differed significantly.

**6.5.3. Orthogonal Matrix for ANOVA:**

Since this was a 2 x 2 x 2 x 2 factorial design, it was decided to use orthogonal matrix for ANOVA. This method is not only simplified the calculations of \( f \) value for one df but helped also in finding the main effects and the interaction effects in a direct way. The method is briefly described below.
**TABLE 6.5**

**ORTHOGONAL MATRIX FOR PARTITION OF SUM OF SQUARES**

| CELL | 1111 | 2111 | 1211 | 1212 | 1221 | 1112 | 1122 | 1121 | 2122 | 2221 | 2212 | 2112 | TSS | Df | EDf | Mss | F   |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|-----|-----|
| EX   | 408  | 369  | 368  | 372  | 319  | 305  | 349  | 319  | 302  | 279  | 282  | 236  | 275  | 266  |     |     |     |     |

**MAIN EFFECT**

|      | A    | B    | C    | D    | A*B  | A*C  | A*D  | B*C  | B*D  | C*D  |      |     |     |     |     |     |     |     |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |

**FIRST ORDER INTERACT**

|      | A*B  | A*C  | A*D  | B*C  | B*D  | C*D  |      |     |     |     |     |     |     |     |     |     |     |
|------|------|------|------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|      | 1    | -1   | -1   | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |
|      | 1    | -1   | -1   | -1   | -1   | -1   | 1    | 1    | 1    | 1    | 1    | 1    |       |     |     |     |     |

**SECOND ORDER INTERACT**

|      | A*B*C | A*B*D | A*C*D | B*C*D |      |     |     |     |     |     |     |     |     |     |     |     |     |     |
|------|-------|-------|-------|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|      | 1     | -1    | -1    | -1    | -1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1    |     |     |     |     |
|      | 1     | -1    | -1    | -1    | -1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1    |     |     |     |     |
|      | 1     | -1    | -1    | -1    | -1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1    |     |     |     |     |
|      | 1     | -1    | -1    | -1    | -1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1    |     |     |     |     |

**THIRD ORDER INTERACT**

|      | A*B*C*D |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|------|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|      | -1      | -1   | -1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1    |     |     |     |     |
|      | 1       | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   |     |     |     |     |
|      | 1       | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   |     |     |     |     |
|      | 1       | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   | -1   |     |     |     |     |

F.05 = 3.91 ** significant at 0.01 level
F.01 = 6.61 *= significant at 0.05 level
NS = Non - significant
The set of orthogonal contrast forms the basis for a complete partitioning of the treatment sum of squares from the analysis of variance. This is the most salient feature of this method. For samples of equal size, the following conditions define a set of orthogonal contrasts.

1. The sum of contrast-coefficients for each contrast must be zero.

2. The sum of the products of any two sets of co-efficients must be zero.

For a set of a n sample means, a set of \((n - 1)\) orthogonal contrasts consume the available degrees of freedom in the set of sample of means. Different sets of orthogonal contrasts can be built upon the same set of sample of means. The number of orthogonal contrasts depends upon the nature of research design, and the interest of investigator. Each set will absorb \((n - 1)\) degree of freedom and will completely partition the treatment of sum of squares. In this design the number of cells is \(2^4 = 16\). There will be \(16 - 1 = 15\) orthogonal contrasts. The orthogonal matrix for the \(2^4\) factorial design is shown in table: 6.5.

For each source, the mean square difference \(\text{MSD}_i\) was computed by the following formula:

\[
\text{MSD}_i = \frac{(\bar{E}_i \overline{D}_i)^2}{n \left(\overline{E}_i^2\right)}
\]
Hence, the F value was computed for each source by the following formula:

\[ F = \frac{\text{MSDi}}{\text{Error variance}} \]

Both the statistics are given in table 6.6.

**TABLE: 6.6**

ANOVA SUMMARY FOR ONE DEGREE OF FREEDOM (2 x 2 x 2 x 2)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MSS</th>
<th>F</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1392.4</td>
<td>1392.4</td>
<td>58.08</td>
<td>** S</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>990.02</td>
<td>990.02</td>
<td>41.299</td>
<td>** S</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>270.4</td>
<td>270.4</td>
<td>11.279</td>
<td>** S</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>324.9</td>
<td>324.9</td>
<td>13.553</td>
<td>** S</td>
</tr>
<tr>
<td>A x B</td>
<td>1</td>
<td>0.025</td>
<td>0.025</td>
<td>0.0010</td>
<td>NS</td>
</tr>
<tr>
<td>A x C</td>
<td>1</td>
<td>22.5</td>
<td>22.5</td>
<td>0.9385</td>
<td>NS</td>
</tr>
<tr>
<td>A x D</td>
<td>1</td>
<td>0.40</td>
<td>0.40</td>
<td>0.0166</td>
<td>NS</td>
</tr>
<tr>
<td>B x C</td>
<td>1</td>
<td>11.025</td>
<td>11.025</td>
<td>0.4599</td>
<td>NS</td>
</tr>
<tr>
<td>B x D</td>
<td>1</td>
<td>9.025</td>
<td>0.025</td>
<td>0.3764</td>
<td>NS</td>
</tr>
<tr>
<td>C x D</td>
<td>1</td>
<td>122.5</td>
<td>122.5</td>
<td>5.11</td>
<td>* S</td>
</tr>
<tr>
<td>A x B x C</td>
<td>1</td>
<td>156.025</td>
<td>156.025</td>
<td>6.5086</td>
<td>* S</td>
</tr>
<tr>
<td>A x B x D</td>
<td>1</td>
<td>1.225</td>
<td>1.225</td>
<td>0.051</td>
<td>NS</td>
</tr>
<tr>
<td>A x C x D</td>
<td>1</td>
<td>32.4</td>
<td>32.4</td>
<td>1.3618</td>
<td>NS</td>
</tr>
<tr>
<td>B x C x D</td>
<td>1</td>
<td>0.625</td>
<td>0.625</td>
<td>0.025</td>
<td>NS</td>
</tr>
<tr>
<td>A x B x C x D</td>
<td>1</td>
<td>15.625</td>
<td>15.625</td>
<td>0.6518</td>
<td>NS</td>
</tr>
<tr>
<td>Error</td>
<td>144</td>
<td>3349.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ F_{.05} = 3.91 \quad ** = \text{Significant at 0.01 level} \]
\[ F_{.01} = 6.81 \quad * = \text{Significant at 0.05 level} \]

NS = Non-significant
The means for the two levels of each main variable were calculated on the basis of the data of Table: 6.1. They are given in the table: 6.7.

TABLE: 6.7
MEANS FOR TWO LEVELS OF MAIN VARIABLES

<table>
<thead>
<tr>
<th>Source</th>
<th>Variables</th>
<th>Levels</th>
<th>Means</th>
<th>Mean Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Treatment</td>
<td>$A_1$</td>
<td>34.652</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$A_2$</td>
<td>28.725</td>
<td>5.9</td>
</tr>
<tr>
<td>B</td>
<td>Sex</td>
<td>$B_1$</td>
<td>34.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$B_2$</td>
<td>29.18</td>
<td>4.92</td>
</tr>
<tr>
<td>C</td>
<td>Intelligence</td>
<td>$C_1$</td>
<td>32.91</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$C_2$</td>
<td>30.37</td>
<td>2.54</td>
</tr>
<tr>
<td>D</td>
<td>Reading Ability</td>
<td>$D_1$</td>
<td>33.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$D_2$</td>
<td>30.27</td>
<td>2.74</td>
</tr>
</tbody>
</table>

After analysing the data, the next step would be the testing of various hypotheses enumerated in the fifth chapter in two parts.

(i) Main effects
(ii) Interaction effects
6.6 Testing of Hypotheses: Main effects:

The hypotheses of the main effects, namely, treatment, sex, intelligence and reading ability were tested one by one.

Study - 1: Treatment V/s Reading Comprehension:

In order to know the effectiveness of the low readability material on the reading comprehension of the students of Class IX, the following hypothesis in substantive form was formulated and put to F test.

\[ H_{A1} : \text{There is a significant difference between the mean scores, on reading comprehension test in social studies of the Experimental group and control group.} \]

From the table 6.5, the observed value for treatment was found to be 58.08. This is greater than the table value 6.81 at .01 level of significance. Hence the hypothesis in directive form is accepted.

From the table 6.6, it can be seen that \( H_{A1} \) is 34.625 and \( M_{A2} \) is 28.725. Here \( M_{A1} < M_{A2} \). Therefore, it is concluded that the students of experimental group (to whom the low readability material was provided) shows better comprehension than those of control group (to whom the low
| EXP. Treatment | cont. Treatment v/s Reading comprehension |
readability material was not provided). In brief, the low readability material has improved the reading comprehension ability of the students. This is also revealed in Graph No.1.

Study - 2: Sex V/s Reading Comprehension:

To study the effect of sex on students reading comprehension ability, the following hypothesis was framed.

\[ H_{02} : \text{There is no significant difference between the reading comprehension of boys and girls.} \]

From table 6.5, it is seen that the value of F for sex is 41.299 which is greater than the required table value 6.81 at .01 level. Therefore the null hypothesis is rejected. There could be two alternative hypotheses.

(i) \[ M_{B1} > M_{B2} \]

(ii) \[ M_{B1} < M_{B2} \]

According to table 6.6, the means for sex are \[ M_{B1} = 34.1 \text{ and } M_{B2} = 29.18. \] Hence \[ M_{B1} > M_{B2}. \]

It is concluded that the reading comprehension of boys is increased more than that of girls by the low readability material in social studies.

This is also revealed in Graph No. 2.
To study the effect of intelligence on reading comprehension of students, the following null hypothesis was built up:

\( H_{03} : \) There is no significant difference between the mean scores, on reading comprehension test of low I.Q. group and high I.Q. group.

From table 6.5, it is observed that the F value for intelligence is 11.279. This observed value is greater than the table value 6.81 at 0.01 level. Hence the null hypothesis was rejected. Now there could be two alternative hypotheses:

(i) \( M_{C1} > M_{C2} \)

(ii) \( M_{C1} < M_{C2} \)

Hence it is concluded that the reading comprehension of high I.Q. group is comparatively better than that of low I.Q. group. In short, the intelligence plays an important role in the achievement of reading comprehension.

This is also revealed in Graph No. 3.
Study - 4: *Reading Ability V/s Reading Comprehension:*

In order to know the effect of Reading Ability of the students on their reading comprehension, the following null hypothesis was made and put to F test:

\[ H_{04} : \text{There is no significant difference between the mean scores, on reading comprehension test of Good and Poor readers.} \]

It is observed, from the table 6.5 that the F value for variable reading ability is 13.533, which is significant at 0.01 level. Hence the null hypothesis was not accepted and so there could be two alternative hypotheses:

(i) \( M_{D1} > M_{D2} \)

(ii) \( M_{D1} < M_{D2} \)

From the table: 6.6, the means for reading ability are \( M_{D1} = 33.01 \) and \( M_{D2} = 30.27 \). Hence \( M_{D1} > M_{D2} \).

It is concluded that the reading comprehension of good readers is better than that of poor readers.

This is also revealed in the Graph No. 4.
6.7 Testing Hypotheses: Interactive Effect:

The statistical data contained in ANOVA summary (Table: 6.5) enables the investigator to test the interaction effects of the treatment (A), Sex (B), Intelligence (C) and Reading Ability (D).

6.7.1. First Order Interaction Effects:

In this section the first order interaction effects of factors viz., AB, AC, AD, BC, BD, CD are studied.

Study - 5: Interaction of Treatment and Sex V/s Reading Comprehension:

To test the interaction effect of A and B, the following hypothesis was framed and put to F test.

\[ H_{05} : \text{There is no significant effect of the interaction of treatment and sex on the reading comprehension.} \]

From table 6.5, it is seen that the value of F for interaction AB is 0.001, which is negligible, so the null hypothesis is accepted. Hence it is concluded that the effect of interaction of treatment and sex is not significant.

This result is perceived in the Graph No. 5.
Study - 6: Interaction of Treatment and Intelligence

V/s Reading Comprehension:

To test whether there exists an interaction effect of A and C, the following hypothesis was put to F test.

\[ H_{06} : \text{There is no significant effect of the interaction of treatment and Intelligence on the reading comprehension.} \]

From the table 6.5, it is found that the F value for interaction AC is 0.9385, which is less than the table value 3.91. So the null hypothesis is accepted. Hence it is concluded that there is no significant interaction effect of treatment and intelligence on the Reading Comprehension of the students.

In the interaction AC Graph No. 6, two lines are not intersecting. Hence no interaction. Result is perceived in it.

Study - 7: Interaction of Treatment and Reading Ability

V/s Reading Comprehension:

To test this interaction (AD) effect, the following hypothesis was put to F test.

\[ H_{07} : \text{There is no significant effect of the interaction of treatment and Reading Ability on reading comprehension.} \]
Graph 6

Treatment

Interaction of treatment and Intelligence
V/S Reading Comprehension
<table>
<thead>
<tr>
<th>EXP</th>
<th>CONT</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Interaction of Treatment and Reading Ability</td>
<td>vs Reading Comprehension</td>
</tr>
</tbody>
</table>

The table indicates a comparison between experimental and control groups in the context of treatment interaction with reading ability and comprehension.
It is seen from the table 6.5 that the F value for interaction AD is 0.0166 which is negligible. So the null hypothesis is accepted. Hence it is concluded that there is no significant effect of interaction treatment (A) and Reading Ability (D) on the reading comprehension.

In the interaction AD Graph No. 7, the lines D_1 and D_2 seem quite near to be parallel. This graph reveals the result of interaction AD effect to be non-significant on reading comprehension.

Study - 8: Interaction of Sex and Intelligence V/s Reading Comprehension:

To investigate the interaction of sex and intelligence, the following hypothesis was put to F - Test.

H_{08} : There is no significant effect of the interaction of sex and I.Q. on the reading comprehension.

From table 6.5, it is observed that the F value for the interaction BC is 0.4549 which is less than the table value 3.91 at .05. Hence it is said that there is no significant interaction effect of sex and intelligence on reading comprehension.

This situation is represented in Graph No. 8 by taking the levels of B on X axis and reading comprehension.
Study - 9: Interaction of Sex and Reading Ability V/s Reading Comprehension:

To study the interaction effect of sex (B) and Reading Ability (D), the following hypothesis was put to F test:

\[ H_{09} : \text{There is no significant effect of the interaction of sex and Reading Ability on the reading comprehension.} \]

From the table 6.5, it is seen that the F value for the interaction BD is 0.3764, which is lesser than the table value 3.91 at .05 level. Hence the null hypothesis is accepted and it is concluded that there is no significant interaction effect of sex and Reading Ability on reading comprehension.

This result is also reflected in Graph No. 9 by taking two levels of B on X axis. The lines \( D_1 \) and \( D_2 \) are nearly parallel. Thus the result of BD is perceived in this graph.
Graph 9

Interaction of Sex and Reading Ability

Sex

Boys

Girls

Reading Comprehension
To investigate the interaction effect of intelligence and reading ability the following null hypothesis was put to F test.

\[ H_{010} : \text{There is no significant effect of the interaction of I.Q. and Reading ability on the reading Comprehension.} \]

From the table 6.5, it is observed that the F value is 5.1. The observed F value is greater than the table F value 3.91 at \(.05\) level and less than the table F value 6.81 at \(.01\) level. It means that it is significant at \(.05\) level. Hence the null-hypothesis is not accepted.

It is concluded that there is a significant effect of Intelligence and Reading Ability on the Reading comprehension.

This result is reflected in Graph No. 10. The levels of C are shown on the horizontal axis. The line \(D_1\) and \(D_2\) are not parallel, because the difference in slopes is visible indicating significant interaction effect.
6.7.2. **Second Order Interaction Effects:**

In this section, the second order interaction effects of the independent variables on reading comprehension are studied.

**Study - 11: Interaction effect of treatment, sex and I.Q. V/s Reading Comprehension:**

To test the second order interaction effect, the following null hypothesis was framed.

\[ H_{011} : \text{There is no significant effect of the interaction of treatment, sex and I.Q. on the reading comprehension.} \]

From the table 6.5, it is seen that the value is greater than the table value 3.91 at 0.05 level. So this interaction effect on comprehension is significant at .05 level. Hence null hypothesis is rejected, and the alternative hypothesis is accepted. It is concluded that the interaction effect of treatment, sex and I.Q. on reading comprehension is noticed.

**Study - 12: Interaction Effect of treatment, sex and Reading Ability V/s Reading Comprehension**

To investigate this second order interaction, the following null hypothesis was tested.
$H_{012}$ : There is no significant effect of the interaction of treatment, sex and reading ability on the reading comprehension.

From the table 6.5, it is observed that the F value corresponding to ABD is 0.051 which is very negligible. Hence the null-hypothesis is accepted. Therefore, it is concluded that the interaction effect of treatment, sex and reading ability was not observed, eventhough each one individually has a significant effect on the reading comprehension.

Study - 13: Interaction of treatment, I.Q. and Reading Ability V/s Reading Comprehension:

To study this second order interaction, the following null hypothesis was tested.

$H_{013}$ : There is no significant effect of the interaction of treatment, I.Q. and reading ability on the reading comprehension.

From the table 6.5, it is seen that the computed F value corresponding to ACD is 1.36. This value is less than the table F value 3.91 at .05 level. Hence the null hypothesis is not rejected. It is concluded that the interaction effect of treatment, I.Q. and reading ability on the reading comprehension is not significant.
Study - 14: Interaction of sex, I.Q. and reading ability v/s Reading Comprehension:

To investigate this second order interaction, the following null-hypothesis was put to F test.

$H_0^{14}$: There is no significant effect of the interaction of sex, I.Q. and reading ability on the reading comprehension.

From table 6.5, it is observed that the F value for BCD is 0.028. This value is very negligible. It is not significant. Hence the null hypothesis is accepted. It is concluded that the interaction effect of sex, I.Q. and reading ability on the reading comprehension is not found to be significant.

6.7.3. Third Order Interaction Effect:

Study - 15: To study this interaction effect, the following null-hypothesis was put to F test.

$H_0^{15}$: There is no significant effect of the interaction of treatment, sex, I.Q. and reading ability on the reading comprehension.

The computed F value corresponding to ABCD is found to be 0.65 from the table 6.5. This value is smaller than the table value 3.91 at 0.05 level.
Hence the null-hypothesis is accepted. It is concluded that the interaction effect of the independent variables A, B, C, D has no significant effect on the reading comprehension, even though each one of the four variables individually has a significant effect on the reading comprehension.