CHAPTER V

ANALYSIS AND INTERPRETATION OF RESULTS
To evaluate the main effects and interaction effects of the variables of teaching strategy, sex, intelligence and personality, the data were analysed and discussed in this chapter. For analysis of data the technique of Analysis of Variance ($3 \times 2 \times 2 \times 3$) was employed on gain scores. The following assumptions, on which it is based, were tested:

(a) Observations within experimentally homogeneous sets should be from normally distributed population.

(b) The sampling within sets should be random and mutually exclusive.

(c) Within groups the variance should be equal.

(d) The contribution to total variance should be additive.

(e) The relationship between the pre-test and the post-test scores should be linear.

The first assumption that observation within experimentally homogenous sets should be from normally distributed population
was tested through descriptive statistics. The means, S.D's, Median, Skewness and Kurtosis for the sample have been entered in Table 5.1. In order to test the first assumption of analysis of variance, frequency polygons with the help of distributions were drawn. These polygons with the help of distributions were drawn. These polygons were prepared for each of three strategies and one for the whole data. These are shown in Figures 5.1 to 5.4. Graphical representation of achievement test scores showed nearly normal distributions.

<table>
<thead>
<tr>
<th></th>
<th>Achievement Scores</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>S.D.</td>
<td>Skewness</td>
</tr>
<tr>
<td>Whole Group (300)</td>
<td>16.81</td>
<td>16.80</td>
<td>5.82</td>
<td>0.005</td>
</tr>
<tr>
<td>Group I (100)</td>
<td>17.87</td>
<td>18.15</td>
<td>5.30</td>
<td>-0.160</td>
</tr>
<tr>
<td>Group II (100)</td>
<td>15.71</td>
<td>15.88</td>
<td>5.20</td>
<td>-0.098</td>
</tr>
<tr>
<td>Group III (100)</td>
<td>16.55</td>
<td>17.28</td>
<td>6.30</td>
<td>-0.348</td>
</tr>
</tbody>
</table>

The values of skewness of achievement scores can be considered within the limits of normal distribution.

As far as second assumption of assigning random and mutually exclusive cases in each cell of \( (3 \times 2 \times 2 \times 3) \) factorial design of ANOVA is concerned, it was satisfied by randomly assigning students to different treatment groups.
Fig. 5.1 FREQUENCY POLYGON FOR STRATEGY I ON ACHIEVEMENT TEST GAIN SCORES
Fig. 5.2 FREQUENCY POLYGON FOR STRATEGY II ON ACHIEVEMENT TEST GAIN SCORES
Fig. 5.3 FREQUENCY POLYGON FOR STRATEGY III ON ACHIEVEMENT TEST GAIN SCORES
Fig. 5.4 FREQUENCY POLYGON FOR TOTAL DATA ON ACHIEVEMENT TEST GAIN SCORES
The third assumption of homogeneity of variance in the groups was tested with the help of Bartlett's test of homogeneity of variance. The results in terms of $X^2$ for each of the three groups have been entered in Table 5.2.

**TABLE 5.2**

**Computation of Bartlett's Test of Homogeneity of Variance**

<table>
<thead>
<tr>
<th>Group</th>
<th>Sum of Squares</th>
<th>Variance</th>
<th>$\log s^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2829</td>
<td>943.00</td>
<td>2.9745</td>
</tr>
<tr>
<td>2</td>
<td>2785</td>
<td>920.33</td>
<td>2.9675</td>
</tr>
<tr>
<td>3</td>
<td>4034</td>
<td>1344.66</td>
<td>3.1284</td>
</tr>
</tbody>
</table>

\[
\sum s^2 = 3215.99 \quad \sum \log s^2 = 9.0704
\]

Mean Variance = $\frac{s^2}{n} = \frac{3215.99}{3} = 1071.9966 \quad \log s^2 = 3.030$

\[
n \log s^2 = 9.0906
\]

\[
\sum \log s^2 = 9.0704
\]

Difference = 0.0202

\[
X^2 = 2.3026 \times (k-1) \times 0.0202
\]

\[
= 2.3026 \times 99 \times 0.0202
\]

\[
= 4.6047
\]

Table value for 2 df at .01 level of significance is 9.210. Because the calculated value of Chi-square is less than the table value at .01 level of significance therefore it can be inferred that group variances are homogeneous.
Fourth assumption of additivity of variance was taken care of in the process of employing ANOVA.

The fifth assumption that relationship between pre-test and post-test score is linear was tested by Montgomery (1976, p. 372). Significant F-ratio revealed that the relationship between pre-test and post-test scores is linear.

After having the basic five assumptions underlying the analysis of variance satisfied, the calculations of \((3 \times 2 \times 2 \times 3)\) analysis of variance were got computed through IBM computer No. 1620.

Four-way analysis of variance was employed on criterion gain scores by varying independent variables of strategies of teaching in three ways strategy \(A_1\) - Lecture-Discussion, strategy \(A_2\) - Induction-Discussion-Drill and strategy \(A_3\) - Programmed Instruction-Demonstration, sex into two - girls and boys; personality at two levels - introverts and extroverts; and intelligence at three levels namely, low, average and above average, wherever significant F-ratios were obtained further analysis was made by computing significance difference between means of various treatment combinations. The result was employed to locate the specific group differences. The discussion of results of main effects have been done in this chapter. The interaction effects have been discussed in next two chapters. Summary of analysis of variance has been entered in Table 5.3.
### TABLE 5.3
Summary of Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>Ss</th>
<th>MV</th>
<th>F-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies (A)</td>
<td>2</td>
<td>96.333</td>
<td>48.166</td>
<td>1.692</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Sex (B)</td>
<td>1</td>
<td>92.042</td>
<td>92.042</td>
<td>3.233</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Personality (C)</td>
<td>1</td>
<td>9.375</td>
<td>9.375</td>
<td>0.30293</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Intelligence (D)</td>
<td>2</td>
<td>374.520</td>
<td>187.263</td>
<td>6.578</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Strategy and Sex (AXB)</td>
<td>2</td>
<td>127.440</td>
<td>63.721</td>
<td>2.238</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategy and Personality (AXC)</td>
<td>2</td>
<td>47.444</td>
<td>23.722</td>
<td>0.833</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategy and Intelligence (AXD)</td>
<td>4</td>
<td>547.130</td>
<td>136.780</td>
<td>4.805</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Sex and Personality (BXC)</td>
<td>1</td>
<td>17.225</td>
<td>17.225</td>
<td>0.605</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Sex and Intelligence (BXD)</td>
<td>2</td>
<td>193.750</td>
<td>96.875</td>
<td>3.403</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Personality and Intelligence (CXD)</td>
<td>2</td>
<td>48.250</td>
<td>24.125</td>
<td>0.847</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategy x Sex x Personality (AXBxXC)</td>
<td>2</td>
<td>21.370</td>
<td>10.685</td>
<td>0.375</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategy x Sex x Intelligence (AXBxD)</td>
<td>4</td>
<td>52.471</td>
<td>13.117</td>
<td>0.460</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategy x Personality x Intelligence (AXCxD)</td>
<td>4</td>
<td>383.300</td>
<td>95.825</td>
<td>3.366</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Sex x Personality x Intelligence (BxCxD)</td>
<td>2</td>
<td>10.953</td>
<td>5.4765</td>
<td>0.192</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Sex x Personality x Intelligence (AXBxCxD)</td>
<td>4</td>
<td>89.486</td>
<td>22.371</td>
<td>0.785</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>

Error Variance: 180  5123.8  28,465

Total: 215
5.1 DISCUSSION OF RESULTS ON THE BASIS OF ANALYSIS OF VARIANCE:

5.1.1 Main Effect of Strategies of Teaching on Achievement in Mathematics:

F-ratio was found to be insignificant (1.692, df 2/180) even at .05 level of significance (vide Table 5.3). The result showed that there is no significant difference in the achievement of three groups taught by three different strategies of teaching. The small differences in mean achievement of groups may be due to sampling error and not due to differential treatment. Hence, the hypothesis namely that significant differences in mathematics achievement do not arise due to different strategies of teaching stands accepted.

The non-significant differences in mean achievements of three groups taught by three different strategies may be due to the reason that all the three strategies have been well planned keeping in view the objectives of the topic, by selecting appropriate methods, materials and media. The effect of strategies have been found only on the total achievement and if analysis would have been category-wise then the groups might have differed significantly in category-wise achievement.

The findings of the present study is supported by the study made by Yadav, G.L. (1981). He concluded that teaching strategies do not effect significantly the achievement in the subject of Chemistry at high school level.
5.1.2 Effect on Achievement due to Variable of Sex:

F-ratio was found to be insignificant (3.233 df 1/180) (vide Table 5.3). It revealed a non-significant difference in mathematics mean achievement scores with respect to sex. The small differences in mean achievement of groups may be due to sampling error. Hence, the hypotheses namely that sex does not account for the differential achievement in mathematics stands accepted.

The result is supported by the study of Robert, H.R. (1972), which concluded that there was no significant difference in the gain scores of boys and girls. Sex acted as a redundant variable.

5.1.3 Main Effect of Personality on Mathematics Achievement:

Contribution to variance in mathematics achievement due to personality types yielded a non-significant F-ratio ($F = .30293$, df 1/180) (vide Table 5.3).

The result showed that personality types namely extroversion and introversion do not account for differential mathematics achievement. Therefore, the hypotheses that personality do not significantly effect achievement in mathematics stands accepted. The result is supported by the study of Mohan and Kumar (1973), which concluded that the two personality types i.e. extroversion and introversion came out to be nearly equal.
5.1.4  **Main Effect of Intelligence on Achievement in Mathematics**:

F-ratio in respect of variable of intelligence was found to be 6.578 with df 2/180 (vide Table 5.3). It is significant at .01 level. It revealed that groups of differential intelligence differed in mathematics achievement. The hypothesis that intelligence does not account for differential achievement in mathematics stands rejected.


The result implied that students at high, average and low levels of intelligence differ on achievement in mathematics.

5.2  **Significance of Difference Between Mean Scores**:

The difference among mean scores of the groups on mathematics achievement were tested for significance among following groups:

1. High Ability ($D_1$) and Average Ability ($D_2$).
2. High Ability ($D_1$) and Low Ability ($D_3$).
3. Average Ability ($D_2$) and Low Ability ($D_3$).

The results of the significant differences have been entered in Table 5.4.
### TABLE 5A

Table showing the t-ratios

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>S.D.</th>
<th>N</th>
<th>SE</th>
<th>CR</th>
<th>Level of Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Ability</td>
<td>16.47</td>
<td>5.72</td>
<td>72</td>
<td>0.9583</td>
<td>1.982</td>
<td>Sig. at .05</td>
</tr>
<tr>
<td>Average Ability</td>
<td>16.58</td>
<td>5.72</td>
<td>72</td>
<td>0.9583</td>
<td>1.982</td>
<td>Sig. at .05</td>
</tr>
<tr>
<td>High Ability</td>
<td>18.47</td>
<td>5.72</td>
<td>72</td>
<td>0.9338</td>
<td>3.362</td>
<td>Sig. at .01</td>
</tr>
<tr>
<td>Low Ability</td>
<td>15.33</td>
<td>5.42</td>
<td>72</td>
<td>0.9338</td>
<td>3.362</td>
<td>Sig. at .01</td>
</tr>
<tr>
<td>Average Ability</td>
<td>16.58</td>
<td>5.72</td>
<td>72</td>
<td>0.9236</td>
<td>1.346</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Low Ability</td>
<td>15.33</td>
<td>5.42</td>
<td>72</td>
<td>0.9236</td>
<td>1.346</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>

Significant at .01 level = 2.61
Significant at .05 level = 1.98

5.3 INTERPRETATION OF RESULTS:

The t-ratios between the mean achievement of high intelligence, and average intelligence groups was found to be 1.972 which is significant at .05 level of significance. The t-ratio between (D1 and D2) high ability and low ability significant groups was found to be significant at .01 level of significance (t = 3.362).

The increasing trend of mean scores on the achievement test from below average group to above average groups indicated that the factor of intelligence significantly affects mathematics achievement.

It can be inferred that pupils of high intelligence score more than those of average and below average intelligence.

However, the difference in the achievement of average intelligence and below average intelligence groups was found to be statistical non-significant. The result revealed that average and below average groups have nearly equal mean scores.
5.3.1 Interaction Effect Between Strategies of Teaching x Levels of Intelligence (A x D) on Achievement

The F-ratio in case of treatment x levels interaction was found to be significant at .01 level of confidence (vide Table 5.3). The significant F-ratio implied that there is significant interaction among different strategies of teaching and levels of intelligence. Hence, the hypotheses namely that there is no significant interaction between levels of intelligence and strategies of teaching stands rejected.

5.3.2 Interaction Effect Between Strategies of Teaching and Sex (A x B) on Achievement

Interaction variance was found to be insignificant even at .05 level, (F = 2.238). The result revealed that there is no significant interaction for strategies of teaching x sex. The hypothesis that there is no significant interaction between sex and strategies of teaching stands rejected. The result is supported by the studies conducted by Robert, H.R. (1972); Sethi, A.S. (1976); and Shitole, C.B. (1976).

5.3.3 Interaction Effect Between Sex and Intelligence

F-ratio was found to be significant at .01 level of confidence (F = 3.403, vide Table 5.3) for sex x intelligence interaction. The significant interaction revealed that a particular level of intelligence in combination with a particular sex may produce significant difference in mathematics achievement ignoring
strategies of teaching. Therefore, the hypothesis that there is no significant interaction between levels of intelligence and sex stands rejected.

All other first order interactions namely, strategy x Sex, Strategy x Personality, Sex x Personality and Personality x Intelligence were found to be statistically insignificant.

Second order interactions between variables of sex, strategies of teaching, intelligence and personality were found to be insignificant at .05 level, except one interaction, namely between Strategies x Personality x Intelligence. This interaction variance was found to be significant at .01 level of confidence (F = 3.366, df 4/180) (vide Table 5.3). The result implied that there was a real interaction among levels of intelligence, different strategies of teaching and personality types. The hypothesis namely that there were no significant second order interaction among the variables of intelligence, strategies of teaching, sex and personality stands partially accepted.

The only third order interaction among variables of sex, strategies of teaching, intelligence and personality was found to be statistically non-significant. The result revealed that there was no real interaction among different levels of the variables. The hypothesis that there is no significant third order interaction stands accepted.