ANALYSIS AND INTERPRETATION

- Preliminary Analysis
- Effect of Mastery Learning Strategy on Problem Solving Ability
- Effect of Mastery Learning Strategy on the components of Problem Solving Ability
- Main effects and interaction effects of Instructional strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem
- Main effects and interaction effects of Instructional Strategy and Previous Achievement on Clarifying the Problem.
ANALYSIS AND INTERPRETATION

The core purpose of the present study was to determine the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

The focus of the study was to determine the effect of Instructional Strategy (Mastery Learning strategy/Conventional Strategy of Teaching) on Problem Solving Ability in Physics of secondary school students, treating Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. For this ANCOVA was performed for the total sample.

Further analysis was done to test whether the effect of the strategy was significant on the three components of Problem Solving Ability. Three separate ANCOVA were performed for the three components namely, Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem whereas the independent variable, Instructional Strategy and the covariates viz; Nonverbal Intelligence, Verbal Intelligence and Previous Achievement remained the same.

Following these analyses three way ANOVA were performed for those components of Problem Solving Ability in which the effect of strategy showed a significant difference. This was performed to find out the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the relevant component of Problem Solving Ability.
Further analysis of variance was done for testing the main effects and interaction effect of Instructional Strategy and Previous Achievement on those components of Problem Solving Ability for which the effect of Instructional Strategy showed a significant difference.

4.1 PRELIMINARY ANALYSIS

The groups for the study were selected on a random basis. The study groups and the sex groups were tested for homogeneity by Multivariate ANOVA for Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status. The result of the MANOVA is given in Table 4.1.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Wilks’ Lambda</th>
<th>Rao’s R</th>
<th>df 1</th>
<th>df 2</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>0.99</td>
<td>0.07</td>
<td>3</td>
<td>68</td>
<td>0.97</td>
</tr>
<tr>
<td>Sex</td>
<td>0.94</td>
<td>1.28</td>
<td>3</td>
<td>68</td>
<td>0.28</td>
</tr>
<tr>
<td>Instructional Strategy-Sex</td>
<td>0.94</td>
<td>1.34</td>
<td>3</td>
<td>68</td>
<td>0.26</td>
</tr>
</tbody>
</table>

The table 4.1 shows that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not
significant at 0.05 level between the classes. Also it becomes evident that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not significant at 0.05 level between the sex groups. Considering the interaction effect between the class and the sex groups, it can be seen that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not significant at 0.05 level between the sex groups within the classes.

Hence it is concluded that the study groups (Control /Experimental) are homogeneous with respect to Nonverbal Intelligence, Verbal intelligence and Socio-Economic Status. Also the Nonverbal Intelligence, Verbal intelligence and Socio -economic Status scores are homogeneous within the sex group for experimental as well as Control group.

Even though the two study groups were considered to be homogeneous, slight initial differences in cognitive variables viz; Previous Achievement, Nonverbal Intelligence and Verbal intelligence needed to be controlled so as to assess the effect of the Instructional Strategy on Problem Solving Ability and hence the right statistical technique could be Analysis of Covariance by which the effects of the extraneous variables are controlled.

**Basic Assumptions of ANCOVA**

Prior to ANCOVA, the data used for analysis was subjected to a thorough examination with a view to know whether the data is sufficient to satisfy the major assumption suggested by Winer (1977), Ferguson
(1971) and Widt and Ahtola (1978) to carry over the ANCOVA procedure.

1. The scores on the dependent variable are a linear combination of independent components, an over all mean, a treatment effect, a linear covariate effect and an error term.

2. The error is normally and independently distributed with mean zero and variance $\sigma^2E$.

3. The (weighted) sum of all groups of the treatment/group effect is zero.

4. The coefficient of the covariate (slope of the regression line) is the same for each treatment group.

5. The covariate is a fixed mathematical variable measured without error, not a stochastic variable.

Tests for Basic Assumptions

To satisfy the basic assumptions of ANCOVA procedure, the collected data were specifically analysed and examined. For this the Normal probability plots for the dependent variable for each group were tested and the values were found to be normal. Entire computations were done using the software, STATISTICA Version 5.1 (1995).

The various plots for each dependent variable viz; (i) Total score of Problem Solving Ability (ii) Score of the first component of Problem Solving Ability (Comprehending the Problem) (iii) Score of the second component of Problem Solving Ability (Clarifying the Problem) and
(iii) Score of the third component of Problem Solving Ability (Finding Solution to the Problem) are given in Figures 4-1, 4-2, 4-3 and 4-4. Also the variances within the group were checked and were found to be homogeneous with respect to the covariates in the case of each dependent variable.
FIGURE 4-1 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Problem Solving Ability. Group 0 represents the Control group and Group 1 represents the Experimental group.
FIGURE 4-2 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Comprehending the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_1_G stands for the variable, Comprehending the Problem.
FIGURE 4-3 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_2__G stands for the variable, Clarifying the Problem.
FIGURE 4-4  Categorized Normal Plot for Control group and Experimental group for the dependent variable: Finding Solution to the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_3_G stands for the variable, Finding Solution to the Problem.
The categorized plots in the figures given above ascertains that the distribution of the scores of dependent variables viz; (i) Total score of Problem Solving Ability (ii) Score of the first component of Problem Solving Ability (Comprehending the Problem) (iii) Score of the second component of Problem Solving Ability (Clarifying the Problem) and (iii) Score of the third component of Problem Solving Ability (Finding Solution to the Problem) are normal in both Experimental as well as Control groups. Thus it validates the use of ANCOVA upon the sample.

Further to test the homogeneity of variances within the group for Experimental as well as Control groups with respect to the covariates in the case of each dependent variable, the F-max, C and Chi-square values were found out to see whether the variances are homogeneous. The table 4.2 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Comprehending the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.
TABLE 4.2

Homogeneity of Variances of the variables Comprehending the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement

<table>
<thead>
<tr>
<th>Tests of Homogeneity of Variances</th>
<th>Hartley F-max</th>
<th>Cochran C</th>
<th>Bartlett Chi-sqr</th>
<th>df</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehending the Problem</td>
<td>1.14</td>
<td>0.53</td>
<td>0.16</td>
<td>1</td>
<td>0.68</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1.00</td>
<td>0.50</td>
<td>0.0</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1.41</td>
<td>0.58</td>
<td>1.06</td>
<td>1</td>
<td>0.30</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1.04</td>
<td>0.51</td>
<td>0.02</td>
<td>1</td>
<td>0.88</td>
</tr>
</tbody>
</table>

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Comprehending the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The table 4.3 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Clarifying the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.
TABLE 4-3
Homogeneity of Variances of the variables, Clarifying the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hartley F-max</th>
<th>Cochran C</th>
<th>Bartlett Chi-sqr</th>
<th>df</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarifying the Problem</td>
<td>1.58</td>
<td>0.61</td>
<td>1.84</td>
<td>1</td>
<td>0.17</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1.00</td>
<td>0.50</td>
<td>0.0</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1.41</td>
<td>0.58</td>
<td>1.06</td>
<td>1</td>
<td>0.30</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1.04</td>
<td>0.51</td>
<td>0.02</td>
<td>1</td>
<td>0.88</td>
</tr>
</tbody>
</table>

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Clarifying the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The table 4.4 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Finding Solution to the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.
Analysis

TABLE 4.4

Homogeneity of Variances of the variables Finding Solution to the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hartley F-max</th>
<th>Cochran C</th>
<th>Bartlett Chi-sqr</th>
<th>df</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarifying the Problem</td>
<td>1.69</td>
<td>0.62</td>
<td>2.46</td>
<td>1</td>
<td>0.11</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1.00</td>
<td>0.50</td>
<td>0.0</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1.41</td>
<td>0.58</td>
<td>1.06</td>
<td>1</td>
<td>0.30</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1.04</td>
<td>0.51</td>
<td>0.02</td>
<td>1</td>
<td>0.88</td>
</tr>
</tbody>
</table>

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Finding Solution to the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The above plots and the tests of homogeneity validate the sanctity of using ANCOVA in the sample for the study.
4.2. EFFECT OF MASTERY LEARNING STRATEGY ON PROBLEM SOLVING ABILITY

The effect of the Mastery Learning Strategy upon the Problem Solving Ability was tested using ANCOVA with Instructional Strategy as the independent variable and Problem Solving Ability (Total gain score of Problem Solving Ability) as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. Table 4.5 shows the result of the ANCOVA performed for the total sample.

**TABLE 4.5**

Summary of Analysis of Covariance with Instructional Strategy as the independent variable and Problem Solving Ability as the dependent variable treating the cognitive variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>28.46</td>
<td>69</td>
<td>26.57</td>
<td>1.07</td>
<td>0.30</td>
</tr>
</tbody>
</table>

The table 4.5 shows that the F value obtained is 1.07 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.30. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on the total score of Problem Solving Ability is not statistically significant.
FIGURE 4-5 Categorized Plot for Control group and Experimental group for the dependent variable: Problem Solving Ability. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_GAIN stands for the variable, Problem Solving Ability.
The table 4.5 and the figure 4-5 reveal that Mastery Learning Strategy does not affect the total score of Problem Solving Ability. Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Problem Solving of students better than the Conventional Strategy.

**Comment**

This result contradicts the research studies which show that Mastery Learning is highly effective when instruction focuses on high-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression (Arredondo and Block 1990, Mevarech 1985, Soled 1987).

The present study was undertaken in the changed context of the new school curriculum of the state of Kerala, which emphasizes Problem Solving approach in the mode of transaction of the curriculum as well as in the presentation of content in the textbook. Thus Mastery Learning Strategy was studied against the Conventional Strategy based on collaborative learning and problem solving approach. The result of this investigation thus, could either mean that Mastery Learning Strategy is not exceedingly good when compared to the Conventional Strategy presently practised in schools or the Conventional Strategy presently practised in schools is as good as the Mastery Learning Strategy in fostering Problem Solving Ability.

All the same, it is of special interest to monitor the gain in achievement made by the two study groups. Achievement as well as Previous Achievement was measured using the same Achievement test
prepared by the investigator. Whereas the pre test scores served as a measure of Previous Achievement, the gain scores, that is, the difference in the posttest scores and the pretest scores served as the measure of achievement for both the study groups. To compare the mean gain in achievement among the study groups, t-test for small sample size was employed and the result shows that the Experimental group had an advantage in gain scores with mean value 17.74 and standard deviation 5.27 while the Control group had a lower value of gain score with mean value 13.85 and standard deviation of 4.60. The t-value obtained is 3.39 for 72 degrees of freedom. And hence the difference between the mean gain scores is statistically significant even at 0.001 level. The result shows that the effect of Mastery Learning Strategy on achievement is significant.

Thus the proven theory that Mastery Learning Strategy increases achievement is applicable in this study also; but what is strikingly noticeable is that the strategy is not better than the conventional Strategy in effecting an increase in Problem Solving Ability.

Looking at the pre test scores of Achievement as well as Problem Solving Ability, the difference is once again striking. The pre test scores on Achievement were very low signifying the lack of competency over the content portion, yet to be taught. But the pre test scores on Problem Solving Ability showed a healthier distribution suggesting that Problem Solving Ability is more innate rather than trained or taught.

While checking the correlation between the gain scores in achievement and the gain scores of Problem Solving Ability in the total sample, it can be seen that the correlation coefficient is only 0.47. This
reveals that the constructs, Problem solving Ability and Achievement are not highly correlated.

In spite of the result that Mastery Learning Strategy did not increase the total score of Problem Solving Ability, the effect of Mastery Learning Strategy on the individual components of Problem Solving Ability was studied.

4.3 EFFECT OF MASTERY LEARNING STRATEGY ON THE COMPONENTS OF PROBLEM SOLVING ABILITY

This section deals with the tests to check whether there is significant effect of Mastery Learning Strategy upon any of the components of the Problem Solving Ability viz; Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem.

4.3.1 EFFECT OF MASTERY LEARNING STRATEGY ON COMPREHENDING THE PROBLEM

This was tested using ANCOVA with Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) as the independent variable, Problem Solving Ability component No.1 (Total gain score of Problem Solving Ability component No.2 viz; Comprehending the Problem) as the dependent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were treated as covariates. Given below is the result of the ANCOVA performed for the total sample.
TABLE 4.6

Summary of
Analysis of Covariance with
Instructional Strategy as the independent variable
and Comprehending the Problem as the dependent variable
treating the controlled variables namely, Nonverbal Intelligence,
Verbal Intelligence and Previous Achievement as covariates

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>10.77</td>
<td>69</td>
<td>7.16</td>
<td>1.50</td>
<td>0.22</td>
</tr>
</tbody>
</table>

The table 4.6 shows that the F value obtained is 1.50 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.22. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Comprehending the Problem is not statistically significant.
FIGURE 4-6 Categorized Plot for Control group and Experimental group for the dependent variable: Comprehending the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_1_G stands for the variable, Comprehending the Problem.
The table 4.6 and the figure 4-6 reveal that Mastery Learning Strategy does not significantly improve Comprehending the Problem of students than the Conventional Strategy in Physics of Standard IX.

Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Comprehending the Problem of students in Physics of Standard IX better than the Conventional Strategy.

4.3.2 EFFECT OF MASTERY LEARNING STRATEGY ON CLARIFYING THE PROBLEM

To see whether there is an effect of Mastery Learning Strategy upon the second component of the Problem Solving Ability, ANCOVA was used with Instructional Strategy as the dependent variable, Problem Solving Ability component No.2 (Total gain score of Problem Solving Ability component No.2 viz; Clarifying the Problem) as the independent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. Given below is the result of the ANCOVA performed for the total sample.
TABLE 4.7
Summary of Analysis of Covariance with Instructional Strategy as the independent variable and Clarifying the Problem as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>27.64</td>
<td>69</td>
<td>6.15</td>
<td>4.49</td>
<td>0.03</td>
</tr>
</tbody>
</table>

The table 4.7 shows that the F value obtained is 4.49 at 69 degrees of freedom, which acquires statistical significance at a probability level of 0.03. The required value for F to be significant for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98 at 0.05 level and 7.01 at 0.01 level. Considering the F value obtained, it can be ascertained that the value is significant at 0.05 level. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant.

The result shows that the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) on Problem Solving Ability component No.2- Clarifying the Problem is significant. Post hoc comparison was done using t-test to find out the group that had an advantage in gain scores. For this t-test for small sample size was employed and the result is given below.
TABLE 4.8
Summary of the t – Test to find out the Significance of Difference in mean gain scores of Clarifying the Problem

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean gain Score</th>
<th>Standard Deviation</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>1.92</td>
<td>2.24</td>
<td></td>
</tr>
<tr>
<td>Experimental group</td>
<td>3.19</td>
<td>2.81</td>
<td>2.15</td>
</tr>
</tbody>
</table>

The table 4.8 shows that the Experimental group had an advantage in gain scores with mean value 3.19 and standard deviation 2.81 while the Control group had a lower value of gain score with mean value 1.92 and standard deviation of 2.24. The t-value to be obtained for the difference to be significant at 0.05 level is 2.00 and that at 0.01 level is 2.65 for 72 degrees of freedom. The value obtained in this case is 2.15, and hence the difference between the mean gain scores is statistically significant at 0.05 level. The result shows that the effect of Mastery Learning Strategy on the Problem Solving Ability component No.2- Clarifying the Problem is significantly higher than that of Conventional Strategy.

The categorized Plot for the dependent variable - Problem Solving Ability component No.2 viz; Clarifying the Problem is given below.
FIGURE 4-7  Categorized Plot for Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_2_G stands for the variable, Clarifying the Problem.
The categorized plot, figure 4-7, gives a visual representation of the mean gain scores for the Clarifying the Problem (PSA_2_G) for the two groups. It is clear that the mean gain scores is significantly high for the Experimental group (Group 1) as compared to the mean gain scores for the Control group (Group 0) as given in the diagram. This ascertains that there is a significant effect of Mastery Learning Strategy on Clarifying the Problem and that the mental processes and skills associated with Clarifying the Problem can be improved with Mastery Learning Strategy significantly better than with the Conventional Strategy.

4.3.3 EFFECT OF MASTERY LEARNING STRATEGY ON FINDING SOLUTION TO THE PROBLEM

To see whether there is an effect of Mastery Learning Strategy upon the third component of the Problem Solving Ability, ANCOVA was used with Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) as the dependent variable, Problem Solving Ability component No.3 (Total gain score of Problem Solving Ability component No.3- Finding Solution to the Problem) as the independent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were treated as covariates. Given in table 4.9 is the result of the ANCOVA performed for the total sample.
TABLE 4.9
Summary of Analysis of Covariance with Instructional Strategy as the independent variable and Finding Solution to the Problem as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>10.28</td>
<td>69</td>
<td>8.79</td>
<td>1.16</td>
<td>0.28</td>
</tr>
</tbody>
</table>

The table 4.9 shows that the F value obtained is 1.16 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.28. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Finding Solution to the Problem is not statistically significant.

The categorized Plot for the dependent variable - Problem Solving Ability component No.3 viz; Finding Solution to the Problem is given as Figure 4-8.
FIGURE 4-8  Categorized Plot for Control group and Experimental group for the dependent variable: Finding Solution to the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA_3_G stands for the variable, Finding Solution to the Problem.
The table 4.9 and the figure 4-8 reveal that Mastery Learning Strategy does not affect Finding Solution to the Problem of students in Physics of Standard IX significantly better than the Conventional Strategy.

Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Finding Solution to the Problem of students in Physics of Standard IX better than the Conventional Strategy. Putting together all the above analyses, which tested the effect of Instructional Strategy on the components of Problem Solving Ability, it can be concluded that Mastery Learning strategy even though does not significantly improve total Problem Solving Ability as a whole when compared to the Conventional Strategy, it does have a significantly better effect upon mental abilities associated with the Clarifying the Problem such as Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/deductive reasoning, Hypothesizing and Checking the testability of hypotheses.

Comment

Pooling the results of ANCOVA performed upon the components of Problem Solving Ability, it becomes evident that Mastery Learning Strategy does not enhance the thought processes that are required for Comprehending the Problem and Finding Solution to the Problem better than the Conventional Strategy. To put it differently, the very original act of interiorising the problem and the crucial act of solving the problem could not be improved quite easily. But it enhances the thought processes associated with Clarifying the Problem. While glancing at the
subcomponents of Clarifying the Problem it becomes revealed that they comprise of the usual thought processes much necessary for academic exercises in the classroom. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/Deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to the fact that in repeated sessions of corrective measures / remedial measures of the Mastery Learning Strategy Cycle, the students were made to think and master the content repeatedly, during which such mental processes were indispensable.

4.4 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM

Following the analyses using ANCOVA, Three way ANOVA was performed for that component of Problem Solving Ability for which the effect of Instructional Strategy showed a significant difference.

The researcher aimed at finding out the main effects and interaction effects of Instructional Strategy and the cognitive variables on the relevant Problem Solving Ability component upon which an effect of Instructional Strategy was established by the earlier test using ANCOVA. The cognitive variables Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were of prime concern in the study. The researcher wanted to find out the effect of these factors on
Problem Solving Ability along with the effect caused by the Instructional Strategy. The factors were varied in two levels and the subjects were classified into Below Average and Above Average Categories with regard to the scores on these factors. The classifications of subjects into these categories were already discussed in chapter III. Thus each of the factors, Instructional Strategy, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement is presented at two levels. The first factor, Instructional Strategy is varied in two ways: Mastery Learning Strategy and the Conventional Strategy; the second factor, Nonverbal Intelligence, is presented at two levels: Below Average Nonverbal Intelligence (BANI) Group and Above average Nonverbal Intelligence (AANI) Group; the third factor is presented at two levels: Below average Verbal Intelligence (BAVI) Group and Above average Verbal Intelligence (AAVI) Group; the fourth factor, Previous Achievement, is presented at two levels: Below average Previous Achievement (BAA) Group and Above average Previous Achievement (AAA) Group.

The researcher considered examining the interaction effects of intelligence with Instructional Strategy and that of Previous Achievement with Instructional Strategy separately. At first, the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2- Clarifying the Problem was tested using ANOVA. Hence the ANOVA technique used is in the 2 X 2 X 2 factorial design. Also this was to be performed for the total sample as well as for boys and girls separately.
4.4.1 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE TOTAL SAMPLE.

In this analysis ANOVA technique used is in the 2 X 2 X 2 factorial design, where the factors are the two types of intelligences in addition to the Instructional Strategy employed in the two study groups.

Given in table 4.10 is the result of the ANOVA performed for the total sample with factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. viz; Clarifying the Problem.

The analysis of variance is performed for the total sample and each factor is presented at two levels. The first factor, Instructional Strategy is varied in two ways: Mastery Learning Strategy and the Conventional Strategy; the second factor, Nonverbal Intelligence, is presented at two levels: Below Average Nonverbal Intelligence (BANI) Group and Above average Nonverbal Intelligence (AANI) Group; the third factor is presented at two levels: Below average Verbal Intelligence (BAVI) Group and Above average Verbal Intelligence (AAVI) Group.
TABLE 4.10

Summary of ANOVA
to find the main and interaction
effects of Instructional Strategy,
Nonverbal Intelligence and Verbal Intelligence
on Clarifying the Problem for the total sample.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>24.67</td>
<td>66</td>
<td>6.79</td>
<td>3.62</td>
<td>0.06</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1</td>
<td>11.02</td>
<td>66</td>
<td>6.79</td>
<td>1.62</td>
<td>0.20</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1</td>
<td>0.53</td>
<td>66</td>
<td>6.79</td>
<td>0.07</td>
<td>0.78</td>
</tr>
<tr>
<td>Instructional Strategy-Nonverbal Intelligence</td>
<td>1</td>
<td>0.04</td>
<td>66</td>
<td>6.79</td>
<td>0.006</td>
<td>0.93</td>
</tr>
<tr>
<td>Instructional Strategy-Verbal Intelligence</td>
<td>1</td>
<td>0.14</td>
<td>66</td>
<td>6.79</td>
<td>0.02</td>
<td>0.88</td>
</tr>
<tr>
<td>Nonverbal Intelligence-Verbal Intelligence</td>
<td>1</td>
<td>1.15</td>
<td>66</td>
<td>6.79</td>
<td>0.17</td>
<td>0.68</td>
</tr>
<tr>
<td>Instructional Strategy-Nonverbal Intelligence-Verbal Intelligence</td>
<td>1</td>
<td>1.80</td>
<td>66</td>
<td>6.79</td>
<td>0.26</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 3.62 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.06. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 1.62 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.20. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.07 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.78. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.10
Analysis 163

shows that the F value obtained is 0.006 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.93. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.02 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.88. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.17 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.68. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.
Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.26 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.60. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

The result shows that none of the factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence has an effect on Clarifying the Problem, when the total sample is considered.

4.4.2 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE GIRLS’ SAMPLE.

Given below is the result of the ANOVA performed for girls with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. In this case the total number of girls in both study groups put together was 34. Total Number of subjects under the category AANI was 17 and that in the category BANI was also 17. Similarly the total Number of subjects under the category AAVI was 19 and that in the category BAVI was also 15.
TABLE 4.11

Summary of ANOVA
to find the main and interaction effects of
Instructional Strategy, Nonverbal Intelligence and
Verbal Intelligence on Clarifying the Problem for girls.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>40.46</td>
<td>26</td>
<td>7.87</td>
<td>5.13*</td>
<td>0.03</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1</td>
<td>10.34</td>
<td>26</td>
<td>7.87</td>
<td>1.31</td>
<td>0.26</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1</td>
<td>5.62</td>
<td>26</td>
<td>7.87</td>
<td>0.71</td>
<td>0.40</td>
</tr>
<tr>
<td>Instructional Strategy - Nonverbal</td>
<td>1</td>
<td>0.19</td>
<td>26</td>
<td>7.87</td>
<td>0.02</td>
<td>0.87</td>
</tr>
<tr>
<td>Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Strategy - Verbal</td>
<td>1</td>
<td>5.84</td>
<td>26</td>
<td>7.87</td>
<td>0.74</td>
<td>0.39</td>
</tr>
<tr>
<td>Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonverbal Intelligence - Verbal</td>
<td>1</td>
<td>4.36</td>
<td>26</td>
<td>7.87</td>
<td>0.55</td>
<td>0.46</td>
</tr>
<tr>
<td>Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Strategy - Nonverbal</td>
<td>1</td>
<td>2.47</td>
<td>26</td>
<td>7.87</td>
<td>0.31</td>
<td>0.58</td>
</tr>
<tr>
<td>Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* - significant at 0.05 level
Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 5.13 at 26 degrees of freedom, which acquires statistical significance at a probability level of 0.03. The required value for F to be significant for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22 at 0.05 level and 7.72 at 0.01 level. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant for girls at 0.05 level.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 1.31 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.26. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.71 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.40. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.
Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.02 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.87. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.74 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.39. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.55 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.46. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of
Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.31 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.58. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

The result shows that the effect of Instructional Strategy on Problem Solving Ability component No.2 viz; Clarifying the Problem is significant for girls. Post hoc comparison was done using t-test to find out the study group that had an advantage in gain scores. For this t-test for small sample size was employed and the result is given below.
TABLE 4.12

Summary of the t – Test to find out the Significance of Difference in mean gain scores of Clarifying the Problem for girls.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean gain Score</th>
<th>Standard Deviation</th>
<th>t- value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (girls)</td>
<td>1.65</td>
<td>2.47</td>
<td></td>
</tr>
<tr>
<td>Experimental group (girls)</td>
<td>4.0</td>
<td>2.96</td>
<td>2.52</td>
</tr>
</tbody>
</table>

The table 4.12 shows that the girls in the Experimental group had an advantage in gain scores with value 4.0 with standard deviation 2.96 while the girls in the Control group had a lower value of gain score with value 1.65 and standard deviation of 2.47. The t-value to be obtained for the value to be significant at 0.05 level is 2.12 and at 0.01 level is 2.92 at 16 degrees of freedom. The value obtained in this case is 2.52, and hence the difference between the mean gain scores is statistically significant at 0.05 level. The result shows that the effect of Mastery Learning Strategy on the Problem Solving Ability component No.2- Clarifying the Problem is significant for girls.

Also it is ascertained that the other factors, Nonverbal Intelligence and Verbal Intelligence do not significantly effect the Problem Solving Ability component No.2- Clarifying the Problem for girls.

The categorized Plot for the dependent variable - Problem Solving Ability component No.2 viz; Clarifying the Problem is presented in figure 4-9.
Figure 4-9 Categorized Plot for girls of Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the girls of Control group and Group 1 represents the girls of Experimental group. PSA_2_G stands for the variable, Clarifying the Problem.
The categorized plot in figure 4-9 gives a visual representation of the mean gain scores for the Problem Solving Ability component No.2 viz; Clarifying the Problem (PSA_2_G) for the two groups. It is clear that the mean gain scores is significantly high for the girls in the Experimental group (Group 1) as compared to the mean gain scores for the girls in the Control group (Group 0) as given in the diagram. This ascertains that there is a significant effect of Mastery Learning Strategy on Clarifying the Problem in the case of girls and that the mental skills associated with Clarifying the Problem can be improved for girls with Mastery Learning Strategy.

Taking a closer look at the subcomponents of Clarifying the Problem, it can be seen that they consist of usual thought processes usually employed in the classroom situation and much necessary for academic exercises as compared to the subcomponents which come under the other two components of Problem Solving Ability. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to the fact that in repeated sessions of corrective measures / remedial measures of the Mastery Learning Strategy Cycle, the students were made to think and master the content repeatedly, during which such mental processes were indispensable.

There is no main effect for variables Verbal Intelligence and Nonverbal Intelligence in enhancing the ability in Clarifying the Problem. Hence it is also clear that the variables Verbal Intelligence
and Nonverbal Intelligence do not interact with Instructional Strategy in enhancing the ability in Clarifying the Problem.

4.4.3 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE BOYS' SAMPLE.

Given below in table 4.13 is the result of the ANOVA performed for boys with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2, viz., Clarifying the Problem.
### TABLE 4.13

Summary of ANOVA to find the main and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem for boys.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>0.23</td>
<td>32</td>
<td>5.88</td>
<td>0.04</td>
<td>0.84</td>
</tr>
<tr>
<td>Nonverbal Intelligence</td>
<td>1</td>
<td>5.11</td>
<td>32</td>
<td>5.88</td>
<td>0.86</td>
<td>0.35</td>
</tr>
<tr>
<td>Verbal Intelligence</td>
<td>1</td>
<td>1.66</td>
<td>32</td>
<td>5.88</td>
<td>0.28</td>
<td>0.59</td>
</tr>
<tr>
<td>Instructional Strategy-Nonverbal Intelligence</td>
<td>1</td>
<td>0.01</td>
<td>32</td>
<td>5.88</td>
<td>0.003</td>
<td>0.95</td>
</tr>
<tr>
<td>Instructional Strategy-Verbal Intelligence</td>
<td>1</td>
<td>10.35</td>
<td>32</td>
<td>5.88</td>
<td>1.75</td>
<td>0.19</td>
</tr>
<tr>
<td>Nonverbal Intelligence-Verbal Intelligence</td>
<td>1</td>
<td>0.10</td>
<td>32</td>
<td>5.88</td>
<td>0.01</td>
<td>0.89</td>
</tr>
<tr>
<td>Instructional Strategy-Nonverbal Intelligence-Verbal Intelligence</td>
<td>1</td>
<td>1.16</td>
<td>32</td>
<td>5.88</td>
<td>0.19</td>
<td>0.66</td>
</tr>
</tbody>
</table>
Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.04 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.84. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.86 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.35. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.28 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.59. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.13
shows that the F value obtained is 0.003 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.95. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 1.75 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.19. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.01 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.89. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.
Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.19 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.66. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

The result shows that none of the factors, Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), Nonverbal Intelligence (Above Average Nonverbal Intelligence/Below Average Nonverbal Intelligence) and Verbal Intelligence(Above Average Verbal Intelligence/Below Average Verbal Intelligence) has an effect on Problem Solving Ability component No.2 when boys of the total sample are considered.

Comment

This result draws attention to the gender difference in acquiring Problem Solving Ability through Mastery Learning Strategy. Whereas girls got benefited by the Mastery Learning Strategy in acquiring the ability of Clarifying the Problem, boys did not. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/Deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to
the fact that in repeated sessions of corrective measures / remedial measures of the ‘Mastery Learning Strategy Cycle’, the students were made to think and master the content repeatedly, during which such mental processes were indispensable. Enhancement of such processes in girls might be the result of the fact that girls take up more sincerely the corrective and remedial measures in a disciplined manner. Boys rather went through the procedures casually without much mental deliberation. And thus girls got themselves rewarded.

Sumathy (1994) studied the hemisphericity, divergent thinking and Problem Solving Ability in Physical Science of the plus two students in Salem and found that boys and girls did not show any difference in the deductive thinking skill, inductive thinking skill, analytical thinking skill, convergent thinking skill, divergent thinking skill and symbolic thinking skill and that girls were better than boys in solving problems involving recall/recognition and in problems involving a combination of principle skill and synthetic skill.

The above study found an increased problem solving ability in Physical Science for girls only in problems involving recall/recognition and in problems involving more than one principle skill and synthetic skill. Thus the gender difference in Problem Solving Ability in the above study is in line with the results obtained in the present study.

Pooling the results of ANOVA on the total sample, girls and boys, it becomes evident that Nonverbal Intelligence (Above Average Nonverbal Intelligence/Below Average Nonverbal Intelligence) and Verbal Intelligence (Above Average Verbal Intelligence/Below Average Verbal Intelligence) have no effect on enhancing the ability in
Clarifying the Problem while using Mastery Learning Strategy. This could be treated as a positive sign in the sense that if at all Problem Solving Ability could be improved by a new technique, it can be improved in all students regardless of their intelligence level.

Another notable point could be the result which indicates that the effect of Instructional Strategy on Clarifying the Problem is not statistically significant when the total sample was considered, especially in the context of ANCOVA performed earlier with Instructional Strategy as the independent variable and Clarifying the Problem as the dependent variable showed a statistically significant effect in the total sample. The analysis of covariance is the better statistical test considering the effect of extraneous variables; hence the result of ANCOVA is taken into confidence admitting the fact that the effect is rather at a lower level of significance.

4.5 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM.

Finally to find out if there existed any main effects or interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for the total sample, girls and boys.
4.5.1 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE TOTAL SAMPLE.

Table 4.14 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the total sample.

**TABLE 4.14**

Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for the total sample

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>20.44</td>
<td>70</td>
<td>6.39</td>
<td>3.20</td>
<td>0.07</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1</td>
<td>2.54</td>
<td>70</td>
<td>6.39</td>
<td>0.40</td>
<td>0.53</td>
</tr>
<tr>
<td>Instructional Strategy - Previous Achievement</td>
<td>1</td>
<td>16.91</td>
<td>70</td>
<td>6.39</td>
<td>2.65</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 3.20 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.07. The required value for F to be
significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 0.40 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.53. The required value for F to be significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 2.65 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.11. The required value for F to be significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the total sample.

The result shows that neither Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) nor Previous Achievement (Above Average Previous Achievement/Below Average Previous Achievement) has a significant effect on Clarifying the Problem when the total sample is considered.
4.5.2 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE GIRLS' SAMPLE.

Further to test the main effects and interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for girls of the total sample. Table 4.15 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the girls of the total sample.

**TABLE 4.15**

Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for girls.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>29.50</td>
<td>30</td>
<td>7.02</td>
<td>4.20</td>
<td>0.05</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1</td>
<td>7.8</td>
<td>30</td>
<td>7.02</td>
<td>1.11</td>
<td>0.30</td>
</tr>
<tr>
<td>Instructional Strategy - Previous Achievement</td>
<td>1</td>
<td>20.15</td>
<td>30</td>
<td>7.02</td>
<td>2.87</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 4.20 at 30 degrees of freedom, which acquires statistical significance at a probability level of 0.05. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant for the girls of the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 1.11 at 30 degrees of freedom, which acquires statistical significance only at a probability level of 0.30. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the effect of Previous Achievement on Clarifying the Problem is not statistically significant for the girls of the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 2.87 at 30 degrees of freedom, which acquires statistical significance only at a probability level of 0.10. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the girls of the total sample.
The result shows that Instructional Strategy has a significant effect on Clarifying the Problem when the girls of the total sample are considered. This result has been already obtained from table 4.11. Accordingly post hoc comparison was done using t-test to find out the study group that had an advantage in gain scores. Consequently it was found that Mastery Learning Strategy had significant effect on Clarifying the Problem in the case of girls.

The present analysis reveals that the factor, Previous Achievement (Above average Previous Achievement / Below Average Previous Achievement) has no significant effect on Clarifying the Problem when the girls of the total sample are considered.

4.5.3 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE BOYS' SAMPLE.

To find out the main effects and interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for boys of the total sample. Table 4.16 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the boys of the total sample.
TABLE 4.16

Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for boys.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df Effect</th>
<th>MS Effect</th>
<th>df Error</th>
<th>MS Error</th>
<th>F</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>1</td>
<td>1.12</td>
<td>36</td>
<td>5.67</td>
<td>0.20</td>
<td>0.66</td>
</tr>
<tr>
<td>Previous Achievement</td>
<td>1</td>
<td>0.03</td>
<td>36</td>
<td>5.67</td>
<td>0.01</td>
<td>0.94</td>
</tr>
<tr>
<td>Instructional Strategy - Previous Achievement</td>
<td>1</td>
<td>1.45</td>
<td>36</td>
<td>5.67</td>
<td>0.26</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.20 at 36 degrees of freedom, which acquires statistical significance only at a probability level of 0.66. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the boys of the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.01 at 36 degrees of freedom, which acquires statistical significance
Analysis

only at a probability level of 0.94. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.26 at 36 degrees of freedom, which acquires statistical significance only at a probability level of 0.62. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the boys of the total sample.

The result shows that neither Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) nor Previous Achievement (Above Average Previous Achievement/Below Average Previous Achievement) has a significant effect on Clarifying the Problem when the boys of the total sample are considered.

Pooling up the ANOVA results of Instructional Strategy and Previous Achievement on the total sample, girls and boys, no significant effect was pronounced for Previous Achievement on Clarifying the Problem. Thus effect of Previous Achievement upon Clarifying the Problem can be ruled out in all cases. Thus all the chances of interaction effects of Previous Achievement with Instructional Strategy also is ruled out.
Comment

The effect of Previous Achievement upon Clarifying the Problem can be ruled out in all cases of girls, boys and the total sample. This means that Previous Achievement will not be a barrier for any effort to increase Problem Solving ability by some new strategy or technique.

Here also as in the case of the three way ANOVA with factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, the effect of Instructional Strategy on Clarifying the Problem is not statistically significant when the total sample was considered. The ANCOVA performed earlier with Instructional Strategy as the independent variable and Clarifying the Problem as the dependent variable showed a statistically significant effect in the total sample. The analysis of covariance is the better statistical test considering the effect of extraneous variables; hence the result of ANCOVA is taken into confidence admitting the fact that the effect is rather at a lower level of significance.