CHAPTER-IV
ANALYSIS OF DATA, INTERPRETATION AND DISCUSSION OF RESULTS

In this chapter, analysis of data pertaining to scores of achievement in mathematics and environmental ethics have been done in order to arrive at meaningful conclusions and generalisations. The data obtained from the experiment has been subjected to preliminary analysis, descriptive as well as suitable inferential statistics.

Keeping in mind the problem, objectives and the hypotheses, following subheads were formed and the obtained data was processed, analyzed and interpreted accordingly.

4.1: Preliminary Analysis
4.2: Descriptive Analysis
4.3 Inferential statistical Analysis

4.1: PRELIMINARY ANALYSIS

A first activity in the analysis of most statistical data is to conduct a careful examination of the data. This will usually involve looking for errors, outlier and missing values in the data, looking at plots and charts of the data examination and the statistical distribution of the data. The later may extend to performing formal statistical distribution tests. So, the data analysis in the present investigation begins with a preliminary analysis for data of each group as follow:

- P-P plots plot of pre, post and gain score of achievement and environmental ethics.

4.1.1 Probability-Probability (P-P) plot:

The alternative approach for testing normality is the probability plot. The categories of P-P plot and Quartile - Quartile are useful for finding the best fitting distribution within a family of distributions. Three types of categories probability plots are Normal, Half Normal and detrended. Normality probability plots provide a quick way to visually inspect to what extent the pattern of data follows a normal distribution. P-P and Q-Q probability plots are used to determine whether the distribution of a variable in the data matches a given distribution. If the variable
matches a test distribution, the probability plots cluster around a straight line. The P-P procedure plots a variable’s cumulative proportions (or empirical cumulative distribution function) against the cumulative proportions of a test distribution. The Q-Q procedure plots the quantiles of a variable’s distribution against the quantiles of a test distribution. The straight line represents what our data would look like if it were perfectly normally distributed. The actual data is represented by the squares plotted along this line. The closer the squares are to the line, the more normally distributed our data looks. Here we considered only P-P plots for all scores and is represented in Figure 4.1-4.3

**Figure 4.1:** P-P plot for Pre, Post and gain score of achievement of class VI students

![Figure 4.1a: Pre Achievement score](image)

![Figure 4.1b: Post Achievement score](image)

![Figure 4.1c: Gain Achievement score](image)
Figures 4.1a, 4.1b and Figure 4.1c depict normal P-P plots for pre, post and gain scores of achievement. The plot shows that all points are closed to the diagonal at high as well low end in pre, post as well as for gain score of achievement, how but there is little variation at the middle of line where some points are short off the diagonal. These variation of points are not too far from diagonal line and considered to be outlier in case of adjustment, but we ignored these variation and pre assumed for analysis point that data are normal. This mean there is no need as such any corrections/modifications or any types of alteration in the data.

**Figure 4.2: P-P plot for Pre, Post and gain score of Environmental Ethics of class VI students**

![Figure 4.2a: Pre Environmental Ethics score](image)

![Figure 4.2b: Post Environmental Ethics score](image)

![Figure 4.2c: Gain Environmental Ethics score](image)
Figures 4.2a, 4.2b and Figure 4.2c depict normal P-P plots for pre, post and gain scores of environmental ethics. The plot shows that all points are closed to the diagonal at high as well low end in gain score of environment ethics of the students where as in case of pre and post, at middle of diagonal line, points showed some variation and far from diagonal line. These variation of points are not too far from diagonal line and considered to be outlier in case of pre and pots scores of environmental ethics, but we ignored these variation and pre assumed for analysis point that data are normal. This mean there is no need as such any corrections /modifications or any types of alteration in the data.

Figure 4.3: P-P plot for total Parental involvement Score of class VI students

A figure 4.3 depicts normal P-P plots for parental involvement scores of the students. The plot shows that all points are closed to the diagonal line at high as well low end for parental involvement scores. There is a zig zag variation at the middle of diagonal line and this variation is not too far line. These variations of points are not too far from diagonal line for considered to be outlier, but we ignored these variations for the research point of view and pre assumed for analysis point that data are normal.

4.2 DESCRIPTIVE ANALYSIS

This section deals with descriptive statistics of achievement in mathematics & environmental ethics and parental involvement scores of the students.
Table 4.1: Means, S.D’S, Skewness, Kurtosis, Minimum and Maximum of pre achievement score, post achievement score, and gain achievement score in mathematics of the students

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Achievement Score</td>
<td>29.22</td>
<td>8.52</td>
<td>0.45</td>
<td>-0.65</td>
<td>15</td>
<td>51</td>
</tr>
<tr>
<td>Post-Achievement Score</td>
<td>35.63</td>
<td>9.58</td>
<td>0.35</td>
<td>-0.99</td>
<td>20</td>
<td>56</td>
</tr>
<tr>
<td>Gain Achievement Score</td>
<td>6.41</td>
<td>3.26</td>
<td>0.91</td>
<td>0.13</td>
<td>2</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 4.1 shows the descriptive statistics of pre, post and gain scores of achievement in mathematics of students. The values of skewness for all the cases depict that the distribution is positively skewed and is less than ±1. These values are within the acceptable limit of normality and may be acceptable as having skewness of moderate degree. Also the values of Kurtosis indicate that the distribution of pre, post and gain score of achievement is approximated to normal distribution and the curve for pre and post achievement scores was platykurtic whereas in the case of gain achievement scores it was leptokurtic.

Table 4.2: Means, S.D’S, Skewness, Kurtosis, Minimum and Maximum of pre, post and gain environmental ethics score of the students

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Environmental Ethics Score</td>
<td>182.46</td>
<td>19.15</td>
<td>-0.70</td>
<td>0.22</td>
<td>134</td>
<td>220</td>
</tr>
<tr>
<td>Post-Environmental Ethics Score</td>
<td>191.91</td>
<td>19.14</td>
<td>-0.87</td>
<td>0.50</td>
<td>144</td>
<td>230</td>
</tr>
<tr>
<td>Gain Environmental Ethics Score</td>
<td>9.45</td>
<td>4.09</td>
<td>0.33</td>
<td>-0.15</td>
<td>2</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 4.2 shows the descriptive statistics of pre, post and gain scores of environmental ethics of students. The values of skewness for pre and gain environmental ethics scores depict that the distribution is positively skewed and for post environmental ethics scores it is negatively skewed and is less than ±1. These
values are within the acceptable limit of normality and may be acceptable as having skewness of moderate degree. Also the values of Kurtosis indicate that the distribution of pre, post and gain score of environmental ethics is approximated to normal distribution and the curve for pre and post achievement scores was leptokurtic whereas in the case of gain achievement scores it was platykurtic.

**Table 4.3: Mean, Median, SD, Skewness, Kurtosis, Minimum and Maximum of total parental involvement score of the students**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Parental Involvement Score</td>
<td>137.41</td>
<td>18.21</td>
<td>0.01</td>
<td>0.99</td>
<td>88.5</td>
<td>193</td>
</tr>
</tbody>
</table>

Table 4.7 shows the descriptive statistics of parental scores of student; Mean, and SD were 137.41 and 18.21 respectively. The value of skewness was -0.01, which depicts the distribution is negatively skewed and is less than ±1. This value is within the acceptable limit of normality and may be acceptable as having skewness of moderate degree and the value of Kurtosis was 0.99; which indicated that the curve was leptokurtic. Thus, it may indicate towards the fact that distribution of parental scores is approximated to normal distribution. Maximum and minimum of parental scores were 193 and 88.5 respectively.

**Table 4.4 : Mean and SD of pre and post scores of achievement & environmental ethics for control group/conventional approach and experimental group/ ecological approach**

<table>
<thead>
<tr>
<th></th>
<th>Control Group/ Conventional Approach</th>
<th>Experimental Group/ Ecological Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Achievement Score</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>27.57</td>
<td>7.09</td>
</tr>
<tr>
<td>Environmental ethics score</td>
<td>178.07</td>
<td>16.81</td>
</tr>
</tbody>
</table>

Table 4.4 represents mean and SD for pre and post score achievement score & Environmental ethics score for control and experimental groups.

In case of pre achievement score mean and SD are 27.57 & 7.09 where in post score mean and SD are 33.0 & 7.65 respectively for control group. For experimental group, pre achievement score mean and SD are 30.95 & 9.59 and post achievement score mean and SD are 38.40 & 10.66 respectively.
Environmental ethics score for pre scores mean & SD are 178.07 and 16.81 where in case of post score mean & SD are 187.52 & 17.25 respectively for control group. For experimental group, pre scores mean & SD are 185.68 and 16.81 where in case of post score mean & SD are 196.53 & 20.14 respectively.

After the treatment, a feedback proforma was given to the experimental group regarding the effectiveness of teaching through ecological approach. It includes statements regarding methodology and activities conducted during the experiment. Responses of experimental group were shown in the following table 4.5:

Table 4.5: Percentage of positive responses of Feedback of Teaching Methodology

<table>
<thead>
<tr>
<th>S.No</th>
<th>Statements</th>
<th>%age of positive response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The teaching method stimulated my interest and thought in mathematics.</td>
<td>100%</td>
</tr>
<tr>
<td>2.</td>
<td>The method integrates theoretical concepts with real-world applications.</td>
<td>94.74%</td>
</tr>
<tr>
<td>3.</td>
<td>The teacher was responsive to students’ needs and problems.</td>
<td>97.37%</td>
</tr>
<tr>
<td>4.</td>
<td>The teacher maintained an environment that was conducive for learning</td>
<td>100%</td>
</tr>
<tr>
<td>5.</td>
<td>The teacher communicated the subject matter effectively</td>
<td>97.37%</td>
</tr>
<tr>
<td>6.</td>
<td>I appreciate the use of ecological method for teaching different topics of Mathematics by the teacher.</td>
<td>97.37%</td>
</tr>
<tr>
<td>7.</td>
<td>I enjoyed different activities and material used for teaching:</td>
<td>100%</td>
</tr>
<tr>
<td>8.</td>
<td>I enjoyed the use of animated videos for Fractions, Decimals, Symmetry, Data Handling and Perimeter and Area</td>
<td>100%</td>
</tr>
<tr>
<td>9.</td>
<td>I appreciated the use of biscuits to explain improper Fractions.</td>
<td>100%</td>
</tr>
<tr>
<td>10.</td>
<td>I liked the use of paper folding activities for learning Fractions, Angles and Lines of Symmetry.</td>
<td>97.37%</td>
</tr>
<tr>
<td>11.</td>
<td>I appreciated the use of graph paper, measuring tape, mats, unifix cubes for teaching Perimeter and Area.</td>
<td>100%</td>
</tr>
<tr>
<td>12.</td>
<td>I enjoyed the use of coloring activity to understand fractions.</td>
<td>97.37%</td>
</tr>
<tr>
<td>13.</td>
<td>I liked the activities conducted in the school grounds.</td>
<td>100%</td>
</tr>
<tr>
<td>14.</td>
<td>I enjoyed collecting data of cars in the parking.</td>
<td>100%</td>
</tr>
<tr>
<td>15.</td>
<td>I took pleasure in preparing tally marks of birthday month of classmates.</td>
<td>100%</td>
</tr>
<tr>
<td>16.</td>
<td>I had fun in the perimeter activity in basketball court.</td>
<td>97.37%</td>
</tr>
<tr>
<td>17.</td>
<td>I enjoyed the group activity for different types of lines.</td>
<td>97.37%</td>
</tr>
<tr>
<td>18.</td>
<td>Examples from classroom for Fractions, Different Types of Angles and Symmetry benefited me greatly.</td>
<td>97.37%</td>
</tr>
<tr>
<td>19.</td>
<td>I enjoyed the perimeter activity in the classroom.</td>
<td>97.37%</td>
</tr>
<tr>
<td>20.</td>
<td>I appreciate students’ participation in bringing objects as examples.</td>
<td>100%</td>
</tr>
<tr>
<td>21.</td>
<td>I enjoyed the nature drawing activity for lines and angles.</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 4.5 depicts that all the students agreed that this method stimulated their interest in mathematics; they enjoyed learning through animated videos, activities conducted in the school ground, collection of data etc. They all also appreciated the use of biscuits, graph paper, measuring tape, mats, unifix cubes for teaching different topics and their participation in different activities in a threat free environment. 97% students appreciated paper folding activities, coloring activity, group activities, collecting examples from classroom and its surroundings. 95% preferred the integration of theoretical concepts with real-world applications. It reflects that ecological approach infuses interest in mathematics but a lot of barriers are there due to which environmental ethics could not be developed in such a short time. Also, the students cherished the new way of learning. The concepts were vivid after following this methodology. But parents need to be aware about all these so they can also contribute towards better understanding of the students.

4.3 STATISTICAL ANALYSIS

The present study employed factorial designs. Factorial designs are referred to as those in which there are repeated measures of the same experimental unit under different conditions. Following the selection of the statistical technique appropriate for the data analysis, in terms of the objectives and the hypotheses of the study, it was decided to employ Two-way Analysis of Variance. The information obtained from a factorial design experiment is more complete and comprehensive than a single factor experiment in the sense that evaluation of interaction effects can be made. Apart from it, the estimates of the effect of the independent variables is also practically more as these estimates are obtained by averaging over a relatively broad range of other relevant experimental variables. In the case of factorial experiments, population is more exclusive than in the case of a single factor experiment (Winer, 1970).

The relative effectiveness of the two teaching methods i.e. ecological approach and conventional approach in terms of mathematics achievement and environmental ethics in relation to parental involvement was determined by analyzing the post test scores. The obtained post test scores for both the groups i.e. group I taught by ecological approach and group II taught by conventional approach were analysed by applying Two way ANOVA.
4.3.1 Preliminary Data Handling

The groups were matched on the basis of classifying variable i.e. parental involvement. Four groups were given parental involvement scale. On the basis of median, the sample was divided into high parental involvement and low parental involvement. The scores of the students on parental involvement scale were matched. t-ratio was calculated, all the four sections had no significant difference on their mean scores. The t-ratio of the mean scores of the parental involvement scale of two randomly selected sections is given in the Table 4.6.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>S.D.</th>
<th>Mean Difference</th>
<th>df</th>
<th>t-ratio</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>270.4</td>
<td>43.99</td>
<td>7.56</td>
<td>80</td>
<td>1.50</td>
<td>Insignificant at 0.05 level</td>
</tr>
<tr>
<td>B</td>
<td>281.74</td>
<td>21.10</td>
<td>11.34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 reveals that mean score of Group A and B were 270.4 and 281.74 respectively. The obtained t-value was 1.50 which was insignificant at 0.05 level. This showed that the difference was insignificant in the mean scores on parental involvement.

Further t-ratio was computed for the pre-test scores of treatment groups at two levels of parental involvement on achievement test in mathematics and was found to be 1.82, i.e. not significant at 0.05 level of significance. t-ratio on pre-test scores on achievement test has been presented in Table 4.7.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>S.D.</th>
<th>Mean Difference</th>
<th>df</th>
<th>t-ratio</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27.57</td>
<td>7.09</td>
<td>1.86</td>
<td>80</td>
<td>1.82</td>
<td>Insignificant at 0.05 level</td>
</tr>
<tr>
<td>B</td>
<td>30.95</td>
<td>9.59</td>
<td>3.38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus, it may be inferred that the two treatment groups were comparable with regard to their previous knowledge.
Each of two groups of students was randomly allocated to the two sub groups that are experimental group and control group.

The data obtained in the form of scores on achievement test in mathematics, environmental ethics and parental involvement was scored carefully. The scores were tabulated. The gain scores were measured by getting the difference in mean obtained from the post-test scores and pre-test scores for each student. The gain scores for achievement in mathematics and environmental ethics were calculated separately. The obtained gain scores were subjected to analysis of variance.

To test the hypothesis analysis of variance was applied. Before applying ANOVA, the following assumptions were verified:

- Observation within the experimentally homogenous sets should be normally distributed in population. It was tested through descriptive statistics. The mean, median, SD, skewness and kurtosis were found to be normal within the limits of didtribution.

- The sampling within the sets should be random and mutually exclusive. In each cell of 2x2 factorial design of ANOVA, sampling within the sets was done randomly. Since, in the present study is pre-test post-test experimental design, the intact groups were randomly assigned to experimental and control group.

- Within the groups variance should be equal. Homogeneity of variance was also taken care of.

Mean gain scores have been analyzed to find difference in gain in achievement with instructional approach and parental involvement as independent variables. The groups were matched on achievement prior to introduction of treatment by analyzing pre test scores. So, there was no need to compute percentage gain.

4.3.2 Testing of Hypothesis:

In this section, we will discuss the significant difference of main effect i.e instructional approaches and parental involvement scores (High & Low) and two way interaction between instructional approaches and parental involvement scores of class VI students. Two way analysis of variances (2X2 ANOVA) was employed in order to
see the significant mean difference for gain achievement in mathematics and environmental ethics scores of the student between instructional strategies and high & low parental involvement scores. It is also employed in order to see interactional effect between variables.

(A). Testing of Hypothesis related to achievement scores

The sum of squares, degrees of freedom and F-ratios for instructional approaches and Parental Involvement with respect to achievement have been given in the following Table 4.8 for ANOVA.

Table 4.8 Summary of Two-Way ANOVA on scores of achievement in mathematics

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>134.98</td>
<td>3</td>
<td>44.99</td>
<td>4.83</td>
<td>0.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>2979.97</td>
<td>1</td>
<td>2979.97</td>
<td>319.75</td>
<td>0.00</td>
</tr>
<tr>
<td>Instructional approaches</td>
<td>118.63</td>
<td>1</td>
<td>118.63</td>
<td>12.73</td>
<td>0.00***</td>
</tr>
<tr>
<td>Parental High and Low score</td>
<td>47.52</td>
<td>1</td>
<td>47.52</td>
<td>5.10</td>
<td>0.03*</td>
</tr>
<tr>
<td>Instructional approaches *Parental High and Low score</td>
<td>3.41</td>
<td>1</td>
<td>3.41</td>
<td>0.37</td>
<td>0.55</td>
</tr>
<tr>
<td>Error</td>
<td>726.93</td>
<td>78</td>
<td>9.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4236.00</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>861.90</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H1: The two instructional approaches will yield equal mean gain scores on achievement in mathematics of class VI students.

F-ratio for two instructional approaches was found to be significant at 0.01 level of confidence. It suggests that two instructional treatments exhibited difference in the mean gains on achievement. Thus the null hypothesis has not been retained. The students taught mathematics by ecological approach exhibited better achievement than those taught by conventional approach.

It may be inferred that the gain achievement score of both strategies were different. The means, Standard Deviation, Standard Error of Mean, Mean Difference and Standard Error of Difference between groups for the mean gain scores on achievement have been presented in Table 4.9.
Table 4.9: Mean gain scores on achievement in mathematics of the control and experimental groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Gain</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>42</td>
<td>5.43</td>
<td>2.59</td>
<td>0.40</td>
<td>-2.02</td>
<td>0.69</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>7.45</td>
<td>3.59</td>
<td>0.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To find out the mean gain scores on achievement in mathematics by both the groups, the difference of the post-test and pre-test was obtained for the two groups. The groups with different instructional approaches differed significantly on the mean gain scores in achievement in mathematics. Table 4.9 shows that the experimental group had more mean gain on achievement in mathematics i.e. (7.45) as compared to that of control group (i.e. 5.43). Thus, ecological approach positively enhances the student achievement.

This finding is in accordance with the research findings of Blomberg (1967) that out-of-doors situation is more effective instructional strategy for sixth graders.

Ryan (1969) reported that outdoor education was better in increasing appreciation for environmental conservation among sixth graders. Recreational and physical educational activities accelerated academic learning and achievement (Thomas, 1990).

Readiness-building and open-ended experiences led to better conceptual understanding to solving authentic mathematical problems (Davis et al.1990)

Nalayini (1991) taught the students of class I to IV through number games and found that it motivated the students to develop better communication skills. Fun activities like reading and coloring stimulated an interest among children (Lee 1994). Better teaching strategies were found to be effective for increasing student’s academic performance in mathematics was reported by Samad (2005).

Tomar (1998) taught environmental science to primary school children and found that it enhanced the positive attitude of the student towards environment. Teaching and learning geography through exposure and field trips were found to be beneficial and fruitful (Kidwai 1999).
Stewart (2000) reported that family, individual and school characteristics are important predictors of academic success among African American students of 12th grade.

Hindi grammar taught by team-game-tournament approach led to better performance than traditional method of teaching grammar was reported by Bishnoi (2001). Children taught by musical activities exhibited enhancement in mathematical understanding (Shilling 2002) and integrating variety of music activities with different mathematical content had positive effects on multiple mathematical ability areas of elementary school students was Song, Margaret & Daniel (2013) findings. Comer (2004) reported that ecological theory students get more motivated to learn in a friendly, non-coercive and supportive environment.

Sharma (2004) reported that students learn more when mathematical concepts are made more simple and living through experimentation and discovery method. Greater the amount of natural exposure, greater the learning of the students in mathematics (NCF 2005).

Glosser (2010) reported that mathematics taught by hands-on experiences and creative ways led to better retention of material. Learning through fantasy play activities was found to be effective for increasing achievement of the students (Subhash, Suresh & Ram (2010). Teaching fractions with the help of poem increased the interest of Class III students was Bagga (2011) finding.

Sharma & Khatoon (2011) reported that the students involved in different activities (i.e. sports, computer and internet related activities) yielded better science performance.

Webb (2011) reported that there are several significant associations between the individual’s ecology of human development and their academic achievement in a homogenous ability grouped mathematics class.

A research-informed, pedagogically reliable, technology-enhanced learning and teaching environment fostered engagement with learning (Czaplinski, Iwona & Mallet, Dann (2015).
Connections between math and other disciplines and with the real world led to have a positive effect on children learning (Glosser 2016).

The study conducted by Daniel and Poole (2009) is devoted to the development of ecological approach and he found that achievement can be changed through teaching with this approach. Thus, ecological approach positively enhances the student achievement. The graphical representation of mean gain of different groups has been presented in figure 4.4 which is given ahead.

**Figure 4.4:** Graphical representation of mean gain scores on achievement by control and experimental groups

H2: The students with low and high parental involvement will yield equal mean gain scores on achievement in mathematics

Referring to the Table 4.8, it may be observed that the F-ratio for the difference between mean gain scores obtained by the students of high and low parental involvement was found to be significant at 0.05 level of confidence. It suggests that the means of the two parental involvement groups may be considered as different at the specified level of confidence. Therefore, the null hypothesis has not
been retained. It may be inferred that the mean scores of high and low parental involvement of the students differ. The mean, Standard Deviation, Standard Error of Mean, Mean Difference and Standard Error of Difference between high and low parental involvement scores for the gain achievement scores have been represented in Table 4.10.

**Table 4.10: Mean gain achievement scores of learners with high & low of parental involvement**

<table>
<thead>
<tr>
<th>Parental Involvement score</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Achievement High</td>
<td>42</td>
<td>6.81</td>
<td>3.22</td>
<td>0.50</td>
<td>0.81</td>
<td>0.72</td>
</tr>
<tr>
<td>Low</td>
<td>40</td>
<td>6.00</td>
<td>3.30</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The students with low and high parental involvement differed significantly on the mean gain scores in achievement in mathematics. The students with high parental involvement had more mean gain on achievement in mathematics (i.e.6.81) as compared to the students with low parental involvement (i.e.6.00).

A number of studies have shown associations between parental involvement, academic achievement and demographic variables. Crimm (1993); Addington (1997); Thakur (2011) and Kaur (2015) very strongly supported the positive effect of high parental involvement on students mathematical achievement. Moline (1998) reported that parental involvement such as distinct styles of interacting with their children and creating emotionally supportive home environments (Desforges & Abouchaar, 2003) was also related to academic success and their educational development (Pomerantz, Mooeeman & Litwack,2007). Hill & Taylor (2004); Martis (2005) and Jeynes (2007) found that parental involvement is an important predictor of achievement.

The results of the present investigation may be justified in the light of basic construct of parental involvement which seems to be quite complex. Various dimensions of parental involvement have been identified by different researchers. But the dimensions which were chosen in the present investigation were mainly focused around activities of parents related with academic guidance at home by way of providing direct instruction or devoting time to the child. Hence involvement of parents into academic activities may led to higher achievement levels for children belonging to high parental involvement group.
The students with high parental involvement had a rise in mean gain with a score as compared to students with low parental involvement. Mean comparison of gain achievement scores between high and low parental involvement is shown in Figure 4.5.

![Mean Gain Scores on Achievement of High and Low Parental Involvement](image)

**Figure 4.5: Mean comparison of the gain achievement scores between high and low parental involvement**

**H3:** There will be no significant interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics.

From table 4.8 we observe that the F-value for the interaction between instructional strategies (ecological approach/ traditional approach) and parental involvement was found to be 0.37 which is not significant even at 0.05 level of significance. So, there is no significant interaction between the instructional treatment and parental involvement. Hence, hypothesis that “there will be no significant interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics” has been retained. It suggests that the mean gain (Total Scores in Mathematics) of the groups due to interaction between instructional approaches and parental involvement (high and low) were not found to be different. The two variables may be treated as independently of each other. It indicates that instructional approaches do not interact with parental involvement to cause variation on achievement in Mathematics of students.
The above results supported by Thakur (2011), he reported that parental involvement and categories of Bloom’s taxonomy do not interact in respect of mean achievement of mathematical skills of VI graders. The mean gains (total scores in science) of the groups of IX graders due to interaction between instructional strategies and parental involvement (high and low) were not different was Sanjam (2013) finding.

(B). Testing of Hypothesis related to environmental ethics scores

The sum of squares, degrees of freedom and F-ratios for instructional approaches and Parental Involvement with respect to environmental ethics has been given in the following Table 4.11 for ANOVA.

**Table 4.11 Summary of two-way ANOVA on scores of environmental ethics**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>51.98</td>
<td>3</td>
<td>17.33</td>
<td>0.85</td>
<td>0.47</td>
</tr>
<tr>
<td>Intercept</td>
<td>7431.00</td>
<td>1</td>
<td>7431.00</td>
<td>364.19</td>
<td>0.00</td>
</tr>
<tr>
<td>Instructional strategies</td>
<td>30.86</td>
<td>1</td>
<td>30.86</td>
<td>1.51</td>
<td>0.22</td>
</tr>
<tr>
<td>Parental High and Low score</td>
<td>2.46</td>
<td>1</td>
<td>2.46</td>
<td>0.12</td>
<td>0.73</td>
</tr>
<tr>
<td>Instructional approaches *Parental High and Low score</td>
<td>9.62</td>
<td>1</td>
<td>9.62</td>
<td>0.47</td>
<td>0.49</td>
</tr>
<tr>
<td>Error</td>
<td>1591.54</td>
<td>78</td>
<td>20.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10065.00</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>1643.52</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**H4:** The two instructional approaches will yield equal mean gain scores on environmental ethics of class VI students.

F-ratio for two instructional approaches was not found to be significant even at 0.05 level of confidence. It suggests that two instructional treatments did not exhibit difference in the mean gains on achievement. Thus the null hypothesis has been retained. The students taught mathematics by ecological approach reflect similar environmental ethics as those taught by conventional approach.

It may be inferred that the gain environmental ethics score of both strategies was not different. The means, Standard Deviation, Standard Error of Mean, Mean Difference and Standard Error of Difference between groups for the mean gain scores on environmental ethics have been presented in Table 4.12.
Table 4.12: Mean gain scores on environmental ethics of the control and experimental groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ethic Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>42</td>
<td>9.45</td>
<td>4.62</td>
<td>0.71</td>
<td>-1.40</td>
<td>0.99</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>10.85</td>
<td>4.32</td>
<td>0.68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To find out the mean gain scores on environmental ethics by both the groups, the difference of the post-test and pre-test was obtained for the two groups. The groups with different instructional approaches did not differ significantly on the mean gain scores in achievement in mathematics. Table 4.12 shows that the experimental group had more mean gain on environmental ethics i.e. (10.85) as compared to that of control group (i.e. 9.45). Thus, ecological approach has no effect in enhancing environmental ethics of the students.

The analysis of results indicates that there is no significant difference between the students exposed to ecological approach and traditional approach with respect to environmental ethics. The students probably were not prepared to learn through ecological approach. They probably have taken time to take the treatment seriously. They have long term association with the classroom teaching, so it is proved to be hindrance so this experiment should be performed little longer. Thus, the ecology of learning is institution based and has to be transformed to include outside environment also. This requires longer period and across subjects.

The study by Kelly (1996), who asserted that the nature of environmental responsiveness (i.e. one’s ethics or reply to the natural environment) could only be understood as it is represented in each person’s unique thought process which reflect interactive and often times competing multifaceted influences and interwining self-concept conditions, the similar results about environmental ethics and instructional strategies. Also, Katherine (1998) reported that environmental ethics and perspectives were not simply inculcated through positive ‘nature’ and community service experiences, but were shaped by racial/ ethnic/ class and gender identities and relations and need to be inculcated by shaping the basic approach as ethics directly lead to curiosity to be aware and responsible towards the environment. Thus, ecological approach shows no effect on environmental ethics of the students.
The graphical representation of mean gain on environmental ethics of control and experimental groups is shown in Figure 4.6.

**Figure 4.6: Graphical representation of mean gain on environmental ethics by control and experimental groups**

**H₅:** The students with low and high parental involvement will yield equal mean gain scores on environmental ethics

Referring to the Table 4.11, it may be observed that the F-ratio for the difference between mean gain scores obtained by the students of high and low parental involvement was not found significant at 0.05 level of confidence. Therefore, the null hypothesis has been retained. The mean, Standard Deviation, Standard Error of Mean, Mean Difference and Standard Error of Difference between high and low parental involvement scores for the gain achievement scores have been represented in Table 4.13.
The students with low and high parental involvement differed significantly on the mean gain scores in achievement in mathematics. The students with high parental involvement had less gain on achievement in mathematics (i.e. 9.76) as compared to the students with low parental involvement (i.e. 10.53).

The above analysis of results shows that there is not a significant difference between the environmental ethics of students with high and low parental involvement. This may be because parents are more result-oriented and hardly bother to make their children aware about the environment. They prefer to be more grades conscious.

Raju (2007) in his study found that the communities, parents and type of the schools do not have any influence on their environmental ethics.

The students with low parental involvement had a rise in mean gain with a score as compared to students with high parental involvement. Mean comparison of gain environmental ethics scores between high and low parental involvements is shown in Figure 4.7.

**Table 4.13: Mean gain environmental ethics scores of learners with high & low of parental involvement**

<table>
<thead>
<tr>
<th>Parental involvement (High and Low)</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain environmental ethics scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>42</td>
<td>9.76</td>
<td>4.57</td>
<td>0.70</td>
<td>-0.76</td>
<td>0.99</td>
</tr>
<tr>
<td>Low</td>
<td>40</td>
<td>10.53</td>
<td>4.46</td>
<td>0.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The students with low and high parental involvement differed significantly on the mean gain scores in achievement in mathematics. The students with high parental involvement had less gain on achievement in mathematics (i.e.9.76) as compared to the students with low parental involvement (i.e.10.53).

The above analysis of results shows that there is not a significant difference between the environmental ethics of students with high and low parental involvement. This may be because parents are more result-oriented and hardly bother to make their children aware about the environment. They prefer to be more grades conscious.

Raju (2007) in his study found that the communities, parents and type of the schools do not have any influence on their environmental ethics.

The students with low parental involvement had a rise in mean gain with a score as compared to students with high parental involvement. Mean comparison of gain environmental ethics scores between high and low parental involvements is shown in Figure 4.7.
Figure 4.7: Mean comparison of the gain environmental ethics score between high and low parental involvement

H₆: There will be no significant interaction between instructional approaches and parental involvement of mathematics students with regard to environmental ethics

The F-value was calculated to see the interaction effect between experimental, control group, environmental ethics and parental involvement. From table 4.11 we observe that the F-value for the interaction between instructional strategies (ecological approach/ traditional approach) and parental involvement with respect to environmental ethics comes out to be 0.47 which is not significant at 0.05 level of significance.

So, there is no significant interaction between the instructional treatment and parental involvement. Hence, hypothesis that “there will be no significant interaction between instructional approaches and parental involvement of mathematics students
with regard to environmental ethics” has been retained. It suggests that the mean gain of the groups due to interaction between instructional approaches and parental involvement (high and low) were not found to be different. The two variables may be treated as independently of each other. It indicates that instructional approaches do not interact with parental involvement to cause variation in environmental ethics of the students.

4.4 DISCUSSION OF THE RESULTS

The present study is divided into two sub-parts viz; performance on achievement test and performance on environmental ethics.

4.4.1 Discussion of results related to mean gain scores on academic achievement:

The results of this study pertaining to effect of instructional strategies viz, ecological approach and conventional approach were found to impact the total gain scores. Gain scores of all the students taught through ecological approach were higher as compared to those taught through conventional approach. The hypothesis that the two instructional approaches will yield equal mean gain scores on achievement in mathematics of class VI students was rejected in favour of superiority of ecological approach over conventional approach.

The results of the present investigation also show that, the mean scores of high parental involvement were found higher than low parental involvement. Thus the hypothesis that the students with low and high parental involvement will yield equal mean gain scores on achievement in mathematics was rejected. It leads to conclude that the parental involvement affects achievement of the students.

Further, the analysis revealed that there was no significant interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics. Thus, parental involvement when interact with the variable instructional strategies have not been found to affect achievement gain scores in mathematics.

It may be observed that use of ecological approach and with the support of parents, there will be an ideal situation for VI graders to enjoy higher strides of achievement. It is also revealed through the feedback taken from the students (as depicted in the Table 4.5) that the use of ecological approach is helpful in enhancing the interest of the students in mathematics.
4.4.2 Discussion of results related to mean gain scores on environmental ethics:

The results of the present study indicated that the two instructional approaches exhibit similar environmental ethics among students. Thus, the hypothesis that the two instructional approaches will yield equal mean gain scores on environmental ethics of class VI students was accepted. The reason may be that it required longer duration of ecological approach in schools. Further research is recommended to examine effectiveness of this approach in developing environmental ethics with an extended time span.

The analysis revealed that the students with low and high parental involvement yielded equal mean gain scores on environmental ethics. This may be because the prevalent teaching and learning mindset of students and their parents is subject and classroom oriented focusing only on academic achievement scores. Most teachers cater to the same by following subject centered teaching.

Further, it was found that there was no interaction effect of instructional approaches and parental involvement on environmental ethics. As ecological approach of teaching can succeed only through participatory approach of all the stakeholders. Hence schools should hold seminars for teachers and parents on the use of this approach. Parents need to appreciate teachers efforts in making learning more environmentally relevant and not consider it waste of time. Only then the student will be able to imbibe environmental ethics through ecological approach.

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