4   Chapter 4: Data Analysis and Interpretation

4.1 <u>Introduction-</u>

The analysis and interpretation of data are presented in this chapter. Analysis of data is the heart of the research report (Best 2001). It is an extensive and comprehensive process intended to study the underlying relationship among various factors. This chapter reports and interprets the findings of this study. Each of the objectives is addressed by analyzing data and then determining whether the hypothesis for that objective is supported or not. As described in Chapter 3, the majority of this study was based on quantitative data collected by using an objective test developed by O-labs. The data obtained by objective test which helped in understanding the effectiveness of virtual laboratories.

Interpretation of data is an extremely important and useful branch of science of statistics. Statistical facts by themselves have no utility, but interpretation makes it possible to utilize the collected data in various fields of activity. The usefulness of collected data lies in its proper interpretation. In the present study, the following prerequisites are kept in mind for the scientific interpretation of data collected through relevant tools.

4.2 Hypothesis in null form-

Best and Kahn (1999) maintain that while testing hypotheses with relevant statistical techniques, the hypotheses should be presumed in null form. In this study all hypotheses stated in chapter III (methodology chapter) are made in null form for statistical testing.

4.3 Statistics used in study-

Data can be analysed in different ways. The subject which deals with analysing data is known as statistics. There are two broad categories of statistics

1. Descriptive statistics
2. Inferential statistics

Descriptive statistics consists of the collection, organization, summarization, and presentation of data. And **inferential** statistics consists of generalizing from samples to populations, performing estimation and hypothesis tests, determining relationships among variables and making predictions.

In this study, researcher used the both types of statistics to analyse the data. Researcher started with descriptive statistics and then to check the hypothesis used inferential statistics.

4.4 Descriptive Statistics-

1. The following table shows the mean, median scores of the students achieved in pre-test, post-test and in retention test with standard deviation, skewness of the total sample:

Table 1-Arithmetic mean of Pre-test, Post-test and retention test scores of students

Test	N	Mean	Median	Standard Deviation	Skewness
Pre-test	25	14.16	15	3.30826	-0.1144
Post-test	25	23.04	23	2.8492	-0.7723
Retention	25	21.16	22	2.809697	-0.91195

Table 1 indicates that the arithmetic mean score of the pre-test and retention test is less than the median value. It means that the value is slightly lower than the median. It indicates that the large number of students are securing above average score in pre-test and in retention test. The negative value of skewness indicates that the performance of students in pre-test, post-test and in retention test is slightly negatively skewed (skew to left).

2. The following table shows the mean, median scores achieved in pre-test by boys and girls with standard deviation, skewness of the sample.

Table 2-Descriptive statistics of pre-test scores achieved by boys and girls

Test	N	Mean	Median	Standard deviation	Skewness
Pre-test	12	14.69	15	2.333	-1.349

(Boys)					
Pre-test (Girls)	13	13.58	13.5	4.0714	0.46640

Table 2 indicates that the arithmetic mean score of the pre-test of boys less than the median value. It indicates that mostly boys are securing above average score in pre-test. And the distribution is negatively skewed. The arithmetic mean score of pre-test of girls is equal to median value. It means the distribution of pre-test score of girls is symmetric.

3. The following table shows the mean, median scores achieved in post-test by boys and girls with standard deviation, skewness of the sample.

Table 3-Descriptive statistics of scores of Post-test achieved by boys and girls

Test	N	Mean	Median	Standard deviation	Skewness
Post-test (Boys)	12	22.23	23	3.354	-0.4081
Post-test (Girls)	13	23.91	23.5	1.800849	0.143216

Table 3 indicates that the arithmetic mean score of the post-test of boys is less than the median value. It indicates that mostly boys are securing above

average score in post-test. And the distribution is negatively skewed. And the arithmetic mean score of post-test of girls is greater than the median value. It means the distribution of post-test score of girls is positively skewed.

4. The following table shows the mean, median scores achieved by students in post-test and in retention test with standard deviation, skewness of the sample:

Table 4-: Descriptive statistics of scores achieved by students in post-test and retention test

Test	N	Mean	Median	Standard deviation	Skewness
Post test	25	23.04	23	2.8492	-0.7723
Retention Test	25	21.16	22	2.809	-0.91195

Table 4 indicates that the arithmetic mean score of the post-test of students nearly equal to median value. It indicates that the distribution of scores of students in post-test is symmetric. The arithmetic mean score of the students in the retention test is less than the median value it means the distribution of score achieved in retention test is negatively skewed.

4.5 <u>Inferential statistics-</u>

Inferential statistics uses in doing generalization from samples to populations, performing estimation and hypothesis tests, determining relationships among variables and making predictions. To test the hypothesis in this study, researcher used dependent paired t-test. This test is used when the samples are dependent. Samples are considered to be dependent samples when the subjects are paired or matched in some way. Here student's achievement is dependent on the treatment which is given to them after conducting pre-test. Researcher analysed the results with the help of paired t-test for different objectives of the study.

1. **Analysis of arithmetic means of pre-test and post-test scores achieved by students with the help of paired t-test-**

   The following table shows the arithmetic mean of scores of pre-test and post-test achieved by students with standard deviation, degree of freedom and t-value. The purpose of conducting this test is to determine whether there is statistical evidence that the mean difference between paired observation on a particular outcome is significantly different or not.

Table 5-Computation of paired t-test between pre-test and post-test stages

Test	N	Mean	Standard deviation	SEM	Mean difference	P value	t value	Degree of freedom	Level of significance at 0.05 level

Pre-test	25	14.16	3.40	0.68	8.88		1.21096	24	Extremely statistically significant
Post-test	25	23.04	2.91	0.58					

The above table shows the comparison of performance of students before and after the integration of virtual lab with theory subject science. The two-tailed P value is less than 0.0001 with degree of freedom 24 and t=12.1096 at 0.05 significance level. It means t value is significant for above paired t-test.

Hence, the stated null hypothesis is rejected which is "There is no significant difference in mean scores of achievement in physics at pre-test and post-test stages of students of class IX taught through integration of virtual laboratory with subject at government Inter College Lalpur Kotdwara Uttarakhand." And

the alternative hypothesis is accepted which is "There is significant difference in mean scores of achievement in physics at pre-test and post-test stages of students of class IX taught through integration of virtual
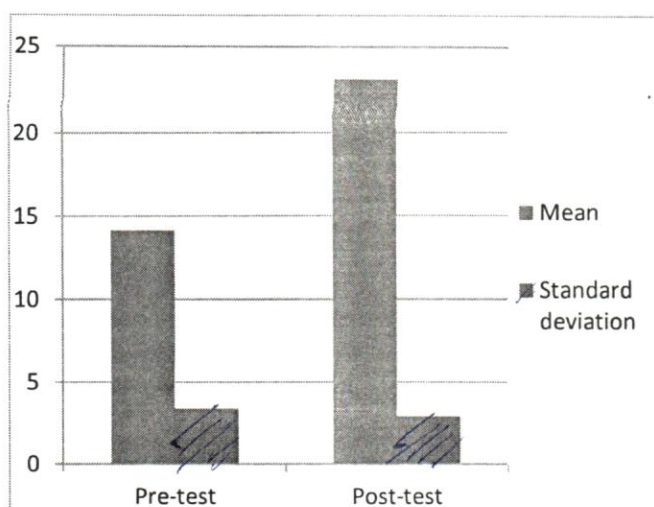
Figure 4.1: Comparison of mean and SD scores obtained by class IX students in pre-test and post-test

2. **Analysis of arithmetic means of pre-test scores achieved by boys and girls separately with the help of paired t-test**

   The following table shows the arithmetic mean scores of pre-test achieved by boys and girls separately with standard deviation, degree of freedom and t-value. The purpose of conducting this test is to determine whether there is statistical evidence that the mean difference between paired observation on a particular outcome is significantly different or not.

   Table 6-Result of paired t-test to compare pre-test scores of boys and girls

Pre-Test	N	Mean	Standard deviation	SEM	Mean difference	Two tailed P-value	t-value	Degree of freedom	Level of significance at 0.05
Boys	12	14.67	2.53	0.73	1.08	0.4359	0.80	11	The

Girls	12	13.58	4.25	1.23			86		difference is considered to be not statistically significant

The above table shows the comparison of performance of girls and boys in pre-test. The two-tailed P value is 0.4359 with degree of freedom 11 and t=0.8086 at 0.05 significance level. It means t value is not significant for above paired t-test.

Hence, the stated null hypothesis is accepted which is "There is no significant difference in mean scores of achievement in physics at pre-test stage of boys and girls of class IX at government Inter College Lalpur Kotdwara Uttarakhand."
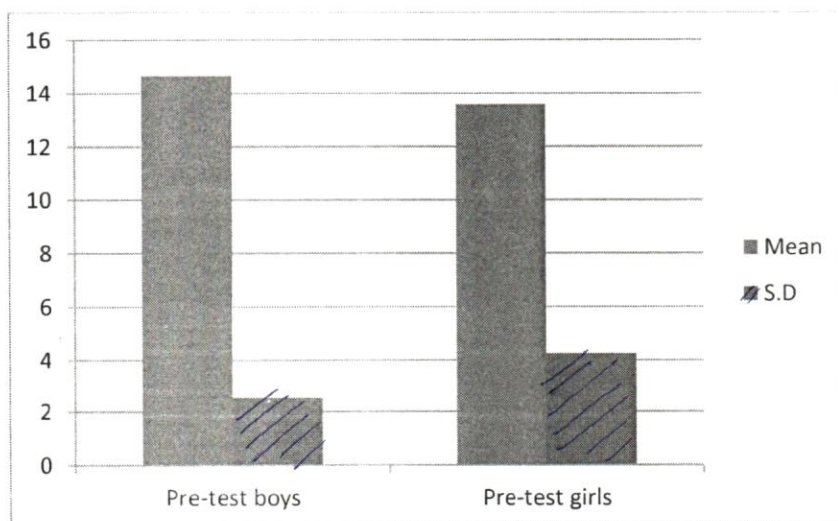

Figure 4.2: Comparison of mean and SD scores obtained by boys and girls of class IX in pre-test

3. **Analysis of arithmetic means of post-test scores achieved by boys and girls separately with the help of paired t-test**
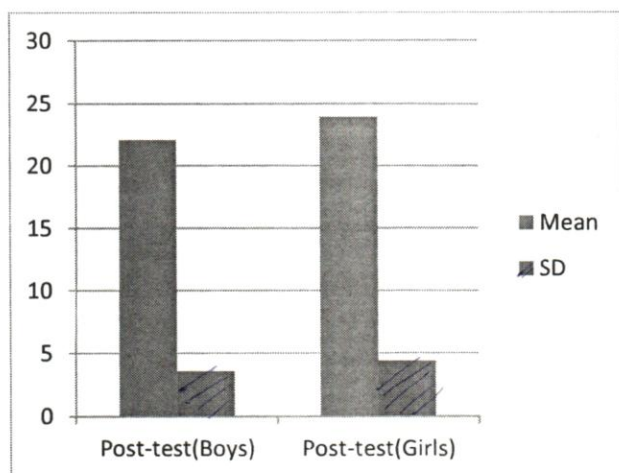
The following table shows the arithmetic mean scores of post-test achieved by boys and girls separately with standard deviation, degree of freedom and t-value. The purpose of conducting this test is to determine whether there is statistical evidence that the mean difference between paired observation on a particular outcome is significantly different or not.

Table 7-Result of paired t-test of post test scores of boys and girls separately

Post-test	N	Mean	Standard deviation	SEM	Mean difference	Two tailed P-value	t-value	Degree of freedom	Level of significance at 0.05 level
Boys	12	22.08	3.60	1.04	1.83	0.1484	1.5542	11	Is not statistically significant
Girls	12	23.92	1.88	0.54					

The above table shows the comparison of performance of girls and boys in post-test. The two-tailed P value is 0.1484 with degree of freedom 11 and t=1.5542 at 0.05 significance level. It means t value is not significant for above paired t-test.

Hence, the stated null hypothesis is accepted which is "There is no significant difference in mean scores of achievement in physics at post-test stage of boys and girls of class IX at government Inter College Lalpur Kotdwara Uttarakhand."

Figure 4.3: Comparison of mean and SD post-test scores of boys and girls of class IX students

4. **Analysis of arithmetic means of pre-test and post-test scores achieved by students with the help of paired t-test-**

The following table shows the arithmetic mean of scores of post-test and retention test achieved by students with standard deviation, degree of freedom and t-value. The purpose of conducting this test is to determine whether there is statistical evidence that the mean difference between paired observation on a particular outcome is significantly different or not.

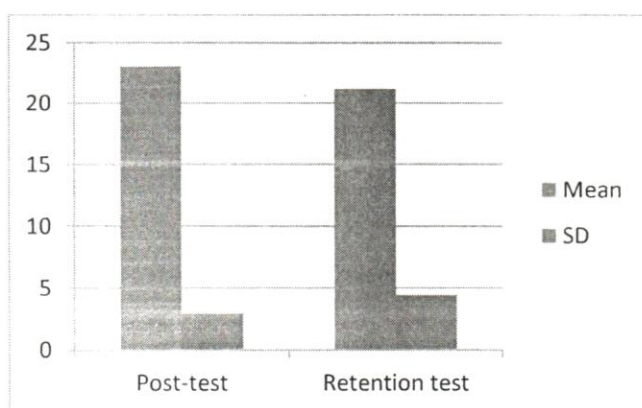**Table 8-Result of paired t-test of scores of post-test and retention test**

Test	N	Mean	Standard deviation	SEM	Mean Difference	Degree of freedom	t-value	Level of significance at 0.05

Post-test	25	23.04	2.91	0.58	1.88	24	12.035	Statistically Significant
Retention-test	25	21.16	2.87	0.57				

The above table shows the comparison of performance of students between post-test stage and retention test in physics. The two-tailed P value is less than 0.0001 with degree of freedom 24 and t=12.035 at 0.05 significance level. It means t value is significant for above paired t-test.

Hence, the stated null hypothesis is rejected which is "There is no significant difference in mean scores of achievement in physics at post-test and retention-test stages of students of class IX taught through integration of virtual laboratory with subject at government Inter College Lalpur Kotdwara Uttarakhand." and

The alternative hypothesis is accepted which is "There is significant difference in mean scores of achievement in physics at post-test and retention-test stages of students of class IX taught through integration of virtual laboratory with subject at government Inter College Lalpur Kotdwara Uttarakhand."

Figure 4.4: Comparison of Mean and SD scores of Post-test and retention test achieved by students

4.6 Analysis of feedback form

In feedback maximum students were impressed with online teaching. For the 25 students, detailed description of points is given below,

Table 9-Analysis of feedback form

Points	Number of students (25)	Total
35	1	35
34	5	170
33	2	66
32	10	320
31	04	124
30	03	90
		805

Maximum points for 26 students were 910. All the students got 805 points, which is 92.00 percentages.

With reference to it investigator concluded that the students were extremely happy with online teaching.

4.6 Result and Discussion-

The main aim of this study was to check the effectiveness of virtual laboratory in terms of achievement of students of class IX in physics. The researcher compared the scores of pre-test and post-test and found that there is a significant difference in mean scores of achievement in physics at pre-test and post-test stages of students of class IX taught through

integration of virtual laboratory with subject. This indicates that integration *of virtual laboratory with subject is effective.* The researcher also analyzed the influence of gender in terms of achievement, to find it the researcher compared the scores of pre-test and post-test of boys and girls separately and found that there is no significant difference in mean scores of achievement in physics at pre-test stage and post-test stage of boys and girls separately. This indicates that there is no role of gender in learning. The researcher also analyzed the retention capability of students after the introduction of virtual laboratory and found that there is significant difference in mean scores of achievement in physics at post-test and retention-test stages of students of class IX taught through integration of virtual laboratory with subject. It means virtual laboratory effectively affected the retention capability of students.

This study found out that the integration of virtual labs with subject is highly effective in developing the laboratory experimental skills in physics. This was supported by many research studies conducted with integration of ICT mode by various researchers, such as, Tatli, and Ayas, (2013) analyzed through their study that virtual chemistry laboratory software is effective as the real laboratory, both in terms of student achievement in the unit and students' ability to recognize laboratory equipment. Akpan and Andre (2000), in their study indicated that students receiving Simulation before Dissection and Simulation Only students learned significantly more anatomy than students receiving dissection before simulation, Dissection- only. Cengiz Tuysuz (2010) identified that the use of virtual lab increased students' achievement levels and made a positive impact on students' attitude towards chemistry.

4.7 <u>Conclusion-</u>

From the above analysis and interpretation of data we can conclude that integration of virtual laboratory with subject is more effective than the traditional method approach to teach students. Especially the introduction of virtual laboratory is highly useful for teaching in this pandemic situation when physical presence in laboratory is not possible. Virtual laboratory can be beneficial for those schools which are located in rural areas and tribal areas where schools have infrastructure limitation. Virtual laboratory can be one of the best alternatives of laboratory. In this tech era teachers can be far sighted to develop such types of laboratory.