Chapter - 4

Analysis and Interpretation of Data

4. Introduction

Analysis of data collected from the experiment and interpretation of the results are presented in this chapter. The analysis of data has been presented in four sections. Out of this four-section, the first section deals with the comparison of pre-test data of experimental and control groups concerning Academic Achievement. Section two deals with the analysis of chapter-wise Achievement tests (i.e. Achievement Test - 2,3,4, and 5) data on the effect of the chapter-wise strategies on Achievement in Chemistry, section three deals with the comparison of post-test data of experimental and control groups for Academic Achievement. Last section four deals with the qualitative analysis of data obtained through the Student's reaction scale for objective two.

The tests mean scores of the experimental group and control group were compared by applying Mann Whitney U-test. These were done to find whether the two groups of students were similar in terms of the dependent variable before being subjected to the treatment. The Mann-Whitney U-test calculation used an online statistical calculator. Though the Experimental and Control Group were matched on academic achievement of Chemistry, this was done to confirm whether the experimental and control two groups were equal in terms of academic achievement in Chemistry. To test this, the following Null Hypothesis was set up:

4.1 Data analysis and Hypotheses Testing

Objective: To study the effectiveness of the strategies based on constructivist learning in Chemistry for Standard XI students in terms of their academic achievement.

H_{O1} :- There is no significant difference in pre-test Academic Achievement mean scores of Experimental Group and Control Group.

To test the above hypotheses Mann Witney U-test was used. The summary table of U-test with reference to Pre achievement test (1) mean scores is given in table 4.1.

Table 4.1: Summary table showing the num*ber, mean scores, SD, U-test value and level of significance for Pre-achievement test-1 scores of experimental group and control group before the treatment.*

Group	N	Mean	SD	Mann Witney U-test value	z- Value	Level of significance
Experimental group	34	18.09	6.39	410.5	3.16536	($p < 0.01$)
Control group	42	23.50	6.15			
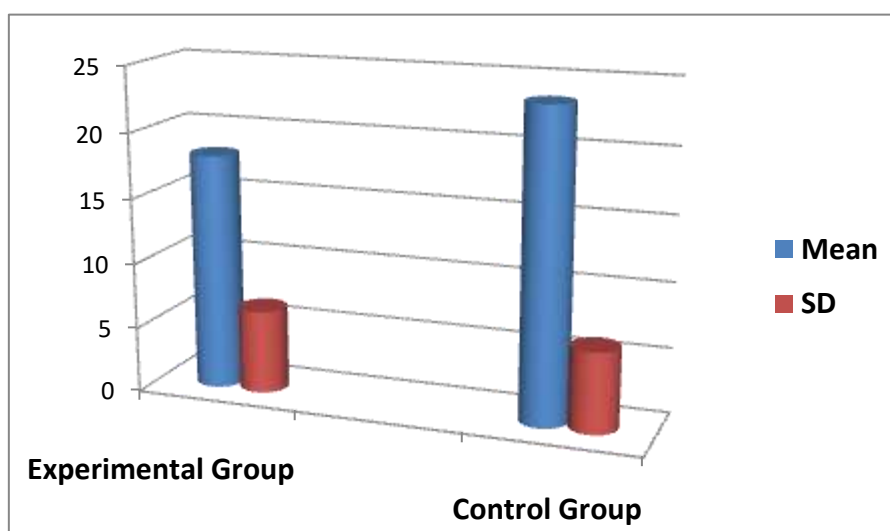
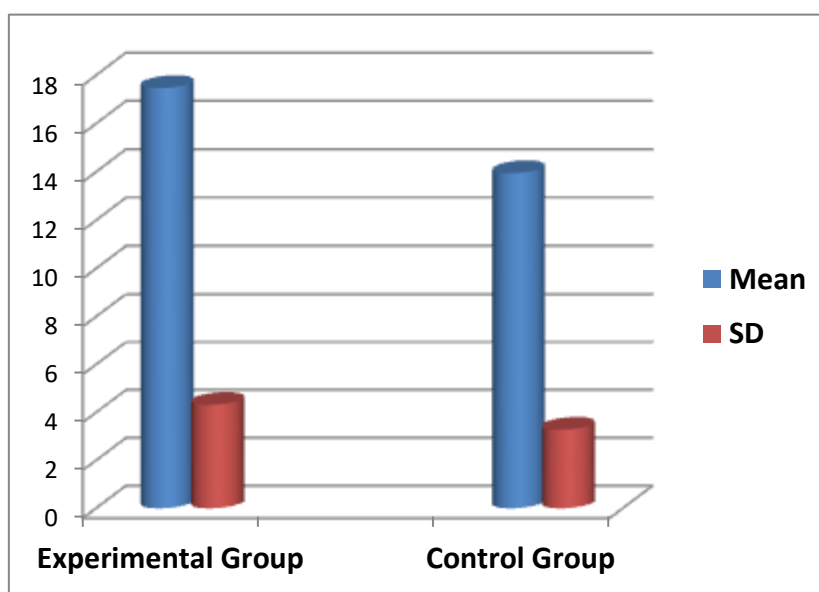**Graph 4.1: Mean and SD Values for Achievement test-1 Scores**

Interpretation: Mean and SD values for pre-achievement scores in graph 4.1 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn = 17.5) than for Control group (Mdn = 23.5), U = 410.5, the p-value is 0.00152, the z-Score is 3.16536. The result is significant at $p < .01$. Thus, the researcher found out there was significant difference in previous standard Chemistry Knowledge between the students of Experimental Group and Control group.

H_{O2} :- There is no significant difference in Achievement Test mean scores at end of the chapters of Experimental Group and Control Group.

i) To test the above hypotheses Mann Whitney U-test was used. The summary table of U-test with reference to achievement test-2 mean scores is given in table 4.2.

Table 4.2: Summary table showing the num*ber, mean scores, SD, U-test value and level* *of significance for achievement test-2 scores of experimental group and control group after* *completed first Unit.*

| Group	N	mean	SD	Mann Witney U-test value	z- Value	Level of significance
Experimental group	34	17.47	4.32	370	3.58846	(p < 0.01)
Control group	42	13.95	3.28			

Graph 4.2: Mean and SD Values for Achievement test-2 Scores

Interpretation: Mean and SD values for achievement scores in graph 4.2 shows that mean of experimental group were slightly greater than control group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn = 18) than for Control group (Mdn = 13), U = 370, the z - score is -3.58846. The p-value is .00034. The result is significant at $p <$ .01. Thus, the researcher found out there was significant difference in Chemistry Knowledge between the students of Experimental Group and Control group.

    ii)   To test the above hypotheses Mann Whitney U-test was used. The summary table of U-test with reference to achievement test-3 mean scores is given in table 4.3.

Table 4.3: Summary table showing the num*ber, mean scores, SD, U-test value and level* *of significance for achievement test-3 scores of experimental group and control group after* *completed Second Unit.*

| Group	N	mean	SD	Mann Witney U-test value	z- Value	Level of significance
Experimental group	34	17.70	4.12	410.5	-2.87808	(p < 0.01)
Control group	42	15.07	3.44			
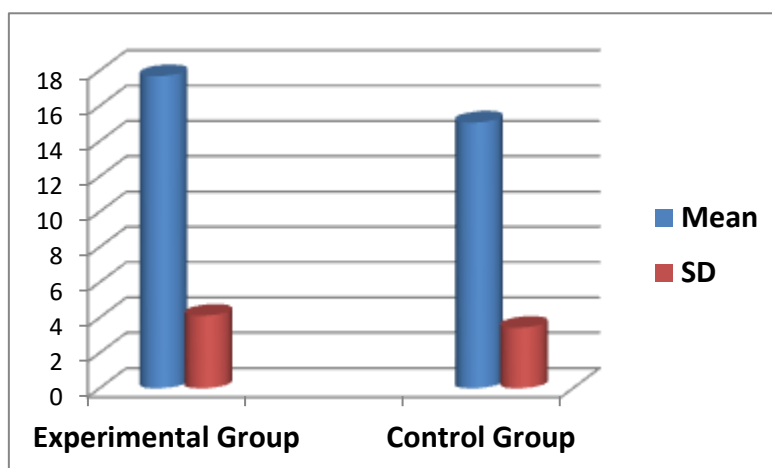
Graph 4.3: Mean and SD Values for Achievement test-1 Scores

Interpretation: Mean and SD values for pre-achievement scores in graph 4.3 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn = 18) than for Control group (Mdn = 15), U = 410.5, the z - score is -2.87808. The p-value is .00398. The result is significant at $p < .01$. Thus, the researcher found out there was significant difference in Chemistry Knowledge between the students of Experimental Group and Control group.

    iii)   To test the above hypotheses Mann Witney U-test was used. The summary table of U-test with reference to achievement test-1 mean scores is given in table 4.4.

Table 4.4: Summary table showing the number, mean scores, SD, U-test value and level of significance for achievement test-4 scores of experimental group and control group after completed third Unit.

| Group	N	mean	SD	Mann Witney U-test value	z- Value	Level of significance
Experimental group	34	17.73	4.44	438	-0.84096	(p < 0.01)
Control group	42	16.26	3.20			
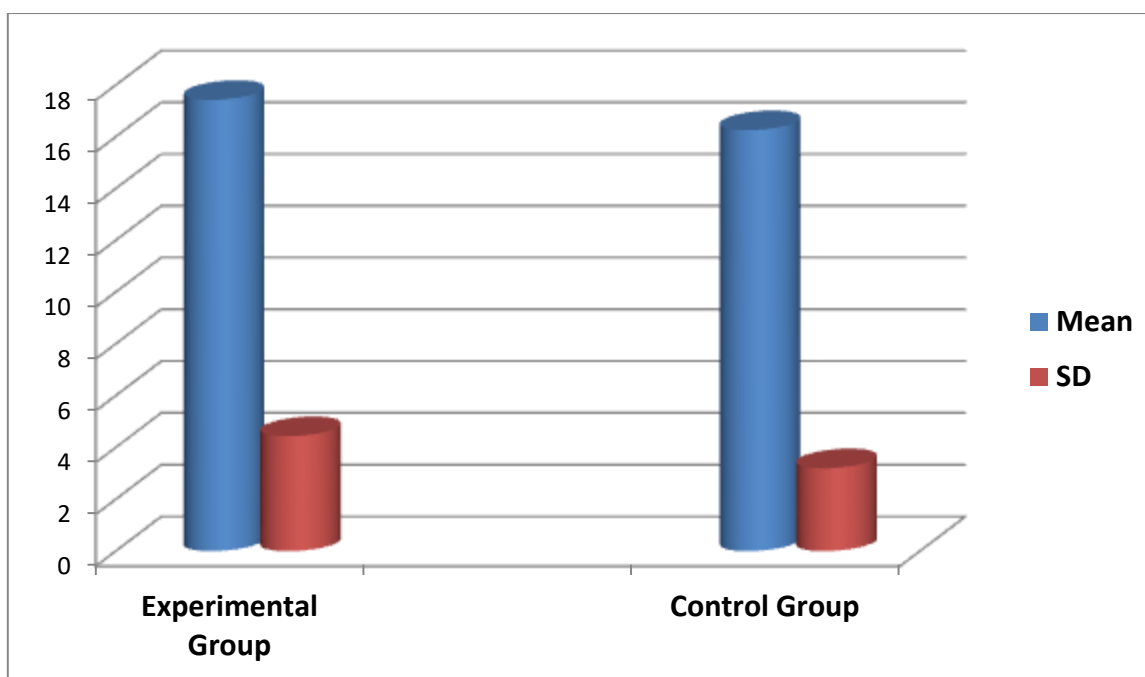
Graph 4.4: Mean and SD Values for Achievement test-1 Scores

Interpretation: Mean and SD values for pre-achievement scores in graph 4.4 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn =18) than for Control group (Mdn = 17), U= 438, the Z-Score is -2.87808. The p-value is .00398. The result is significant at $p < .01$. Thus, the researcher found out there was significant difference in Chemistry Knowledge between the students of Experimental Group and Control group.

iv) To test the above hypotheses Mann Witney U-test was used. The summary table of U-test with reference to achievement test-1 mean scores is given in table 4.5.

**Table 4.5: Summary table showing the num*ber, mean scores, SD, U-test value and level of significance for achievement test-5 scores of experimental group and control group after completed fourth Unit.*

Group	N	Mean	SD	Mann Witney U-test value	z- Value	Level of significance
Experimental group	34	18.71	3.64	444.5	-2.81018	(p < 0.01)
Control group	42	16.12	3.71			
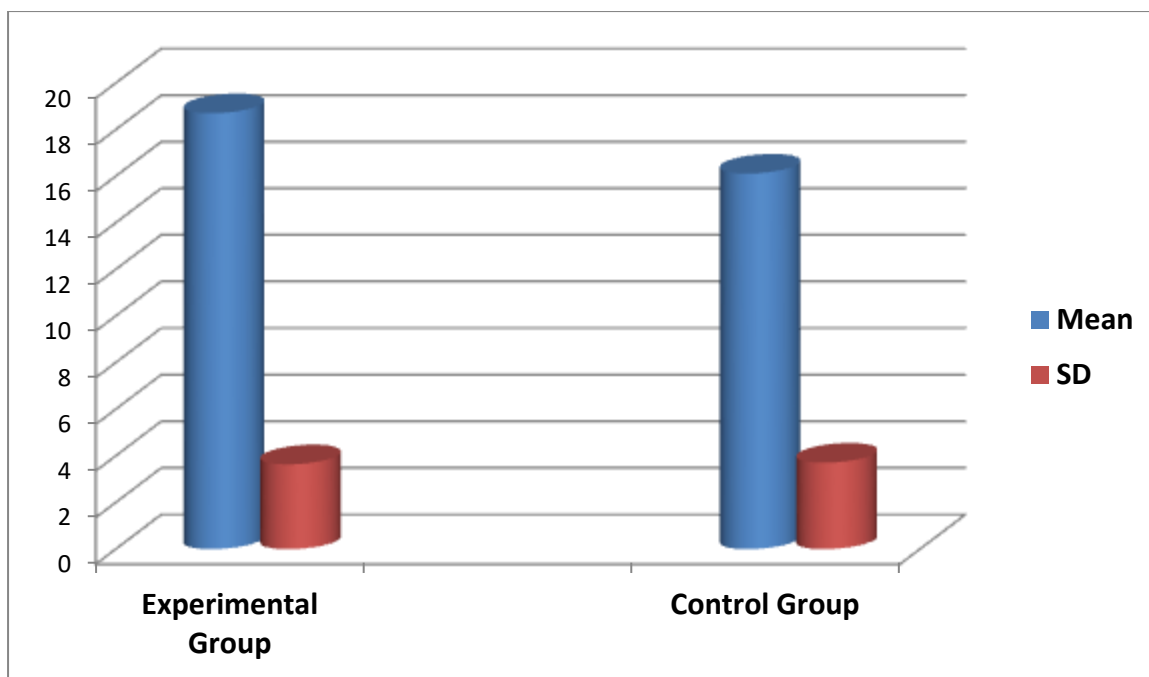
Graph 4.5: Mean and SD Values for Achievement test-1 Scores

Interpretation: Mean and SD values for pre-achievement scores in graph 4.5 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn = 19) than for Control group (Mdn = 16), U = 444.5, the z-Score is -2.81018. The p-value is 0.00496. The result is significant at $p < 0.01$. Thus, the researcher found out there was significant difference in Chemistry Knowledge between the students of Experimental Group and Control group.

H_{O3} :- There is no significant difference in post-test Achievement mean scores of experimental and control groups.

To test the above hypotheses Mann-Whitney U-test was used. The summary table of U-test with reference to Post achievement test mean scores is given in table 4.6.

Table 4.6: Summary table showing the num*ber, mean scores, SD, U-test value and level of significance for achievement test-6 scores of experimental group and control group after completed the treatment.*

Group	N	Mean	SD	Mann Witney U-test value	z - Value	Level of significance
Experimental group	34	31.53	7.90	451.5	-2.73705	(p < 0.01)
Control group	42	26.76	5.49			

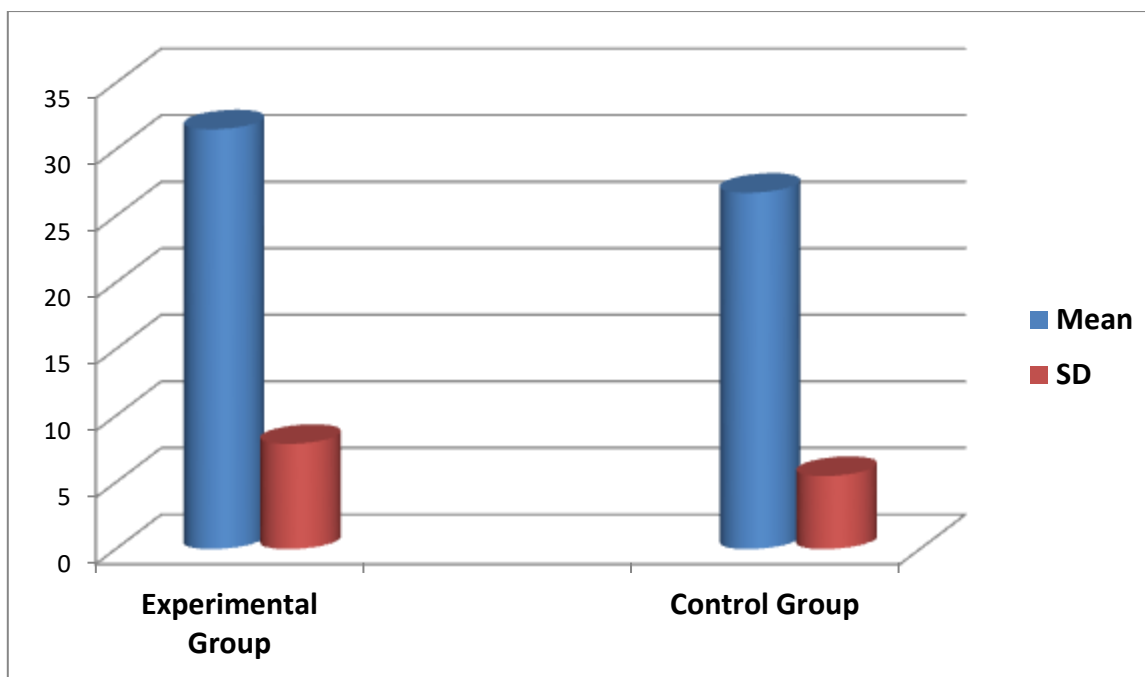**Graph 4.6: Mean and SD Values for Achievement test-1 Scores**

Interpretation: Mean and SD values for pre-achievement scores in graph 4.6 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for Experimental group (Mdn = 31.5) than for Control group (Mdn = 27), U = 451.5, the z- Score is -2.73705. The p-value is 0.00614. The result is significant at $p < 0.01$. Thus, the researcher found out there was significant difference in Chemistry Knowledge between the students of Experimental Group and Control group.

H$_{O4}$:- There is no significant relation in terms of standard X chemistry knowledge (pre-test) and standard XI Chemistry concepts (post-test) of experimental group and control group.

Table 4.7: Summary table showing the num*ber, mean scores, SD, U-test value and level of significance for pre-test – post-test scores of experimental group.*

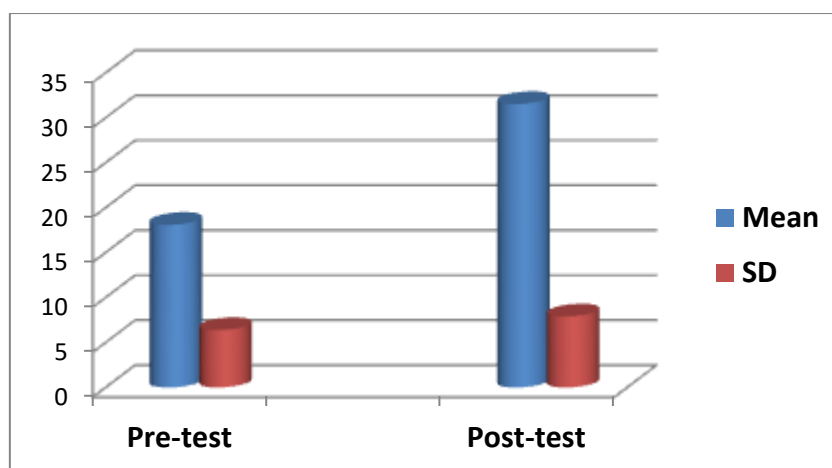| Test	N	mean	SD	Mann Witney U-test value	z- Value	Level of significance
Pre-test	34	18.09	6.39	111.5	-5.71575	(p < 0.01)
Post-test	42	31.53	7.90			

Graph 4.7: Mean and SD Values for Achievement test-1 Scores

Interpretation: Mean and SD values for pre-achievement scores in graph 4.7 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for pre-test (Mdn = 17.5) than for post-test (Mdn = 31.5), **U = 111.5,** the z-Score is -5.71575. The p-value is < .00001.The result is significant at $p < 0.01$. Thus, the researcher found out there was significant difference in Achievement between the Pre-test and Post-test.

Table 4.8: Summary table showing the num*ber, mean scores, SD, U-test value and level of significance for pre-test – post-test scores of Control group.*

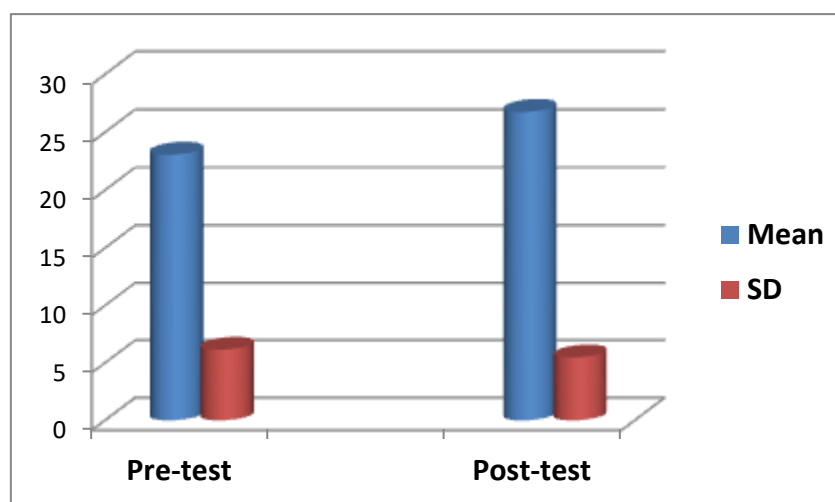| Test	N	Mean	SD	Mann Witney U-test value	z- Value	Level of significance
Pre-test	34	23.07	6.15	595.5	-2.55857	(p < 0.01)
Post-test	42	26.76	5.48			

Graph 4.8: Mean and SD Values for Achievement test-1 Scores

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Interpretation: Mean and SD values for pre-achievement scores in graph 4.8 shows that mean of control group were slightly greater than experimental group. A Mann-Whitney test indicated that the Achievement test was greater for pre-test (Mdn = 23.5) than for post-test (Mdn = 27), U = 595.5, the z- Score is -2.55857. The p-value is .01046. The result is significant at $p < 0.01$. Thus, the researcher found out there was significant difference in Achievement between the Pre-test and Post-test.

Objective: To study the reaction of students to the strategy based on constructivist learning in Chemistry.

This section deals with the qualitative analysis of data obtained through the Student's reaction scale. The quantitative results are supported by the qualitative analysis of the responses of students on the Student Reaction which aimed at collecting their opinion towards Constructivist Strategies of teaching Chemistry. The reactions toward learning through constructivist strategy were collected in the form of a five-point Likert scale (i.e. Always, Frequently, Occasionally, Rarely, and Never). Types of responses are calculated in form of frequency and percentage. The statements are mixed in the questionnaire. Which assess new learning method was easy to understand or enjoyable, developed interest into chemistry learning, self-learning or solved the problem/numerical and learning environment through Reaction scale. It was found in frequency and percentage of 34 close-ended statements given in table 4.9 and table 4.10. The statements are mixed in the questionnaire are responses given in table 4.9 and table 4.10 easy to understand or enjoyable (3, 6, 9, 16, 31), developed an interest (4, 5, 8, 19, 21) in chemistry learning, self-learning (7, 11, 13, 20) or solved problem/numerical (27, 33, 34), student achievement (12, 26) and learning environment (1, 14, 30) through Reaction scale. Most of the responses are favoring all variables. Very few are not clear all-time easy to understand, it is described in frequency and percentage in Table 4.9 and Table 4.10.

Table 4.9: Reactions of students

St. no.*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Always	50% (17)	56% (19)	44% (15)	44% (15)	44% (15)	47% (16)	35% (12)	53% (18)	41% (14)	44% (15)	38% (13)	47% (16)	53% (18)	53% (18)	38% (13)	56% (19)	41% (14)
Frequently	47% (16)	32% (11)	47% (16)	41% (14)	50% (17)	44% (15)	50% (15)	32% (11)	56% (19)	41% (14)	47% (16)	44% (15)	41% (14)	38% (13)	56% (19)	41% (14)	53% (18)
Occasionally	9% (3)	12% (4)	9% (3)	9% (3)	3% (1)	6% (2)	9% (3)	12% (4)	3% (1)	12% (4)	12% (4)	6% (2)	6% (2)	9% (3)	3% (1)	3% (1)	6% (2)
Rarely	0% (0)	0% (0)	0% (0)	3% (1)	3% (1)	3% (1)	6% (2)	3% (1)	0% (0)	3% (1)	3% (1)	3% (1)	0% (0)	0% (0)	3% (1)	0% (0)	0% (0)
Never	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)

Table 4.10: Reactions of students

St. no.*	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Always	62% (21)	35% (12)	56% (20)	38% (13)	38% (13)	53% (18)	44% (15)	53% (18)	53% (18)	56% (19)	56% (19)	41% (14)	53% (18)	44% (15)	62% (21)	50% (17)	71% (24)
Frequently	29% (10)	59% (20)	32% (11)	56% (19)	50% (17)	41% (14)	53% (18)	44% (15)	44% (15)	35% (12)	41% (14)	53% (18)	44% (15)	44% (15)	37% (13)	47% (16)	29% (10)
Occasionally	6% (2)	3% (1)	6% (2)	6% (2)	12% (4)	6% (2)	3% (1)	3% (1)	0% (0)	9% (3)	3% (1)	3% (1)	3% (1)	9% (3)	0% (0)	3% (1)	0% (0)
Rarely	3% (1)	3% (1)	3% (1)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	3% (1)	0% (0)	3% (1)	0% (0)	0% (0)	0% (0)
Never	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)

Note : St. no. = Statement number, Percentage % (No. of Student responses)

Students Reactions to the Experiment in Chemistry

The overall study of the reactions of all students shows that there is a positive and increased understanding in chemistry. This is shown in the Figure NO.4.
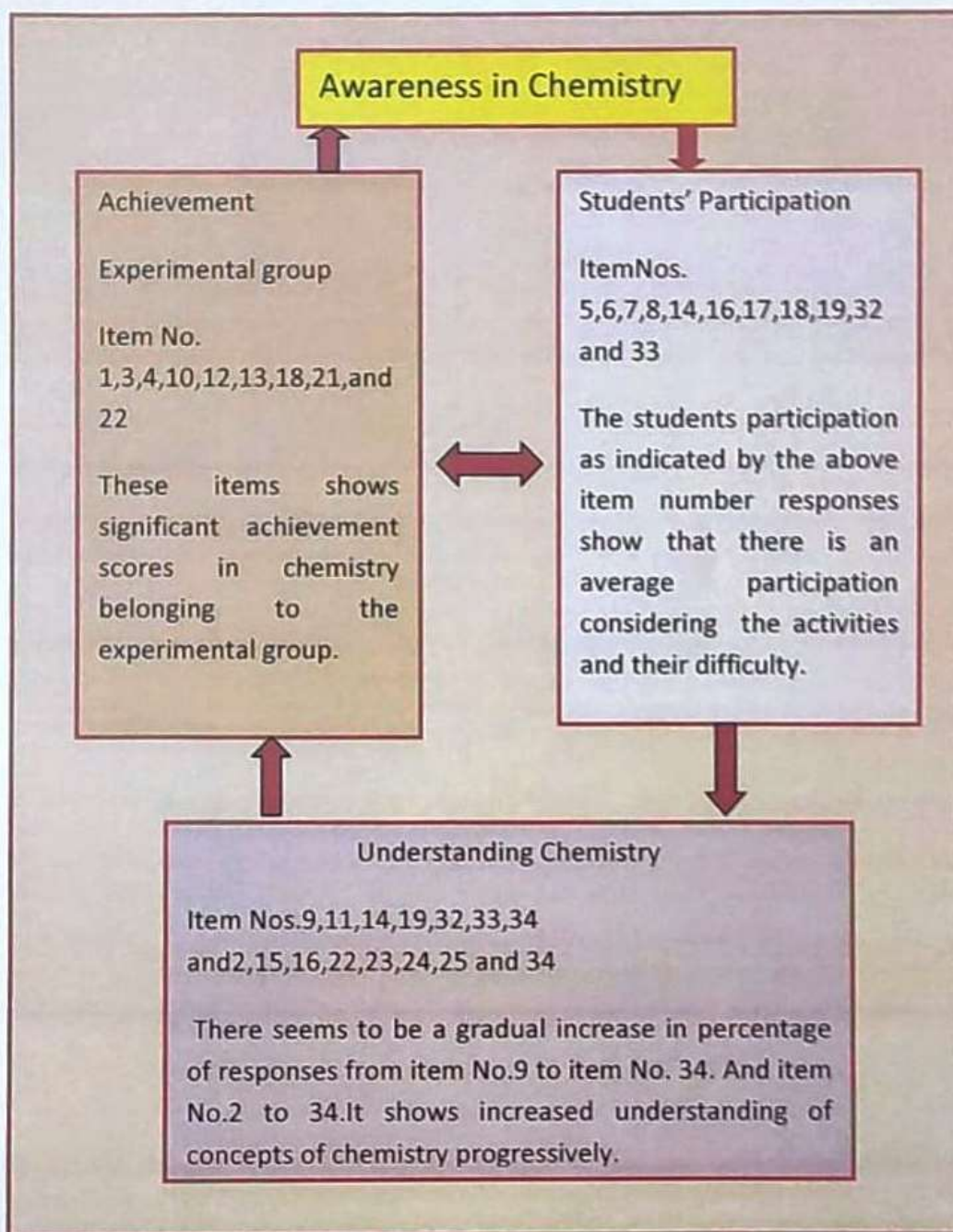
Awareness in Chemistry

Achievement

Experimental group

Item No.
1,3,4,10,12,13,18,21,and 22

These items shows significant achievement scores in chemistry belonging to the experimental group.

Students' Participation

ItemNos.
5,6,7,8,14,16,17,18,19,32 and 33

The students participation as indicated by the above item number responses show that there is an average participation considering the activities and their difficulty.

Understanding Chemistry

Item Nos.9,11,14,19,32,33,34 and2,15,16,22,23,24,25 and 34

There seems to be a gradual increase in percentage of responses from item No.9 to item No. 34. And item No.2 to 34.It shows increased understanding of concepts of chemistry progressively.

Figure 4.9 showing the Reactions of Students of experimental group in Chemistry

The quantitative results are supported by the qualitative analysis of the responses of students on the Student Reaction Scale which aimed at collecting their opinion towards Social Constructivist Strategies of teaching Chemistry. It was found that:

- 95% of the students liked the Constructivist Strategies of teaching Chemistry and opined that they have learned the Chemistry topics meaningfully through these strategies.
- 96% of students expressed that they learned Chemistry lessons without any difficulty and enjoyed learning Chemistry in the Social constructivist classroom.
- 97% of students agreed that the new method of teaching helped them in understanding each other in a better way.
- 99% of students liked doing activities cooperatively in a group and 98% of them opined that Constructivist strategies fostered attachment between their Group members.
- 93% of them opined that the encouragement received by them during engaging in activities even when the answer was not immediately apparent was motivating and 92% of students expressed that the group activity provided an opportunity to learn provides a less stressful environment and the evaluation procedure followed developed a healthy competition in the group.
- 96% of students liked the classroom environment because it helped them in building a good relationship with their classmates.
- 97% of students liked to work in cooperative groups and expressed that the cooperative and collaborative work helped them in understanding the content of Chemistry clearly.
- 96% of students agreed that the activities which helped them to learn new knowledge on their own brought a feeling of pride and confidence in their abilities to plan, organize and learn new knowledge. 97% of them opined that the activities made their learning meaningful.

Apparently, through the analysis of the reaction of the students, it can be concluded that the students distinctly liked the way the Chemistry lessons were introduced, the learning environment, and the activities and assignments are given to them to learn the content.