CHAPTER - V

CHAPTER – V
DATA ANALYSIS AND INTERPRETATION

5.0 INTRODUCTION

The Chapter-V has been developed to elaborate the several analytical procedures conducted on the data collected for and from the present experimental research study. An Analysis, according to **Kothari & Garg (2014)** is mean to the computation of certain indices or measures along with searching for patterns of relationship that exist among the data groups. Analysis in case of experimental data, involves estimating the values of unknown parameters of the population and testing of hypotheses for drawing inferences. Analysis may mainly categorize as (a) Descriptive Statistics/ analysis and (b) Inferential Statistics/analysis (also known as Statistical analysis).

Descriptive Statistics/analysis is about the study of the distributions of one or more variables involved in the study. While, Inferential Statistics/analysis is concerned with the various tests of significance for testing hypotheses in order to determine with what validity data can be said to indicate some conclusion/s. With such focuses, the analyses were conducted for the present research study presented in this Chapter-V.

As the efficacy of the developed SOLO based Instructional Strategy had been measured with the help analysis of the data collected for the present experimental research study. Comparison between the achievements of the experimental and control group as well reactions expressed by the experimental group were the measurable as well as the decisive components of the study. With the same reference, this Chapter has been develop to elaborate with justifications about the fulfillment of the objectives formulated for the present research study and also to test all the hypotheses framed with respect to each objectives.

There were five out of total seven Objectives that is Objective-3 to 7 were dealing with study of the effectiveness for the present research study and total seventeen Hypotheses were framed with respect to the said five Objectives which are presented Objective-wise here in the further sections.

For the present experimental study, only post-tests were administered on both the control group and experimental group for their achievements in all the five chapters as well as an overall or final achievement in the class – IX Mathematics. The five chapters selected from Class-IX Mathematics textbook for CBSE (2014-2015) are as:

(1) Chapter – 12 Heron's Formula;
(2) Chapter – 4 Linear Equation (L. E.) in Two Variables;
(3) Chapter–8 Quadrilaterals;
(4) Chapter–14 Statistics;
(5) Chapter–15 Probability.

Here, in this study the meaning of achievement is with respect to the Levels of Understanding and progressiveness from surface to deeper Understanding as it means according to SOLO Taxonomy. Though, the researcher of this study made effort to analyze the Level of Understanding of both the groups through the Statistical analysis of the Achievement Tests through all the five levels of SOLO Taxonomy which is presented ahead. Further Rasch Model had been employed in terms to study and conclude about the learners' ability in the form of Understanding with respect to the difficulty levels of the items of the Achievement tests.

Before the detailed analysis, several Graphical presentations are shown below to study and interpret about the present experimental research study.

5.1 GRAPHICAL PRESENTATIONS AND INTERPRETATIONS

In terms to observe the significant differences of the individualized scores, the Graphical Presentations are shown on all the six Achievement Test-scores in terms to depict about the comparisons between the achievements of experimental group and control group and also to observe performances of the individuals of each group.

Following tables-5.1 and 5.2 are showing the scores achieved by both the experimental and control group in all the chapter-wise Post-tests as well as in Overall/Final achievement test.

Table – 5.1:
Achievement Test-Scores gained by an Experimental group in all the Post-tests

Experimental Group (E)						
Sr. Code	Chapter-wise Achievement Test Scores (Out of MM-25)					FINAL TEST (MM-75)
	Chapter-12	Chapter-4	Chapter-8	Chapter-14	Chapter-15	
E – S01	12.25	16.00	19.00	13.50	15.00	50.00
E – S02	20.50	20.00	17.00	18.00	22.50	62.00
E – S03	18.00	14.00	21.50	17.50	19.50	51.00
E – S04	18.00	21.00	16.50	20.00	22.00	66.00
E – S05	18.50	20.00	19.50	18.00	22.50	53.50
E – S06	21.75	17.00	18.50	17.75	21.00	46.50
E – S07	21.50	17.50	18.50	19.50	21.50	47.00
E – S08	20.00	19.50	16.50	21.00	22.50	50.50
E – S09	12.00	15.50	18.50	21.00	23.00	47.50
E - S10	16.50	17.75	18.50	19.00	20.00	49.00
E - S11	11.50	16.00	16.00	20.50	23.50	51.50
E - S12	12.50	18.00	15.00	21.50	22.00	50.00
E - S13	13.50	16.50	17.00	17.50	19.50	48.00
E - S14	23.50	21.50	19.00	21.00	21.00	51.50
E - S15	22.50	20.50	19.75	19.25	20.00	55.75
E - S16	23.00	16.50	19.00	19.50	20.50	56.75
E - S17	18.00	17.00	21.00	18.00	24.00	54.25
E - S18	18.00	16.50	20.00	20.50	21.50	61.25
E - S19	21.00	16.00	15.50	17.50	19.50	51.50
E - S20	23.00	17.00	17.00	18.00	22.50	53.75
E - S21	21.75	15.50	18.50	18.75	18.50	58.75
E - S22	22.50	19.00	20.25	16.25	19.00	67.50
E - S23	13.50	16.00	16.25	19.50	15.50	50.00
E - S24	15.50	22.50	18.00	20.75	20.50	47.00
E - S25	20.00	20.50	19.00	22.00	23.00	58.50
E - S26	17.50	22.00	13.00	18.00	18.50	53.25
E - S27	21.00	21.00	19.00	15.50	18.00	64.50
E - S28	18.50	16.00	18.50	18.50	21.50	61.50
E - S29	13.00	15.00	16.00	18.50	19.00	42.75
E - S30	21.50	17.50	18.50	19.00	23.00	53.00
Mean	18.34	17.96	18.01	18.84	20.67	53.80
SD	03.80	02.33	01.87	01.86	02.20	06.26
Var.	14.43	05.45	03.49	03.44	04.85	14.43

Table – 5.2:
Achievement Test-Scores gained by a Control group in all the Post-tests

Control Group (C)						
Sr. Code	Chapter-wise Achievement Test Scores (Out of MM-25)					FINAL TEST (MM-75)
	Chapter-12	Chapter-4	Chapter-8	Chapter-14	Chapter-15	
C – S01	20.50	20.00	10.50	15.50	15.00	21.50
C – S02	09.50	06.50	13.00	13.50	14.50	33.00
C – S03	10.50	12.50	02.25	08.50	14.50	23.50
C – S04	08.75	11.50	16.50	09.75	14.00	23.00
C – S05	02.00	09.50	08.50	08.00	12.00	11.00
C – S06	02.25	10.00	10.75	10.00	12.00	27.50
C – S07	12.00	11.25	1.50	10.25	12.50	12.50
C – S08	13.75	15.50	15.00	13.50	16.00	19.00
C – S09	11.00	19.00	19.00	09.25	16.00	30.25
C - S10	03.50	05.50	12.25	07.25	09.00	15.50
C - S11	13.00	12.50	11.50	03.25	11.00	19.50
C - S12	06.00	15.00	18.00	05.25	09.00	20.50
C - S13	01.50	09.25	15.50	07.75	10.00	11.00
C - S14	13.00	12.25	14.50	09.75	10.50	14.50
C - S15	14.50	11.00	17.00	07.25	16.00	23.00
C - S16	03.75	10.75	06.50	06.25	15.00	19.00
C - S17	08.25	14.50	06.00	08.25	15.50	23.50
C - S18	19.00	20.00	16.00	09.25	13.50	27.50
C - S19	04.00	18.50	12.50	10.50	15.50	20.00
C - S20	06.25	12.00	17.50	07.75	13.50	14.00
C - S21	05.25	11.50	08.50	09.00	13.50	17.00
C - S22	10.00	21.00	16.00	08.00	13.00	26.50
C - S23	10.75	21.00	06.50	09.50	08.50	25.50
C - S24	05.00	20.50	15.50	09.50	12.50	12.50
C - S25	06.00	10.00	15.50	11.25	08.50	12.50
C - S26	09.00	17.50	17.50	08.50	11.50	17.00
C - S27	05.00	04.50	10.50	05.50	09.00	14.50
C - S28	06.00	17.50	08.50	07.00	10.00	23.50
C - S29	01.50	09.50	11.50	08.00	08.00	15.00
C - S30	05.50	14.00	05.50	10.50	10.50	18.00
Mean	8.23	13.47	11.99	8.92	12.33	19.71
SD	4.92	4.70	4.78	2.50	2.58	5.90
Var.	24.22	22.14	22.88	6.23	6.66	34.85

All the test-score data given in the above tables are plotted on the following graphs (figure – 5.1 to 5.6). Here in this presentation, scores of all the subjects (students) of a sample could be observed. Two lines present the overall performance of the two groups in a respective achievement test along with individual performances of the subjects of a respective group.

Here in a graph, S1 to S30 on X-axis shows the achievements of the sample that is subjects (students) of both the experimental and control groups. Y-axis is depicted with the range of test-score values.

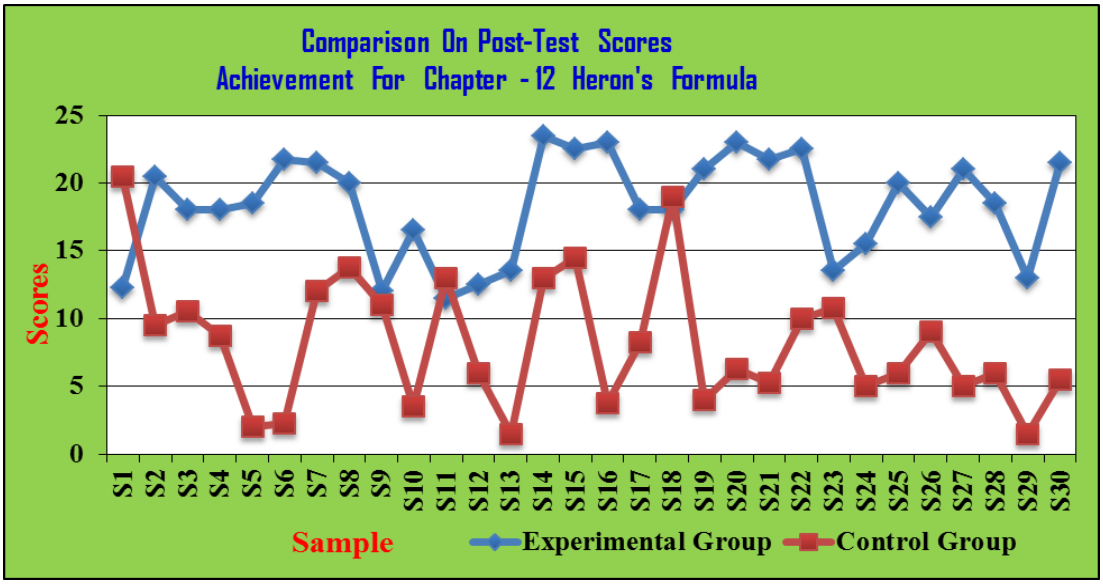


Figure-5.1: Graph to compare Post- test scores of both the groups For Chapter-12

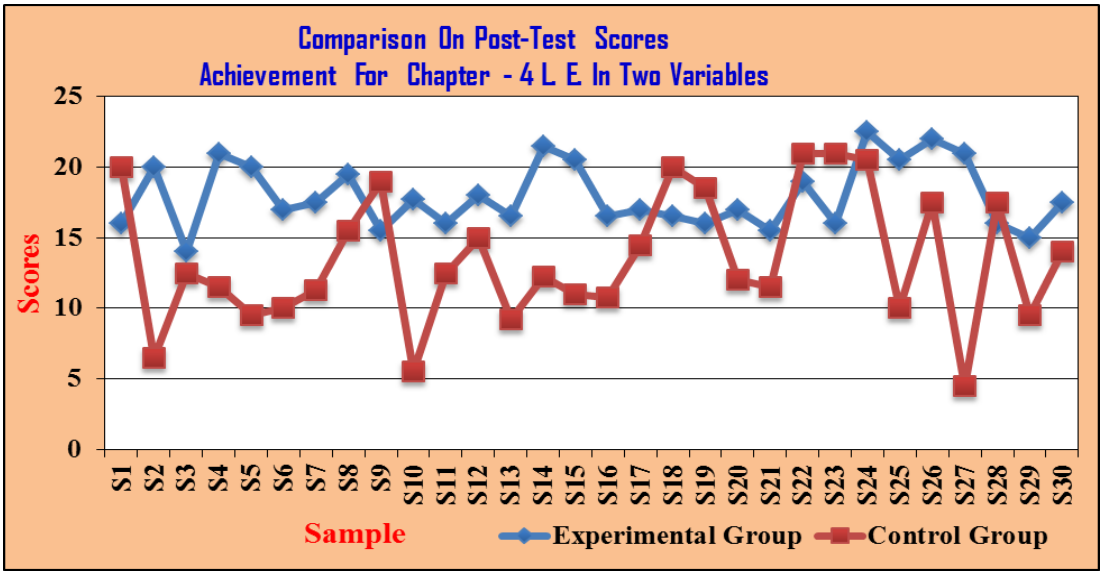


Figure-5.2: Graph to compare Post- test scores of both the groups For Chapter-4

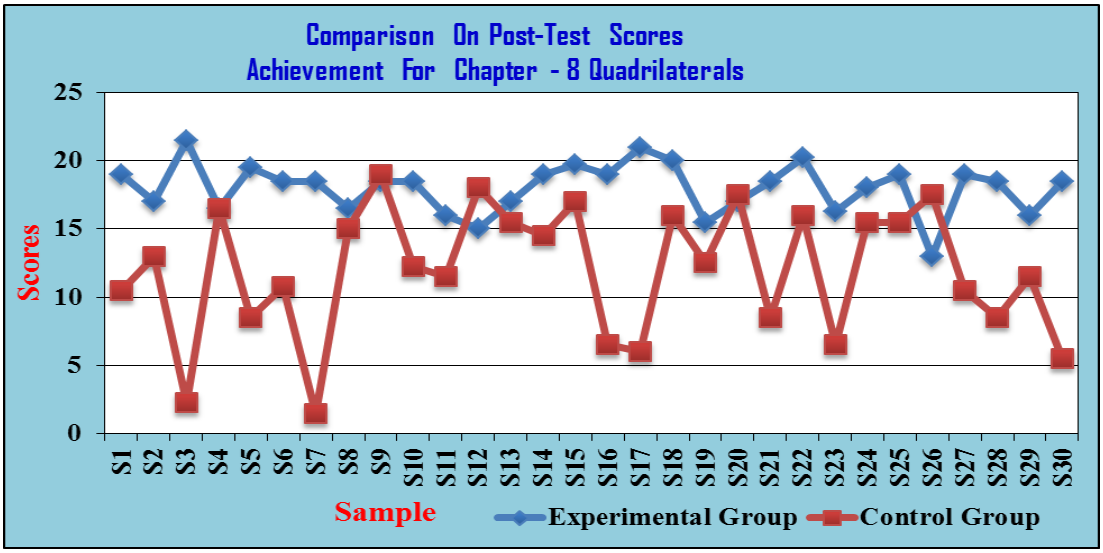


Figure-5.3: Graph to compare Post- test scores of both the groups For Chapter-8

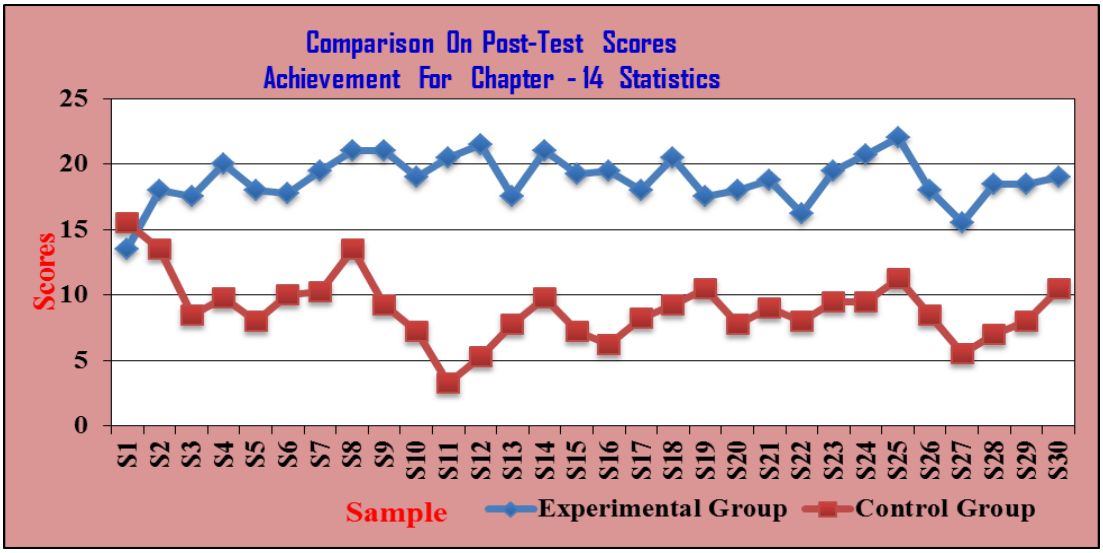


Figure-5.4: Graph to compare Post- test scores of both the groups For Chapter-14

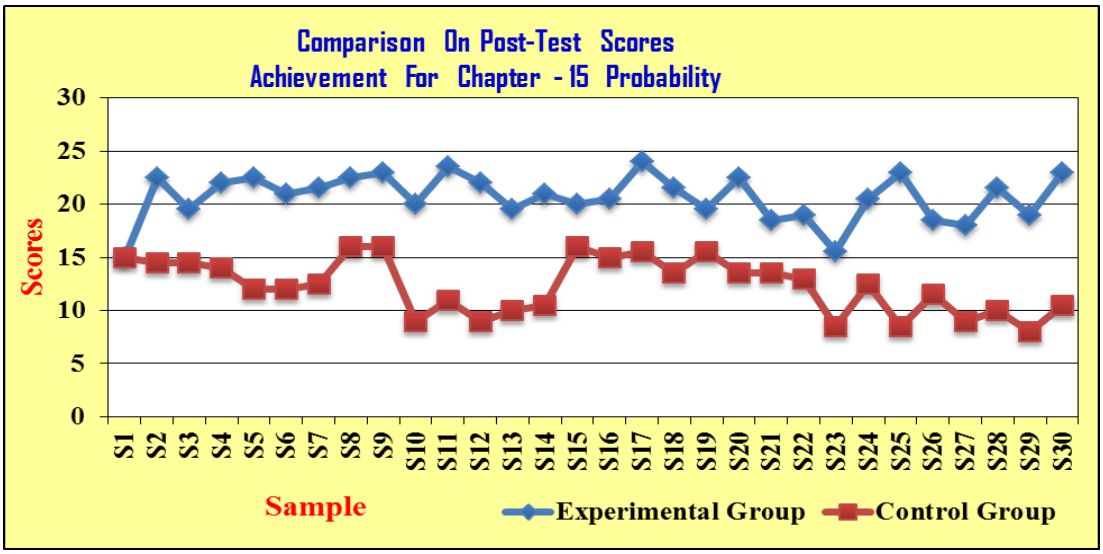


Figure-5.5: Graph to compare Post- test scores of both the groups For Chapter-15

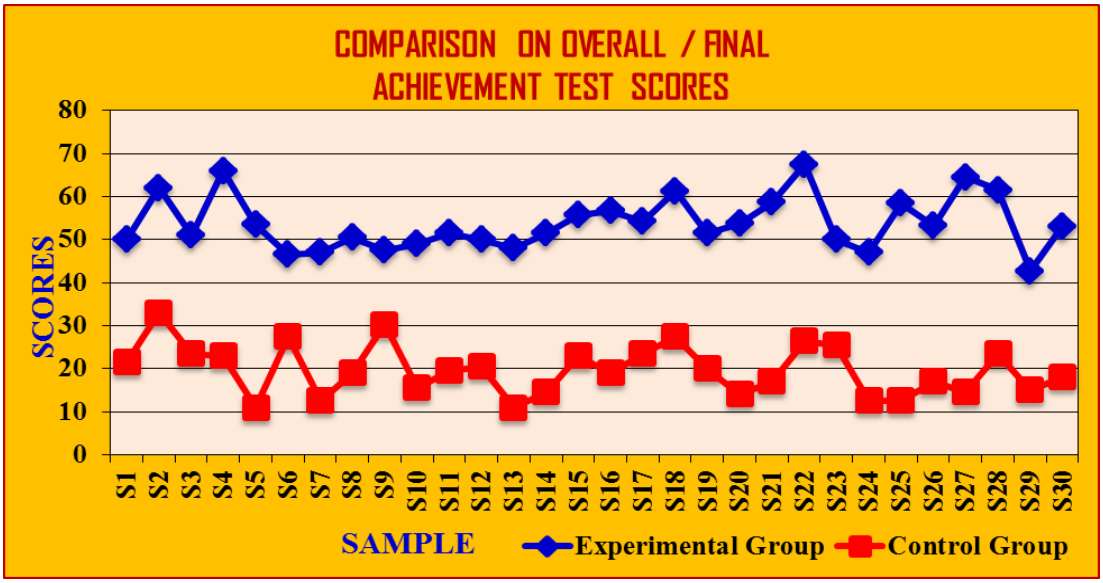


Figure-5.6: Graph to compare Post- test scores of both the groups For Overall Test

Interpretation

From above all of the six graphs (figure-5.1 to 5.6), the reasonable and positive differences had been examined between the achievements at all six Post-test activities attempted by both the groups. Then, the interpretations could be drawn out from the graphical presentations as the experimental group that is the group studied though the new/developed SOLO based Instructional Strategy had gained more scores in all the six Post-tests and performed better compare to a control group that studied through the conventional mode.

From these Graphical presentations, it shows that the developed SOLO based instructional strategy was effective as observed with reference to all the Chapter-wise Achievement Tests as well Overall Achievement test conducted at Post-test level and had a considerable effect of progressive learning or/and understanding in Mathematics of the experimental group students studied through the developed instructional strategy compare to control group students studied through the conventional mode.

5.2 DESCRIPTIVE STATISTICS AND INTERPRETATIONS

The data collected through post-tests were initially analyzed using Descriptive Statistics or Analysis by using Measures of Central Tendency. Here, the comparisons on the Mean and SD values calculated on post-test scores for both the groups are

presented below in the tabular form in table-5.3 as well 5.4 and further Graphical presentation of the same is given below as figure – 5.7 and 5.8.

Table – 5.3:
Comparison on Mean of Post-test scores for both the groups

Mean	Chapter-12	Chapter-4	Chapter-8	Chapter-14	Chapter-15	Overall
Experimental Group	18.34	17.96	18.01	18.84	20.67	53.80
Control Group	8.23	13.47	11.99	8.92	12.33	19.71

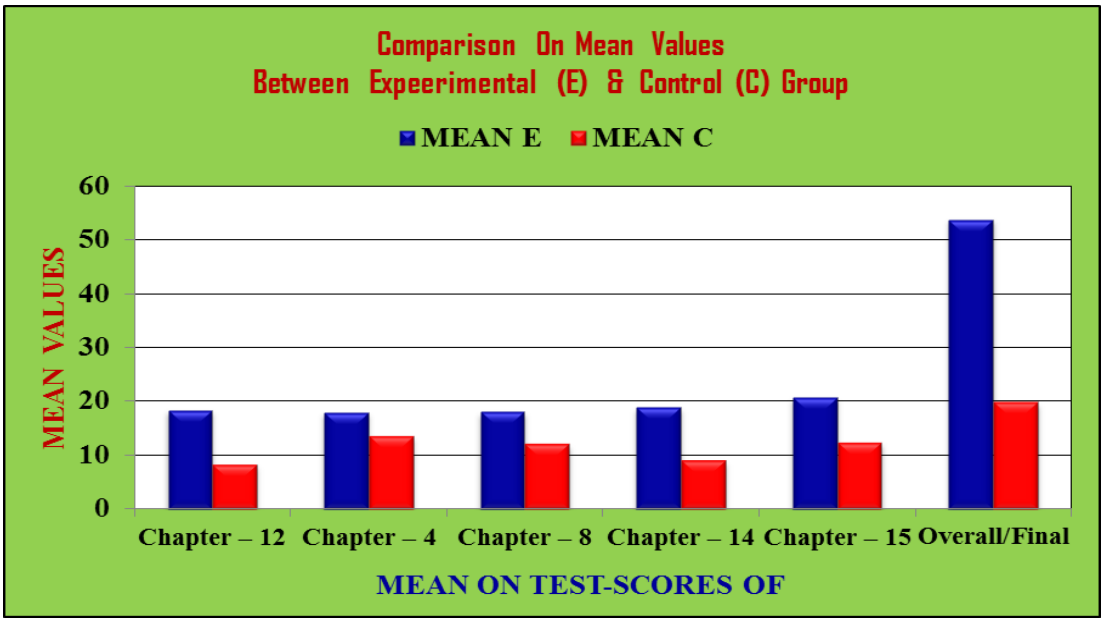


Figure-5.7: Graph to compare both the groups on Means of the Post-test scores

Table – 5.4:
Comparison on SD of Post-test scores for both the groups

Standard Deviation (SD)	Chapter-12	Chapter-4	Chapter-8	Chapter-14	Chapter-15	Overall
Experimental Group	3.80	2.33	1.87	1.86	2.20	6.26
Control Group	4.92	4.70	4.78	2.50	2.58	5.90

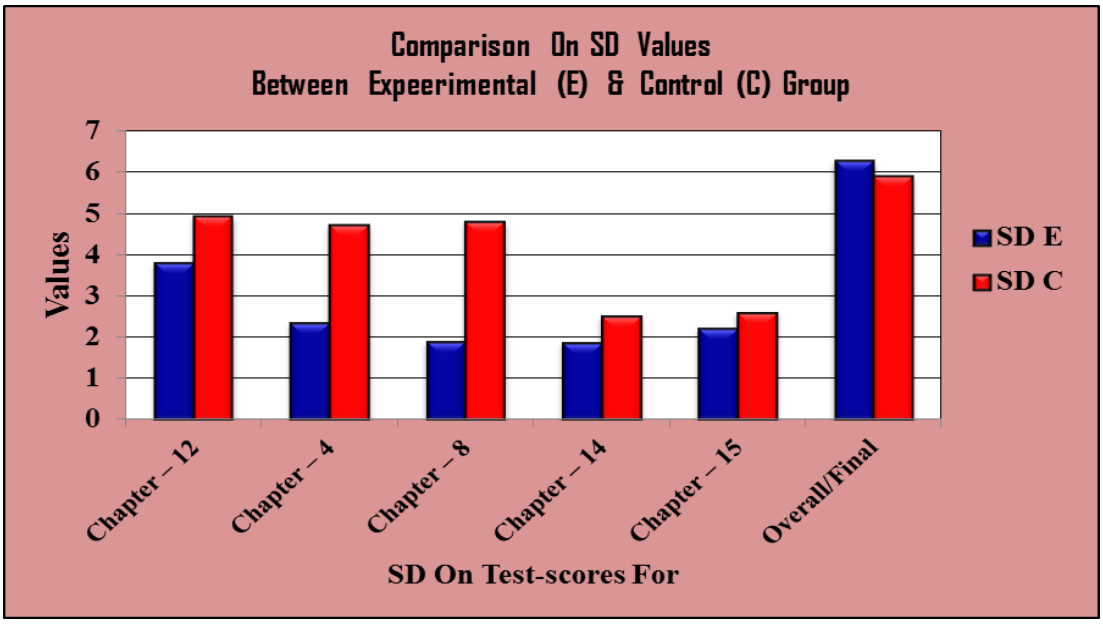


Figure-5.8: Graph to compare both the groups on SD of the Post-test scores

Interpretation

The above tabular and the graphical presentations (table-5.3 and figure-5.7) on the Mean values calculated on all the Achievement test-scores of both the groups evident that as:

- The Mean gain scores of an Achievement test observed for chapter- 12 Heron's Formula gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

- The Mean gain scores of an Achievement test observed for chapter- 4 Linear equation in two variables gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

- The Mean gain scores of an Achievement test observed for chapter-8 Quadrilaterals gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

- The Mean gain scores of an Achievement test observed for chapter- 14 Statistics gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

- The Mean gain scores of an Achievement test observed for chapter- 15 Probability gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

- The Mean gain scores observed for an Overall/Final Achievement test gained at post-test by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain scores of the control group studied through the conventional mode.

This signifies that the developed SOLO based instructional strategy was effective with reference to the Mean gain scores of all the six Achievement tests and had a reasonable and positive effect of progressive learning or/and understanding in Mathematics of the experimental group studied through the developed instructional strategy compare to control group studied through the conventional mode.

The tabular and the graphical presentations (table-5.4 and figure-5.8) on the SD values calculated on test-scores of both the groups evident that the deviations are of lower standard on all the chapter-wise test-score data of experimental group studied through the developed SOLO based Instructional Strategy compare to the same of control group studied through the conventional method. While in the case of Overall test-score data, deviation is of higher standard of experimental group compare to control group but Mean gain score of experimental group is higher than the Mean gain score of control group.

This also indicates that the developed SOLO based instructional strategy was effective with reference to the Standard Deviations observed on Mean gain scores of all the six Achievement tests and had a reasonable and positive effect of progressive

learning or/and understanding in Mathematics of the experimental group students compare to control group students.

Further section is explaining about the Inferential Statistics conducted on the data of Achievement test for both the groups and it is presented objective-wise.

5.3 DATA ANALYSIS AND INTERPRETATIONS ON ACHIEVEMENTS

Inferential Statistics was applied on the data collected through the tools of Achievement tests and Reaction scales of the present experimental research study. With the help of these measuring tools and the Hypotheses were framed for the Objectives - 3 to 7 were tested through several Statistical analyses and interpretations were derived based on the numerical outcomes as well the tests of the Hypotheses.

This Data analysis was conducted in the context of testing Hypotheses in terms to test the significance of the present research study. Then, Mann-Whitney U Test – a Non-parametric method had been employed is reported here. The Ranks as well Rank-sum calculated on the scores achieved by both the groups in chapter-wise Post-tests as well in Final/Overall Achievement Test are presented in the following tables. For the procedures of assigning the ranks to the relative test-scores, the function/formula **'RANK.AVG(number, ref, order)'** in MS-Excel 2010 had been used and then further procedural derivations made according to mentioned by the Mann-Whitney test method.

(Here in this analysis, 'Calculated value' is means to 'Observed value' and 'Critical value' is means to 'Expected value')

5.3.1 Analysis And Interpretations On The Chapter-wise Achievement Test-scores With Respect To Objective – 3 And Hypotheses - H_1 to H_5

Objective – 3: To study the effectiveness of the developed SOLO Taxonomy based instructional strategy with respect to the chapter-wise achievement of the group studied through developed instructional strategy.

5.3.1.1 Hypothesis (H_1) Testing On Achievement Test For Chapter - 12

***H_1**: There will be no significant difference between the mean scores of Achievement test observed for a chapter-Heron's Formula at Post-test among the group studied*

through developed instructional strategy and the group studied through conventional mode.

Table – 5.5:
Ranks assigned to Post-test Scores of both the groups for Chapter-12

Rank On Post-test Scores For Chapter – 12 Heron's Formula						
Sr. No.	**Experimental Group**			**Control Group**		
	Sr. Code	**Score**	**Rank**	**Sr. Code**	**Score**	**Rank**
1	E – S01	12.25	**27**	C – S01	20.50	**48.5**
2	E – S02	20.50	**48.5**	C – S02	9.50	**19**
3	E – S03	18.00	**40.5**	C – S03	10.50	**21**
4	E – S04	18.00	**40.5**	C – S04	8.75	**17**
5	E – S05	18.50	**43.5**	C – S05	2.00	**3**
6	E – S06	21.75	**54.5**	C – S06	2.25	**4**
7	E – S07	21.50	**52.5**	C – S07	12.00	**25.5**
8	E – S08	20.00	**46.5**	C – S08	13.75	**34**
9	E – S09	12.00	**25.5**	C – S09	11.00	**23**
10	E - S10	16.50	**37**	C - S10	3.50	**5**
11	E - S11	11.50	**24**	C - S11	13.00	**30**
12	E - S12	12.50	**28**	C - S12	6.00	**13**
13	E - S13	13.50	**32.5**	C - S13	1.50	**1.5**
14	E - S14	23.50	**60**	C - S14	13.00	**30**
15	E - S15	22.50	**56.5**	C - S15	14.50	**35**
16	E - S16	23.00	**58.5**	C - S16	3.75	**6**
17	E - S17	18.00	**40.5**	C - S17	8.25	**16**
18	E - S18	18.00	**40.5**	C - S18	19.00	**45**
19	E - S19	21.00	**50.5**	C - S19	4.00	**7**
20	E - S20	23.00	**58.5**	C - S20	6.25	**15**
21	E - S21	21.75	**54.5**	C - S21	5.25	**10**
22	E - S22	22.50	**56.5**	C - S22	10.00	**20**
23	E - S23	13.50	**32.5**	C - S23	10.75	**22**
24	E - S24	15.50	**36**	C - S24	5.00	**8.5**
25	E - S25	20.00	**46.5**	C - S25	6.00	**13**
26	E - S26	17.50	**38**	C - S26	9.00	**18**
27	E - S27	21.00	**50.5**	C - S27	5.00	**8.5**
28	E - S28	18.50	**43.5**	C - S28	6.00	**13**
29	E - S29	13.00	**30**	C - S29	1.50	**1.5**
30	E - S30	21.50	**52.5**	C - S30	5.50	**11**
RANKSUM – R1 =			**1306**	**RANKSUM – R2 =**		**524**

So, Larger Rank-sum = **Tx = R1 = 1306**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1306

= 1365 – 1306 = 59

Calculated U = 59

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 59 < Critical U = 127 at Significance Level of 0.05
- Calculated U = 59 < Critical U = 105 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_1 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Achievement test gained for Chapter-12 Heron's Formula at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

5.3.1.2 Hypothesis (H_2) Testing On Achievement Test For Chapter – 4

H_2: *There will be no significant difference between the mean scores of Achievement test observed for a chapter-Linear Equation In Two Variables at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.*

Table – 5.6:
Ranks assigned to Post-test Scores of both the groups for Chapter-4

Rank On Post-test Scores For Chapter – 4 L.E. In Two Variables						
Sr. No.	Experimental Group			Control Group		
	Sr. Code	Score	Rank	Sr. Code	Score	Rank
1	E – S01	16.00	**28**	C – S01	20.00	**48.5**
2	E – S02	20.00	**48.5**	C – S02	6.50	**3**
3	E – S03	14.00	**18.5**	C – S03	12.50	**16.5**
4	E – S04	21.00	**55.5**	C – S04	11.50	**12.5**
5	E – S05	20.00	**48.5**	C – S05	9.50	**5.5**
6	E – S06	17.00	**35**	C – S06	10.00	**7.5**
7	E – S07	17.50	**38.5**	C – S07	11.25	**11**
8	E – S08	19.50	**46**	C – S08	15.50	**24**
9	E – S09	15.50	**24**	C – S09	19.00	**44.5**
10	E - S10	17.75	**41**	C - S10	5.50	**2**
11	E - S11	16.00	**28**	C - S11	12.50	**16.5**
12	E - S12	18.00	**42**	C - S12	15.00	**21.5**
13	E - S13	16.50	**32**	C - S13	9.25	**4**

14	E - S14	21.50	**58**	C - S14	12.25	**15**
15	E - S15	20.50	**52**	C - S15	11.00	**10**
16	E - S16	16.50	**32**	C - S16	10.75	**9**
17	E - S17	17.00	**35**	C - S17	14.50	**20**
18	E - S18	16.50	**32**	C - S18	20.00	**48.5**
19	E - S19	16.00	**28**	C - S19	18.50	**43**
20	E - S20	17.00	**35**	C - S20	12.00	**14**
21	E - S21	15.50	**24**	C - S21	11.50	**12.5**
22	E - S22	19.00	**44.5**	C - S22	21.00	**55.5**
23	E - S23	16.00	**28**	C - S23	21.00	**55.5**
24	E - S24	22.50	**60**	C - S24	20.50	**52**
25	E - S25	20.50	**52**	C - S25	10.00	**7.5**
26	E - S26	22.00	**59**	C - S26	17.50	**38.5**
27	E - S27	21.00	**55.5**	C - S27	4.50	**1**
28	E - S28	16.00	**28**	C - S28	17.50	**38.5**
29	E - S29	15.00	**21.5**	C - S29	9.50	**5.5**
30	E - S30	17.50	**38.5**	C - S30	14.00	**18.5**
	RANKSUM – R1 =		**1168.5**	**RANKSUM – R2 =**		**661.5**

So, Larger Rank-sum = **Tx = R1 = 1168.5**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1168.5

= 1365 – 1168.5 = 196.5

Calculated U = 196.5

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 196.5 > Critical U = 127 at Significance Level of 0.05
- Calculated U = 196.5 > Critical U = 105 at Significance Level of 0.01

So, now further it need to analyze by calculating new critical value for U as required because of large sample size (n1=n2=30) of the present study.

Calculating new Critical value U for large sample as below:

$\mathbf{U_{critical}}$ = $\mathbf{Mean_u - z * SD_u - 0.5}$

$Mean_u$ = n1*n2 / 2 = 450

SD_u = sqrt [n1*n2*(n1+n2+1) / 12] = 67.6

$\mathbf{U_{critical}}$ = **318** for z = 1.96 at Significance Level of 0.05

$\mathbf{U_{critical}}$ = **276.1** for z = 2.58 at Significance Level of 0.01

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U=196.5 < Critical U = 318 at Significance Level of 0.05
- Calculated U=196.5 < Critical U = 276.1 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_2 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Achievement test gained for Chapter - 4 Linear Equation in two variables at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

5.3.1.3 Hypothesis (H_3) Testing On Achievement Test For Chapter – 8

H_3: *There will be no significant difference between the mean scores of Achievement test observed for a chapter-Quadrilaterals at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.*

Table – 5.7:
Ranks assigned to Post-test Scores of both the groups for Chapter-8

Rank On Post-test Scores For Chapter – 8 Quadrilaterals						
Sr. No.	Experimental Group			Control Group		
	Sr. Code	Score	Rank	Sr. Code	Score	Rank
1	E – S01	19.00	**51.5**	C – S01	10.50	**10.5**
2	E – S02	17.00	**35.5**	C – S02	13.00	**17.5**
3	E – S03	21.50	**60**	C – S03	2.25	**2**
4	E – S04	16.50	**32**	C – S04	16.50	**32**
5	E – S05	19.50	**55**	C – S05	8.50	**8**
6	E – S06	18.50	**45**	C – S06	10.75	**12**
7	E – S07	18.50	**45**	C – S07	1.50	**1**
8	E – S08	16.50	**32**	C – S08	15.00	**20.5**
9	E – S09	18.50	**45**	C – S09	19.00	**51.5**
10	E - S10	18.50	**45**	C - S10	12.25	**15**
11	E - S11	16.00	**27.5**	C - S11	11.50	**13.5**
12	E - S12	15.00	**20.5**	C - S12	18.00	**40.5**
13	E - S13	17.00	**35.5**	C - S13	15.50	**23.5**
14	E - S14	19.00	**51.5**	C - S14	14.50	**19**
15	E - S15	19.75	**56**	C - S15	17.00	**35.5**
16	E - S16	19.00	**51.5**	C - S16	6.50	**5.5**

17	E - S17	21.00	**59**	C - S17	6.00	**4**
18	E - S18	20.00	**57**	C - S18	16.00	**27.5**
19	E - S19	15.50	**23.5**	C - S19	12.50	**16**
20	E - S20	17.00	**35.5**	C - S20	17.50	**38.5**
21	E - S21	18.50	**45**	C - S21	8.50	**8**
22	E - S22	20.25	**58**	C - S22	16.00	**27.5**
23	E - S23	16.25	**30**	C - S23	6.50	**5.5**
24	E - S24	18.00	**40.5**	C - S24	15.50	**23.5**
25	E - S25	19.00	**51.5**	C - S25	15.50	**23.5**
26	E - S26	13.00	**17.5**	C - S26	17.50	**38.5**
27	E - S27	19.00	**51.5**	C - S27	10.50	**10.5**
28	E - S28	18.50	**45**	C - S28	8.50	**8**
29	E - S29	16.00	**27.5**	C - S29	11.50	**13.5**
30	E - S30	18.50	**45**	C - S30	5.50	**3**
		RANKSUM – R1 =	**1275**	**RANKSUM – R2 =**		**555**

So, Larger Rank-sum = **Tx = R1 = 1275**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1275

= 1365 – 1275 = 90

Calculated U = 90

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 90 < Critical U = 127 at Significance Level of 0.05
- Calculated U = 90 < Critical U = 105 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_3 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Achievement test gained for Chapter-8 Quadrilaterals at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

5.3.1.4 Hypothesis (H_4) Testing On Achievement Test For Chapter – 14

***H_4**: There will be no significant difference between the mean scores of Achievement test observed for a chapter-Statistics at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.*

Table – 5.8:
Ranks assigned to Post-test Scores of both the groups for Chapter-14

Rank On Post-test Scores For Chapter – 14 Statistics						
Sr. No.	Experimental Group			Control Group		
	Sr. Code	Score	Rank	Sr. Code	Score	Rank
1	E – S01	13.50	**29**	C – S01	15.50	**31.5**
2	E – S02	18.00	**40**	C – S02	13.50	**29**
3	E – S03	17.50	**35**	C – S03	8.50	**14.5**
4	E – S04	20.00	**52**	C – S04	9.75	**21.5**
5	E – S05	18.00	**40**	C – S05	8.00	**11**
6	E – S06	17.75	**37**	C – S06	10.00	**23**
7	E – S07	19.50	**50**	C – S07	10.25	**24**
8	E – S08	21.00	**57**	C – S08	13.50	**29**
9	E – S09	21.00	**57**	C – S09	9.25	**17.5**
10	E - S10	19.00	**46.5**	C - S10	7.25	**6.5**
11	E - S11	20.50	**53.5**	C - S11	3.25	**1**
12	E - S12	21.50	**59**	C - S12	5.25	**2**
13	E - S13	17.50	**35**	C - S13	7.75	**8.5**
14	E - S14	21.00	**57**	C - S14	9.75	**21.5**
15	E - S15	19.25	**48**	C - S15	7.25	**6.5**
16	E - S16	19.50	**50**	C - S16	6.25	**4**
17	E - S17	18.00	**40**	C - S17	8.25	**13**
18	E - S18	20.50	**53.5**	C - S18	9.25	**17.5**
19	E - S19	17.50	**35**	C - S19	10.50	**25.5**
20	E - S20	18.00	**40**	C - S20	7.75	**8.5**
21	E - S21	18.75	**45**	C - S21	9.00	**16**
22	E - S22	16.25	**33**	C - S22	8.00	**11**
23	E - S23	19.50	**50**	C - S23	9.50	**19.5**
24	E - S24	20.75	**55**	C - S24	9.50	**19.5**
25	E - S25	22.00	**60**	C - S25	11.25	**27**
26	E - S26	18.00	**40**	C - S26	8.50	**14.5**
27	E - S27	15.50	**31.5**	C - S27	5.50	**3**
28	E - S28	18.50	**43.5**	C - S28	7.00	**5**
29	E - S29	18.50	**43.5**	C - S29	8.00	**11**
30	E - S30	19.00	**46.5**	C - S30	10.50	**25.5**
		RANKSUM – R1 =	**1362.5**	**RANKSUM – R2 =**		**467.5**

So, Larger Rank-sum = **Tx = R1 = 1362.5**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1362.5 = 2.5

Calculated U = 2.5

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 2.5 < Critical U = 127 at Significance Level of 0.05
- Calculated U = 2.5 < Critical U = 105 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_4 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Achievement test gained for Chapter-14 Statistics at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

5.3.1.5 Hypothesis (H_5) Testing On Achievement Test For Chapter – 15

H_5: *There will be no significant difference between the mean scores of Achievement test observed for a chapter-Probability at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.*

Table – 5.9:
Ranks assigned to Post-test Scores of both the groups for Chapter-15

Rank On Post-test Scores For Chapter – 15 Probability						
Sr. No.	Experimental Group			Control Group		
	Sr. Code	Score	Rank	Sr. Code	Score	Rank
1	E – S01	15.00	**25**	C – S01	15.00	**25**
2	E – S02	22.50	**53.5**	C – S02	14.50	**22.5**
3	E – S03	19.50	**39**	C – S03	14.50	**22.5**
4	E – S04	22.00	**50.5**	C – S04	14.00	**21**
5	E – S05	22.50	**53.5**	C – S05	12.00	**13.5**
6	E – S06	21.00	**45.5**	C – S06	12.00	**13.5**
7	E – S07	21.50	**48**	C – S07	12.50	**15.5**
8	E – S08	22.50	**53.5**	C – S08	16.00	**31**
9	E – S09	23.00	**57**	C – S09	16.00	**31**
10	E - S10	20.00	**41.5**	C - S10	9.00	**5**
11	E - S11	23.50	**59**	C - S11	11.00	**11**
12	E - S12	22.00	**50.5**	C - S12	9.00	**5**
13	E - S13	19.50	**39**	C - S13	10.00	**7.5**
14	E - S14	21.00	**45.5**	C - S14	10.50	**9.5**
15	E - S15	20.00	**41.5**	C - S15	16.00	**31**
16	E - S16	20.50	**43.5**	C - S16	15.00	**25**
17	E - S17	24.00	**60**	C - S17	15.50	**28**

18	E - S18	21.50	**48**	C - S18	13.50	**19**
19	E - S19	19.50	**39**	C - S19	15.50	**28**
20	E - S20	22.50	**53.5**	C - S20	13.50	**19**
21	E - S21	18.50	**34.5**	C - S21	13.50	**19**
22	E - S22	19.00	**36.5**	C - S22	13.00	**17**
23	E - S23	15.50	**28**	C - S23	8.50	**2.5**
24	E - S24	20.50	**43.5**	C - S24	12.50	**15.5**
25	E - S25	23.00	**57**	C - S25	8.50	**2.5**
26	E - S26	18.50	**34.5**	C - S26	11.50	**12**
27	E - S27	18.00	**33**	C - S27	9.00	**5**
28	E - S28	21.50	**48**	C - S28	10.00	**7.5**
29	E - S29	19.00	**36.5**	C - S29	8.00	**1**
30	E - S30	23.00	**57**	C - S30	10.50	**9.5**
		RANKSUM – R1 =	**1355**	**RANKSUM – R2 =**		**475**

So, Larger Rank-sum = **Tx = R1 = 1355**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1355

= 1365 – 1355 = 10

Calculated U = 10

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 10 < Critical U = 127 at Significance Level of 0.05
- Calculated U = 10 < Critical U = 105 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_5 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Achievement test gained for Chapter-15 Probability at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

Thus, the performances of the experimental group had shown positive and better than the control group through all the chapter-wise achievement tests at post-test level.

5.3.2 Analysis And Interpretations On An Overall / Final Achievement Test-scores With Respect To Objective – 4 And Hypothesis - H_6

Objective – 4: To study the effectiveness of the developed SOLO Taxonomy based instructional strategy with respect to the overall achievement of the group studied through developed instructional strategy.

***H_6**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode.*

Table – 5.10:
Ranks assigned to Final/Overall Achievement Test Scores of both the groups

Rank On Overall / Final Achievement Test Scores						
Sr. No.	**Experimental Group**			**Control Group**		
	Sr. Code	**Score**	**Rank**	**Sr. Code**	**Score**	**Rank**
1	E – S01	50.00	**39**	C – S01	21.50	**19**
2	E – S02	62.00	**57**	C – S02	33.00	**30**
3	E – S03	51.00	**42**	C – S03	23.50	**23**
4	E – S04	66.00	**59**	C – S04	23.00	**20.5**
5	E – S05	53.50	**48**	C – S05	11.00	**1.5**
6	E – S06	46.50	**32**	C – S06	27.50	**27.5**
7	E – S07	47.00	**33.5**	C – S07	12.50	**4**
8	E – S08	50.50	**41**	C – S08	19.00	**14.5**
9	E – S09	47.50	**35**	C – S09	30.25	**29**
10	E - S10	49.00	**37**	C - S10	15.50	**10**
11	E - S11	51.50	**44**	C - S11	19.50	**16**
12	E - S12	50.00	**39**	C - S12	20.50	**18**
13	E - S13	48.00	**36**	C - S13	11.00	**1.5**
14	E - S14	51.50	**44**	C - S14	14.50	**7.5**
15	E - S15	55.75	**51**	C - S15	23.00	**20.5**
16	E - S16	56.75	**52**	C - S16	19.00	**14.5**
17	E - S17	54.25	**50**	C - S17	23.50	**23**
18	E - S18	61.25	**55**	C - S18	27.50	**27.5**
19	E - S19	51.50	**44**	C - S19	20.00	**17**
20	E - S20	53.75	**49**	C - S20	14.00	**6**
21	E - S21	58.75	**54**	C - S21	17.00	**11.5**
22	E - S22	67.50	**60**	C - S22	26.50	**26**
23	E - S23	50.00	**39**	C - S23	25.50	**25**

24	E - S24	47.00	**33.5**	C - S24	12.50	**4**
25	E - S25	58.50	**53**	C - S25	12.50	**4**
26	E - S26	53.25	**47**	C - S26	17.00	**11.5**
27	E - S27	64.50	**58**	C - S27	14.50	**7.5**
28	E - S28	61.50	**56**	C - S28	23.50	**23**
29	E - S29	42.75	**31**	C - S29	15.00	**9**
30	E - S30	53.00	**46**	C - S30	18.00	**13**
RANKSUM – R1 =			**1365**	RANKSUM – R2 =		**465**

So, Larger Rank-sum = **Tx = R1 = 1365**

n1 = n2 = 30 ➔ **nx = 30**

Calculated **U** = n1* n2 + nx * (nx + 1)/2 - Tx

= 30*30+30*(31)/2 – 1365

= 1365 – 1365 = 0

Calculated U = 0

As comparing the Calculated U with the highest Critical values of the U-Table, then

- Calculated U = 0 < Critical U = 127 at Significance Level of 0.05
- Calculated U = 0 < Critical U = 105 at Significance Level of 0.01

Interpretation

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_6 and it could be conclude as there is highly significant difference (p<0.01) between the mean scores of Overall/Final Achievement test gained at Post-test among the group studied through developed instructional strategy and the group studied through conventional mode.

It could be conclude from all the calculations conducted above with reference to the analyses on all the post-tests scores using the Mann-Whitney U test that all the relevant null hypotheses had been rejected and it had shown the positive favors towards the overall effectiveness of the SOLO based developed Instructional Strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the hypotheses testing and significant differences (p<0.01) found

for the achievements in all the Post-tests at both the significant levels as 0.05 and 0.01 as well had a significant effect of progressive learning and/or understanding in Mathematics of the experimental group studied through the developed instructional strategy compare to control group studied through the conventional mode.

Now, to observe the SOLO level-wise progressiveness in learning of both the groups, the Mann-Whitney U Test had been used for the analysis and reported in the next sub-section. For this analysis, only the scores of the Overall/Final achievement test had been taken to observe the significant differences between the achievements of both the groups at each of the SOLO levels and for the same, graphical presentations also have been given below to conclude about the study.

5.3.3 Analysis And Interpretations On The SOLO Level-wise Achievements With Respect To The Objective – 5 And Hypotheses – H_7 to H_{11}

Objective – 5: To study the effectiveness of the developed SOLO Taxonomy based instructional strategy with respect to the SOLO Level-wise achievement of the group studied through developed instructional strategy.

As in SOLO Taxonomy is comprised with five levels as (i) Pre-structure; (ii) Uni-structure; (iii) Multi-structure; (iv) Relational and (v) Extended-abstract which are arranged in a hierarchy manner to structure the learning referred to means of progressive Understanding. That is all the levels proceeds for the surface to deeper learning or Understanding. With this knowledge, here also analysis is conducted on the Final/Overall Achievement (Post) Test to study and compare the progressive learning as well Understanding achieved by the subjects of both the sample-groups. Final Achievement Test was consist maximum marks of 75 which was mainly divided into five sections with respect to the five levels of the SOLO Taxonomy as shown below.

5.3.3.1 Graphical Presentations For Comparison Of Groups On SOLO Levels

Following are the tabular and graphical presentations about the SOLO level-wise performances of both the groups. The scores of the final achievement test are

segregated SOLO level-wise for both the groups are tabulated in the tables-5.11 and 5.12 respectively.

Table – 5.11:
SOLO Level-wise break-up for Overall Achievement scores of an Experimental group

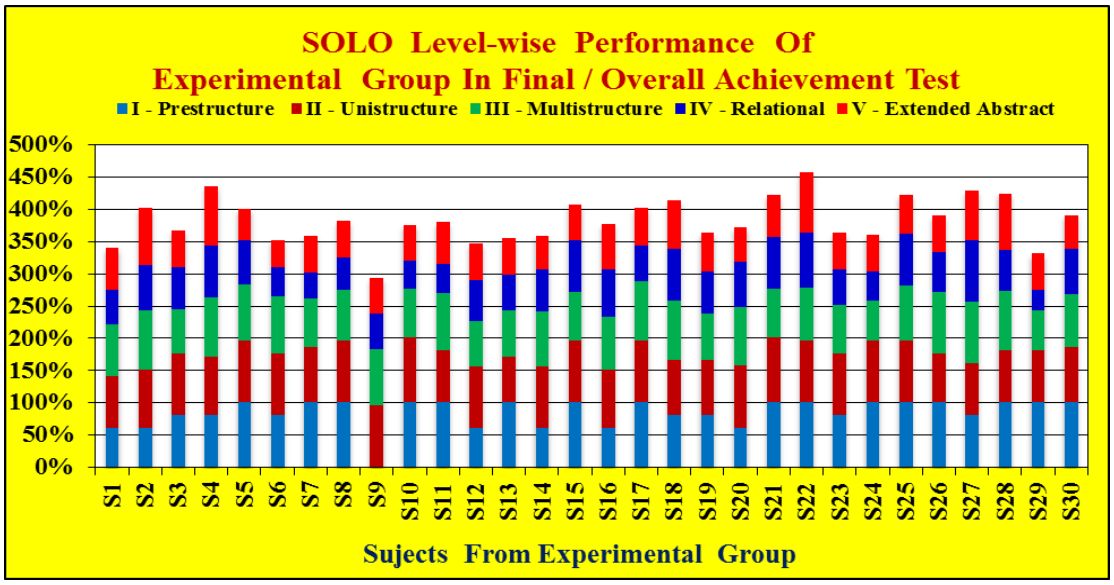
Experimental Group (E)						
Sr. Code	SOLO Level-wise Break-up Of Final/Overall Achievement Scores					TOTAL SCORE (MM-75)
	Prestructure	Unistructure	Multistucture	Relational	Ext. Abstract	
	I	II	III	IV	V	
	MM - 05	MM - 10	MM - 15	MM - 20	MM - 25	
E – S01	3.00	8.00	12.00	11.00	16.00	50.00
E – S02	3.00	9.00	14.00	14.00	22.00	62.00
E – S03	4.00	9.50	10.50	13.00	14.00	51.00
E – S04	4.00	9.00	14.00	16.00	23.00	66.00
E – S05	5.00	9.50	13.25	13.50	12.25	53.50
E – S06	4.00	9.50	13.50	9.00	10.50	46.50
E – S07	5.00	8.50	11.50	8.00	14.00	47.00
E – S08	5.00	9.50	12.00	10.00	14.00	50.50
E – S09	0.00	9.50	13.00	11.00	14.00	47.50
E - S10	5.00	10.00	11.50	8.50	14.00	49.00
E - S11	5.00	8.00	13.50	9.00	16.00	51.50
E - S12	3.00	9.50	10.50	13.00	14.00	50.00
E - S13	5.00	7.00	11.00	11.00	14.00	48.00
E - S14	3.00	9.50	13.00	13.00	13.00	51.50
E - S15	5.00	9.50	11.50	15.75	14.00	55.75
E - S16	3.00	9.00	12.25	15.00	17.50	56.75
E - S17	5.00	9.50	14.00	10.75	15.00	54.25
E - S18	4.00	8.50	14.00	15.75	19.00	61.25
E - S19	4.00	8.50	11.00	13.00	15.00	51.50
E - S20	3.00	9.75	13.50	14.00	13.50	53.75
E - S21	5.00	10.00	11.50	15.75	16.50	58.75
E - S22	5.00	9.50	12.50	17.00	23.50	67.50
E - S23	4.00	9.50	11.50	11.00	14.00	50.00
E - S24	5.00	9.50	9.50	9.00	14.00	47.00
E - S25	5.00	9.50	13.00	16.00	15.00	58.50
E - S26	5.00	7.50	14.50	12.25	14.00	53.25
E - S27	4.00	8.00	14.50	19.00	19.00	64.50
E - S28	5.00	8.00	14.00	12.50	22.00	61.50
E - S29	5.00	8.00	9.50	6.25	14.00	42.75
E - S30	5.00	8.50	12.50	13.75	13.25	53.00

Table – 5.12:
SOLO Level-wise break-up for Overall Achievement scores of a Control group

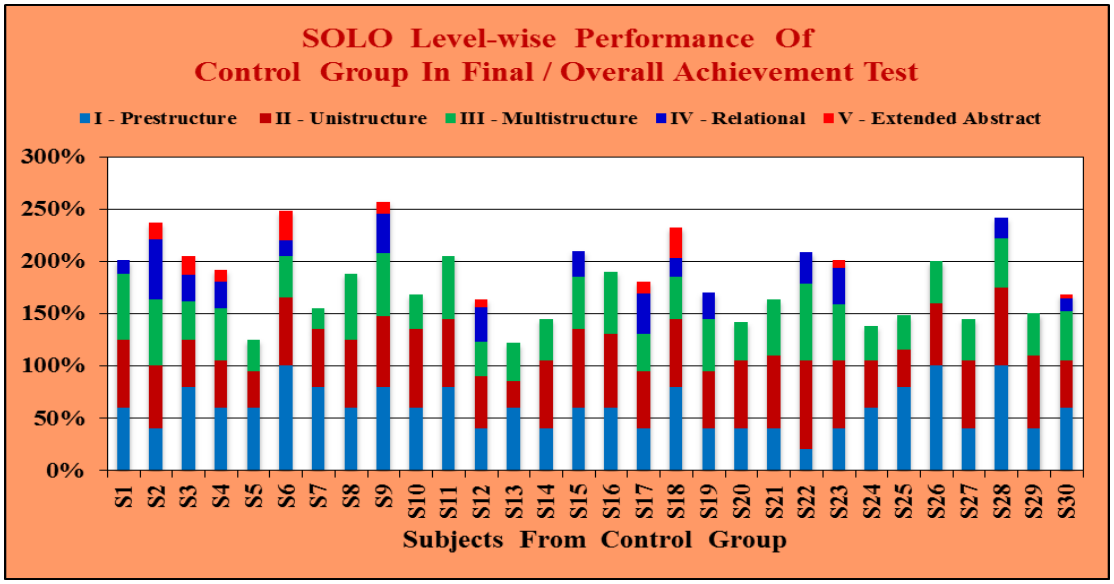
Control Group (C)						
Sr. Code	SOLO Level-wise Break-up Of Final/Overall Achievement Scores					TOTAL SCORE (MM-75)
	Prestructure ●	Unistructure I	Multistucture III	Relational III	Ext. Abstract III	
	I	II	III	IV	V	
	MM - 05	MM - 10	MM - 15	MM - 20	MM - 25	
C – S01	3.00	6.50	9.50	2.50	0.00	21.50
C – S02	2.00	6.00	9.50	11.50	4.00	33.00
C – S03	4.00	4.50	5.50	5.00	4.50	23.50
C – S04	3.00	4.50	7.50	5.00	3.00	23.00
C – S05	3.00	3.50	4.50	0.00	0.00	11.00
C – S06	5.00	6.50	6.00	3.00	7.00	27.50
C – S07	4.00	5.50	3.00	0.00	0.00	12.50
C – S08	3.00	6.50	9.50	0.00	0.00	19.00
C – S09	4.00	6.75	9.00	7.50	3.00	30.25
C - S10	3.00	7.50	5.00	0.00	0.00	15.50
C - S11	4.00	6.50	9.00	0.00	0.00	19.50
C - S12	2.00	5.00	5.00	6.50	2.00	20.50
C - S13	3.00	2.50	5.50	0.00	0.00	11.00
C - S14	2.00	6.50	6.00	0.00	0.00	14.50
C - S15	3.00	7.50	7.50	5.00	0.00	23.00
C - S16	3.00	7.00	9.00	0.00	0.00	19.00
C - S17	2.00	5.50	5.25	7.75	3.00	23.50
C - S18	4.00	6.50	6.00	3.50	7.50	27.50
C - S19	2.00	5.50	7.50	5.00	0.00	20.00
C - S20	2.00	6.50	5.50	0.00	0.00	14.00
C - S21	2.00	7.00	8.00	0.00	0.00	17.00
C - S22	1.00	8.50	11.00	6.00	0.00	26.50
C - S23	2.00	6.50	8.00	7.00	2.00	25.50
C - S24	3.00	4.50	5.00	0.00	0.00	12.50
C - S25	4.00	3.50	5.00	0.00	0.00	12.50
C - S26	5.00	6.00	6.00	0.00	0.00	17.00
C - S27	2.00	6.50	6.00	0.00	0.00	14.50
C - S28	5.00	7.50	7.00	4.00	0.00	23.50
C - S29	2.00	7.00	6.00	0.00	0.00	15.00
C - S30	3.00	4.50	7.00	2.50	1.00	18.00

The following two separate graphs shown in the figures-5.9 and 5.10 present the performances of all the subjects (students) from each group respectively. Hence,

individual performances could be observed and compared from these two graphs. Also, the progressive achievements meant to learning or understanding could be seen at each of the SOLO levels in terms of the stacks as shown in the individualized bars of the graphs. Each bar with five colored parts or stacks within a bar indicates performance of an individual through all the five SOLO levels.



Figure–5.9: Performance of subjects from an Experimental group through SOLO levels



Figure–5.10: Performance of subjects from a Control group through SOLO levels

From these graphical presentations, the reasonable and positive differences could be observed for the Overall or Final Achievement test at individual levels and conclude that the performance of an experimental group is better than a control group.

Following are the graphical presentations to compare the performances of both the groups together in Overall/Final Achievement test through each of the SOLO levels.

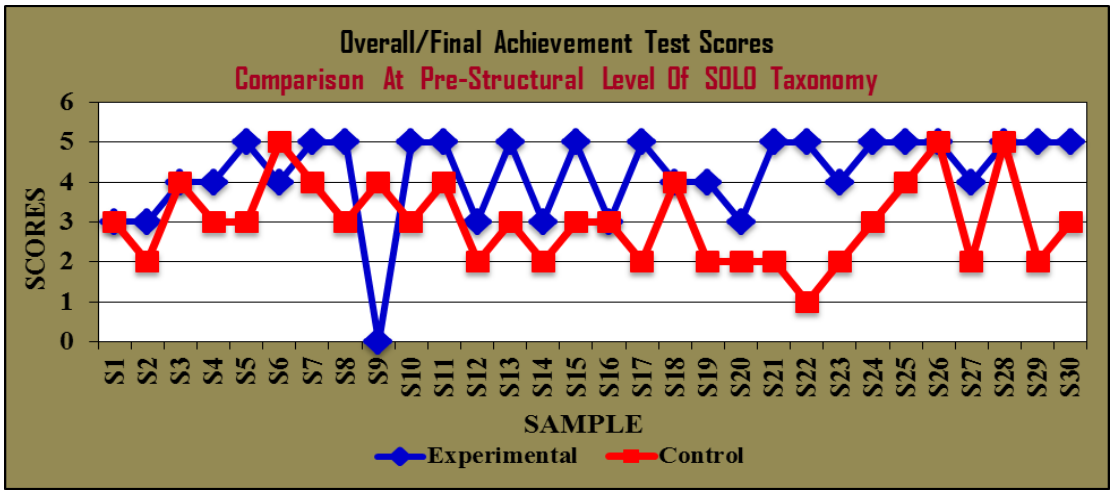


Figure 5.11: Comparison of two groups on Overall test at Prestructure level of SOLO

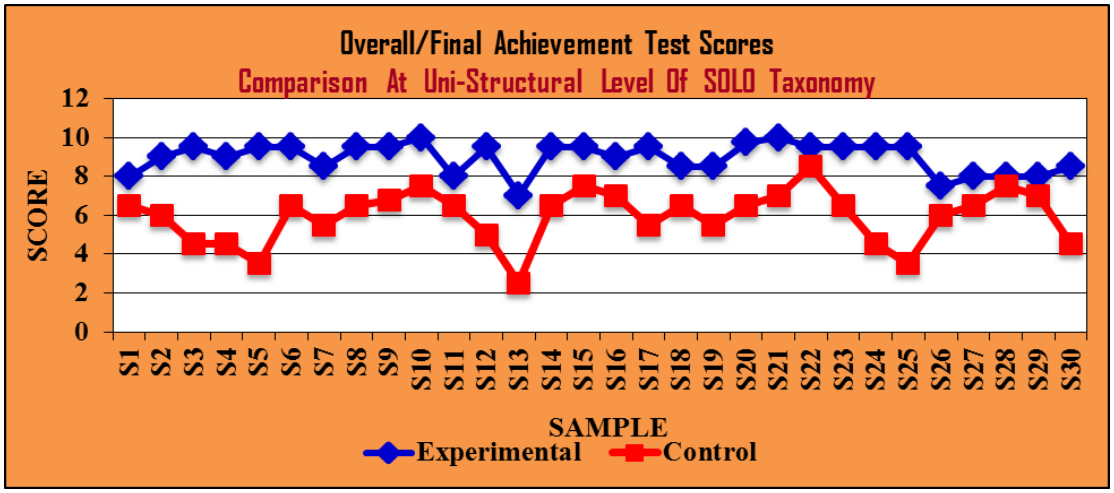


Figure 5.12: Comparison of two groups on Overall test at Unistructure level of SOLO

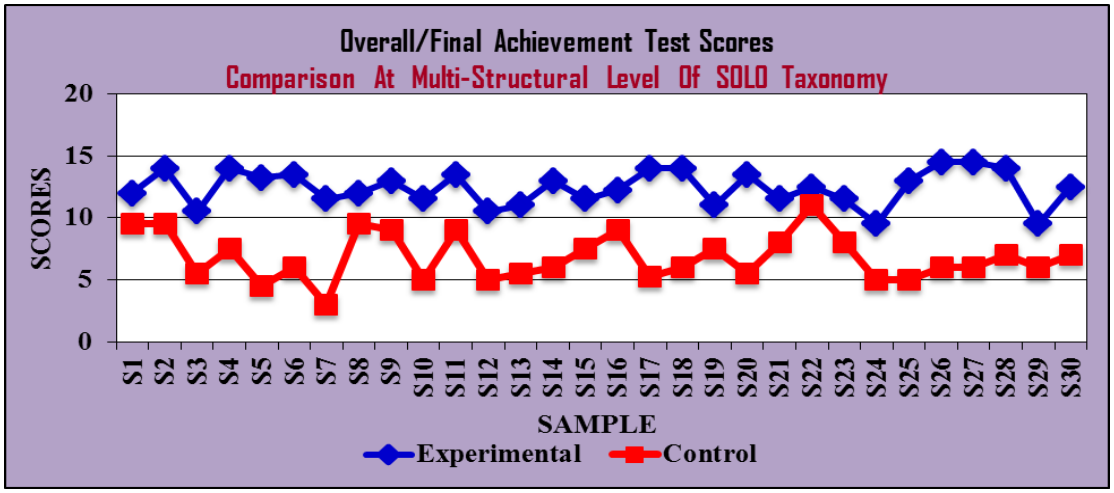


Figure 5.13: Comparison of two groups on Overall test at Multistructure level of SOLO

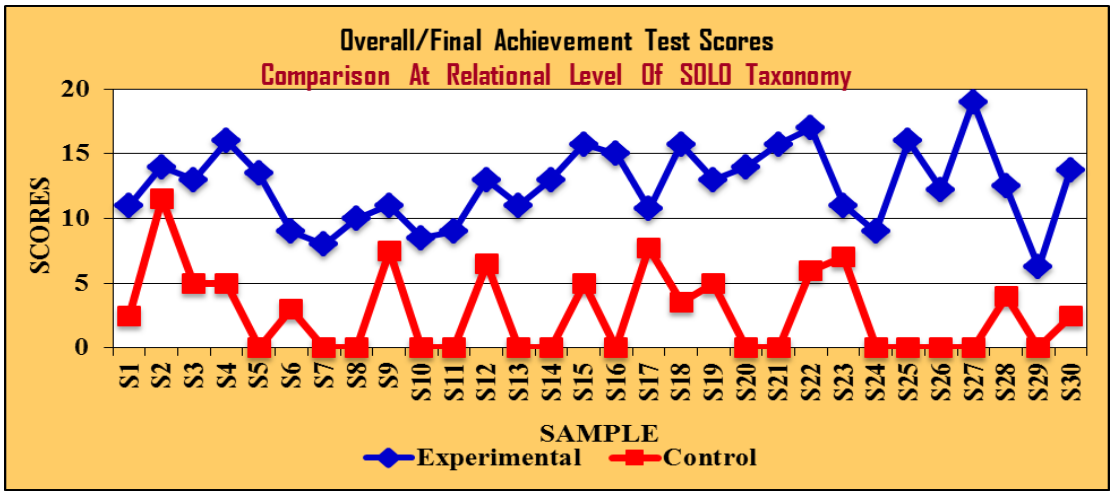


Figure 5.14: Comparison of two groups on Overall test at Relational level of SOLO

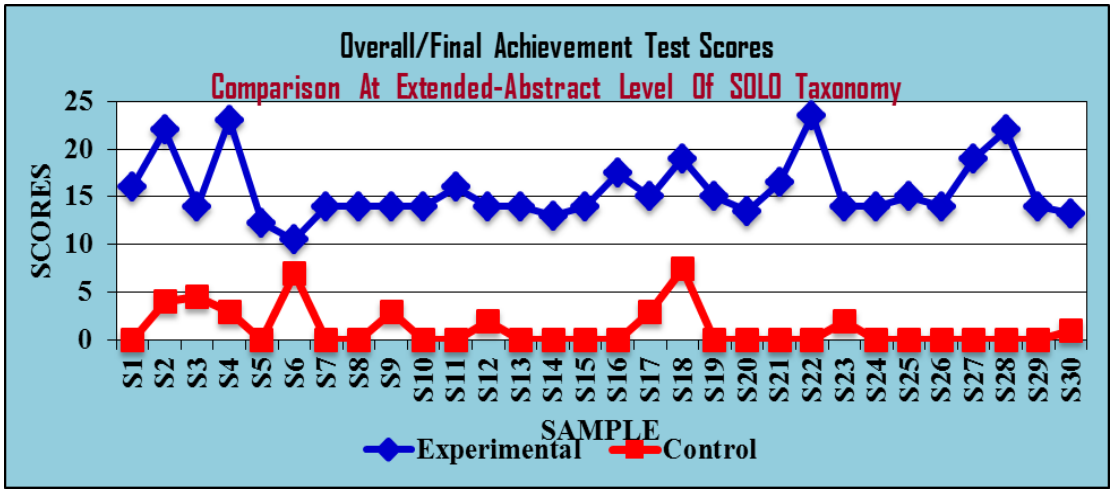


Figure 5.15: Comparison of two groups on Overall test at Ext. Abstract level of SOLO

It is shown by two separate lines plotted on the graphs (in figure – 5.11 to 5.15) indicating the comparisons in terms to specify the considerable differences between the experimental and control group at each level of the SOLO Taxonomy that is at the level of Prestructure, Unistructure, Multistructure, Relational and Extended (Ext.) Abstract. Hence, conclude that the performance of an experimental group is better than a control group at each level of the SOLO Taxonomy.

Interpretation

From these Graphical presentations, it signifies that the developed SOLO based instructional strategy was effective as observed on Overall Achievement test-scores through all the five levels (prestructure, unistructure, multistructure, relational and extended abstract) of SOLO Taxonomy and had a reasonable and positive effect of progressive learning or understanding in Mathematics of the experimental group

students studied through the developed instructional strategy compare to control group students studied through the conventional mode.

5.3.3.2 Descriptive Analysis For Comparison Of Groups On SOLO Levels

Another analysis made to observe the study is by applying Descriptive statistics on the scores gained by both the groups in an Overall/Final achievement test at all the five levels of the SOLO Taxonomy. Following table–5.13 is showing the values for the Mean and SD calculated on the Overall Achievement test-scores achieved by both the groups for each of the SOLO level. And the figure-5.16 is the graphical representation for the same.

Table – 5.13:
Mean and SD on Overall Test-scores of both the groups at all the SOLO levels

Measure	Group	Pre-structure	Uni-structure	Multi-structure	Relational	Ext.-Abstract
Mean	E	4.20	8.96	12.42	12.56	15.67
	C	3.00	5.94	6.81	2.73	1.23
SD	E	1.13	0.79	1.43	3.01	3.28
	C	1.05	1.37	1.88	3.23	2.13

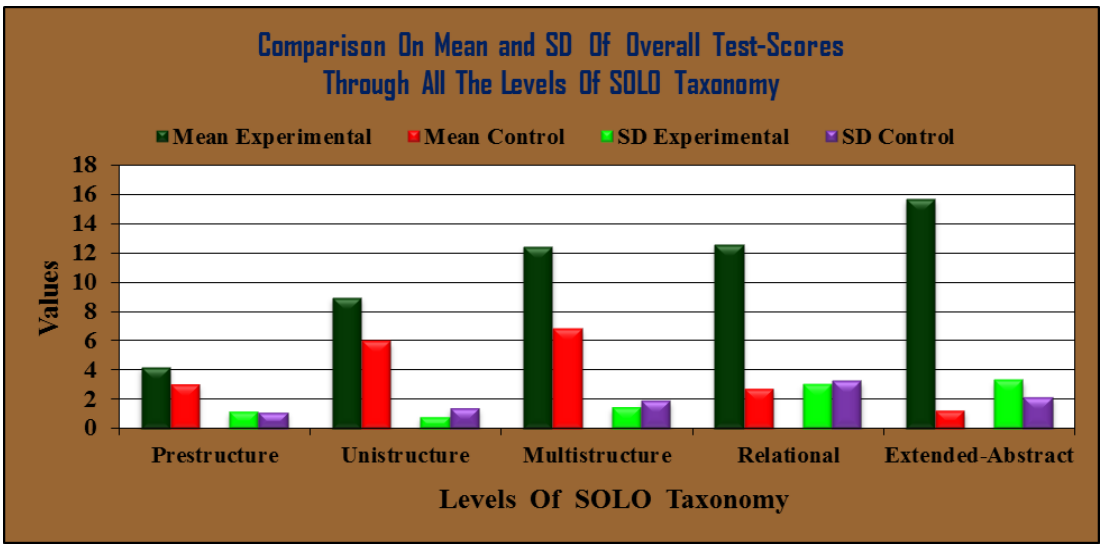


Figure 5.16: Mean and SD on Overall Test-scores of two groups at all the SOLO levels

Interpretation

The above tabular and the graphical presentations (table-5.13 and figure-5.16) is on the Mean and SD values calculated on Overall Achievement test-scores at each of the five levels of SOLO taxonomy of both the groups evident that as:

- The Mean gain score of an Overall Achievement test gained at Prestructural level of SOLO taxonomy by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain score of the control group studied through the conventional mode.

- The Mean gain score of an Overall Achievement test gained at Unistructural level of SOLO taxonomy by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain score of the control group studied through the conventional mode.

- The Mean gain score of an Overall Achievement test gained at Multistructural level of SOLO taxonomy by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain score of the control group studied through the conventional mode.

- The Mean gain score of an Overall Achievement test gained at Relational level of SOLO taxonomy by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain score of the control group studied through the conventional mode.

- The Mean gain score of an Overall Achievement test gained at Extended Abstract level of SOLO taxonomy by an experimental group studied through the developed SOLO based Instructional Strategy are reasonably and positively greater than the Mean gain score of the control group studied through the conventional mode.

Thus from the above tabular and graphical presentations, the reasonable and positive differences between the achievements of two groups of the study has been observed.

This signifies that the developed SOLO based instructional strategy was effective with reference to the Mean as well Standard Deviation of Overall Achievement tests-scores observed at each of the five levels (prestructure, unistructure, multistructure, relational and extended abstract) of SOLO taxonomy and had a reasonable and positive effect of progressive learning or understanding in Mathematics of the experimental group studied through the developed instructional strategy compare to control group studied through the conventional mode.

5.3.3.3 Hypotheses (H_7 to H_{11}) Testing On Overall Achievement Test At All The Five Levels Of SOLO Taxonomy

***H_7**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode at Pre-structural level of the SOLO Taxonomy.*

***H_8**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode at Uni-structural level of the SOLO Taxonomy.*

***H_9**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode at Multi-structural level of the SOLO Taxonomy.*

***H_{10}**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode at Relational level of the SOLO Taxonomy.*

***H_{11}**: There will be no significant difference between the mean scores of Overall Achievement Test observed among the group studied through developed instructional strategy and the group studied through conventional mode at Extended Abstract level of the SOLO Taxonomy.*

To test the above mentioned hypotheses, Non-parametric method that is Mann-Whitney (MW) U Test method had been employed in terms to study the significance differences through all the five levels of SOLO Taxonomy. The MWU test was applied on the scores of Overall Achievement test and the outcome are summarized in the following table – 5.14. This inferential analysis was the determinant to interpret about the developed and implemented SOLO based Instructional Strategy.

Table – 5.14:
Summary of SOLO Level-wise Analysis on Overall Achievement Test Using MW U-Test

Sr. No.	SOLO Levels	Sum Of Ranks		Max. RankSum R_x	Calculated (R_x using) U	Hypothesis Testing At Levels	
		R1	R2			0.05	0.01
1	Prestructure	1185	645	1185	180	H_7 Rejected	H_7 Rejected
2	Unistructure	1350	480	1350	15	H_8 Rejected	H_8 Rejected
3	Multistructure	1357	473	1357	08	H_9 Rejected	H_9 Rejected
4	Relational	1349	481	1349	16	H_{10} Rejected	H_{10} Rejected
5	Extended Abstract	1365	465	1365	00	H_{11} Rejected	H_{11} Rejected

Interpretation

Thus, it could be conclude from the calculated U values given in the above table that all the mentioned null hypotheses have been rejected and it shows the positive favors towards the overall effectiveness of the developed SOLO based Instructional Strategy.

As Calculated U is less than the critical value (tabled) for both the 0.05 and 0.01 significant levels. Thus, it rejects the null hypotheses H_7 to H_{11} and it could be conclude as there is highly significant difference ($p<0.01$) between the mean scores of Overall/Final Achievement Post-test gained at all the five levels of SOLO taxonomy by the group studied through developed instructional strategy and the group studied through conventional mode.

This signifies that the developed SOLO based instructional strategy was effective with reference to the hypotheses testing and significant differences ($p<0.01$) found for the achievements in an Overall Achievement test through all five levels of SOLO Taxonomy at both the significant levels as 0.05 and 0.01 as well had a significant effect of progressive learning and/or understanding in Mathematics of the experimental group studied through the developed instructional strategy compare to control group studied through the conventional mode.

5.3.4 Overall Interpretations On The Analysis Of Achievement Tests

From all the analyses of the Post-test scores as presented above sub-sections, indicate the significant differences between the performances of both the experimental and control groups based on the scores as 'Outcomes' of all the Post-tests. Also all the conclusions reveal the positive favors towards the SOLO based Instructional Strategy which was developed and implemented by the researcher for this experimental research study. These remarks tend to conclude as overall the developed Instructional Strategy was effective. Also, it had shown positive as well progressive achievements were proceeded SOLO Level-wise that is from surface (lower) to deeper (higher) level as per the theory of SOLO taxonomy advocates for the level-wise increase in Understanding.

Further, the same aspects had been examined through the reactions as well reflections of the sample with respect to their various experiences for learning as well Understanding through the developed SOLO based Instructional Strategy. These reactions were analyzed by using appropriate techniques are presented in the next section.

5.4 DATA ANALYSIS AND INTERPRETATIONS ON REACTIONS

Another way to perceive about the effectiveness of the developed Instructional Strategy as well about its implementation as an overall Intervention program is to collect the feedback from the participants or the beneficiaries. For the present research study too, the researcher had developed tools to collect the reactions and responses towards the learning experiences through several components of the Intervention Program. The Reaction Tools were developed by the researcher for the present research study regard to collect reactions about the learning of selected chapters; about the achievements tests and about the overall experiences. All the Reaction tools were consisting of majorly close-ended question items.

The 'Frequency distribution and Percentages' method, Chi-square test and the graphical presentations were used to observe the significance differences on the reactions. The analyses of the Reaction Tools are mainly divided in two following sub-sections as: (i) Analysis on the data of the Chapter-wise Reflection -Reaction sheet and (ii) Analysis on the data of the Overall Reaction Scale.

5.4.1 Analysis And Interpretations On The Chapter - wise Reactions With Respect To Objective – 6 And Hypotheses - H_{12} to H_{16}

Objective – 6: To study the effectiveness of the developed SOLO Taxonomy based instructional strategy with respect to chapter-wise reactions of the group studied through developed instructional strategy.

The chapter-wise Reaction tool as 'SOLO Level-wise Reflective Reaction Sheet' was developed by the researcher of the present research study, with aim to collect the immediate as well timely reflections for each of the chapters and reactions about the learning experiences for gained by an experimental group studied through SOLO based developed Instructional Strategy.

The graphs shown in the figures-5.17 to 5.21 are depicted with the data based on reactions received with respect to learning of each chapter. These graphs are plotted with mainly two bars as green coloured and red coloured bars with respect to the item-statements of a reaction tool. A green bar indicates an item-statement is 'Positively in Favor' and red bar indicates an item-statement 'Not in Favor'. Each item-statement of a tool inherently reveals the means of understanding noted as responses about specific topic or content of a respective/said chapter. Thus, considerable differences could be seen between the green and red bars in terms to the numbers and heights of the bars plotted on a graph.

5.4.1.1 Hypothesis (H_{12}) Testing On The Reactions For A Chapter – 12

H_{12}: *There will be no significant difference in the reactions for the learning experiences gained for a chapter-Heron's Formula by the group studied through the developed instructional strategy.*

Following table-5.15(a) is showing the frequency distribution and the percentages of the responses in the form of reactions received for the corresponding close-ended item-statements about the learning experiences for Chapter-12 Heron's Formula as experienced through developed instructional strategy by an experimental group. And the said percentages are plotted on a graph shown in figure–5.17 about the responses received with respect to various items of reaction tool for a Chapter-12.

Table – 5.15(a):
Frequency (n) Distribution and Percentages (%) on reaction-responses for Chapter-12
(Total Responses Received = 35)

Chapter – 12 Heron's Formula				
SOLO Levels	**Item No.**	**Item-Statements About My Learning Experiences and Achievements**	**n**	**%**
	I-1)	**Whether I have participated in an Activity-1 'Block Counting Method' for finding the area of various geometrical shapes ?**		
	a)	Yes	**29**	**82.9%**
	b)	No as I was absent in school	**05**	**17.1%**
	c)	No as I was engaged with other school-activity	**01**	
	I-2)	**How was an Activity-1 ?**		
	a)	Easy but of primary grade level	**10**	**34.5%**
	b)	Difficult	**00**	**00.0%**
	c)	Appropriate to understand and to learn about the Area of various shapes	**16**	**55.2%**
	d)	Not appropriate for the grade of IX	**03**	**10.4%**
	I-3)	**How was an Activity-1 for me ?**		
	a)	Interesting & Just enjoyed	**20**	**69.0%**
	b)	Not Interesting	**01**	**03.5%**
	c)	I have experienced a new way of learning about the Areas and Perimeters	**04**	**13.8%**
	d)	Don't know	**04**	**13.8%**
●	**I-4)**	**What I have learnt from this Activity-1 ?**		
	a)	Learnt about the new method for finding the Areas and Perimeters	**11**	**38.0%**
	b)	Concept of Area and Perimeter got understood clearly through this activity	**05**	**17.2%**
	c)	Helped me to recall my previous knowledge that learnt in previous class/grade	**13**	**45.0%**
	d)	Nothing	**00**	**00.0%**
	I-5)	**Where I found difficulties in doing this Activity-1 ?**		
	a)	Having less time	**02**	**07.0%**
	b)	Counting the Blocks outside the shapes in terms to find the Perimeter	**02**	**07.0%**
	c)	Counting the Fractional Blocks in terms to find the Area and Perimeter of given shapes	**12**	**41.4%**
	d)	No difficulties	**13**	**45.0%**
▌	**I-6)**	**Whether I have solved the Worksheet given for Activity – 2 on the Types of Triangles (Based on Sides) given as home-assignment (with 3 examples)?**		
	a)	Yes	**32**	**91.4%**

	b)	No	**03**	**08.6%**
	I-7)	**Which are the following topics or concepts learnt or understood by me completely? Let me put tick mark/s.**		
	a)	The Types of Triangles based on the angles and the sides	**18**	**56.3%**
	b)	Differentiation between Scalene, Isosceles and Equilateral triangles	**25**	**78.1%**
	c)	Finding the value of height/s in Isosceles and Equilateral triangles using Pythagoras theorem	**27**	**84.4%**
	d)	Finding the Area of triangles by using a basic formula A = ½ x b x h, when height is known	**22**	**68.8%**
III	**I-8)**	**Whether I have participated in an Activity-3 on Heights/ Altitude of a Triangle (Knowing heights/altitude of a Triangle from all its vertices) given in small group?**		
	a)	Yes	**33**	**94.3%**
	b)	No as I was absent in school	**02**	**05.7%**
	c)	No as I was engaged with other school-activity	**00**	
	I-9)	**How was an Activity-3 for me ?**		
	a)	Gave a clear idea about identifying the heights from any vertex of a triangle is whether its internal (interior) or external(exterior) or on an edge	**30**	**91.0%**
	b)	Not understood this activity	**00**	**00.0%**
	c)	Understood an activity but concept of identifying the height is not clearly understood by me	**00**	**00.0%**
	d)	I Don't know as other member/s of my group did this activity	**03**	**09.1%**
III	**I-10)**	**Whether I have solved a Practise Worksheet given as home-task about to find the area of Triangles by using Heron's Formula (with 3 examples and one Tangram activity)?**		
	a)	Yes	**31**	**88.6%**
	b)	No	**04**	**11.4%**
	I-11)	**How I found this Practise worksheet for me ?**		
	a)	Interesting & enjoyed the examples to solve by using Heron's formula	**18**	**58.1%**
	b)	What rubbish, as sides of the triangles were not given and I was to do or to find	**01**	**03.2%**
	c)	Confused with the examples	**07**	**22.6%**
III	d)	Don't know	**05**	**16.1%**
	I-12)	**I have learnt about the Quadrilaterals in Grade -VIII.**		
	a)	Yes	**32**	**91.4%**
	b)	No	**00**	**00.0%**
	c)	Don't know	**02**	**05.7%**

	d)	Kept it as optional	**01**	**02.9%**
	I-13)	**I am able to relate the Triangles with the Quadrilaterals and able to divide the quadrilaterals to form the triangle shapes within it.**		
	a)	Absolutely	**26**	**74.3%**
	b)	In some quadrilaterals only	**04**	**11.4%**
	c)	Not at all	**00**	**00.0%**
	d)	No comments	**01**	**02.9%**
	I-14)	**Learning /knowing about the concept of Pyramids for me was:**		
	a)	Interesting	**31**	**88.6%**
	b)	Non-interesting	**02**	**05.7%**
	c)	Time-pass	**01**	**02.9%**
	d)	Higher level learning	**01**	**02.9%**
	I-15)	**'Concepts/topics arrangement through Hexagonal shapes'- a Graphical Organiser helped me to understand thoroughly the concepts of Heron's formula.**		
	a)	Yes-Innovatively & more than my expectations	**23**	**65.7%**
	b)	Not understood & confused	**00**	**00.0%**
	c)	Partially understood	**10**	**28.6%**
	d)	Don't' know	**02**	**05.7%**
	I-16)	**Whether my Knowledge /Understanding have been improved?**		
	a)	Yes but little	**08**	**22.9%**
	b)	Yes and more	**19**	**54.3%**
	c)	Unable to say	**08**	**22.9%**
	d)	No/Not much	**00**	**00.0%**

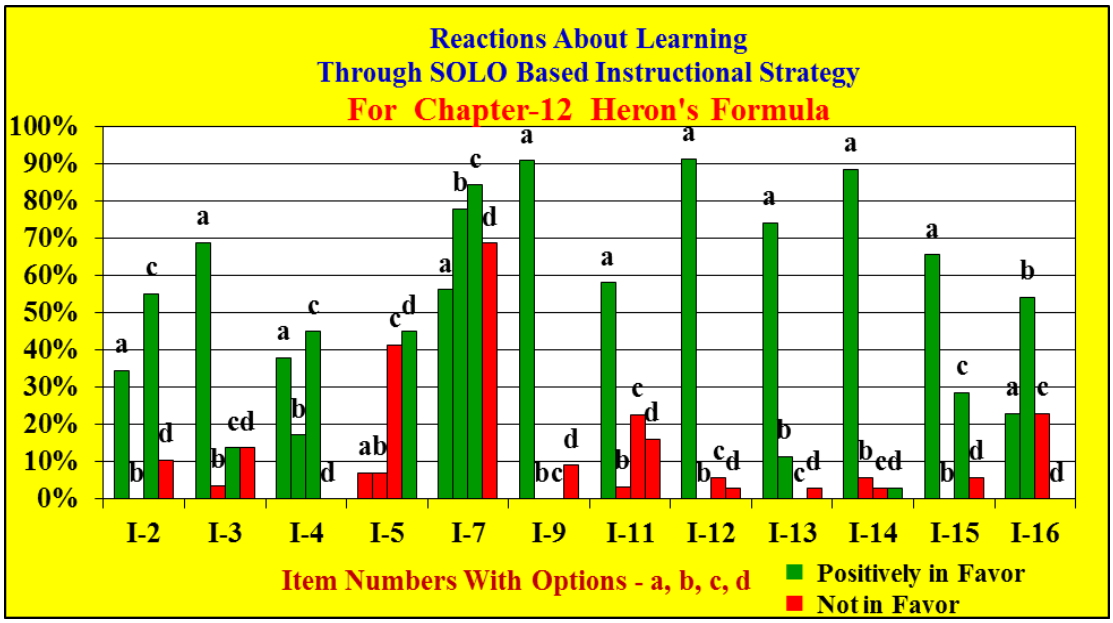


Figure-5.17: Reactions by an Experimental group about learning of a Chapter – 12

Following table-5.15(b) is showing the outcome of the analysis performed on the data as shown in table-5.15(a) as well in a figure-5.17 using the Chi-Square method.

Table – 5.15(b):
Hypothesis testing by using Chi-Square on Reactions received for Chapter-12

Reactions For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Significant Levels
	Total	**Positive**	**Neutral**	**Non-positive**			
Chapter - 12	**48**	**22**	**08**	**18**	**6.50**	**2**	**H_{12} Rejected at 0.1 and 0.05**

Interpretation

So, from the above table and the graph it was observed as out of total 48 options to response for the reactions, 22 options with positive favor were responded with higher percentages (green bars with high percentages) while 18 options with non-positive favor were responded with lower percentages (red bars) while 08 options were responded with neutral (no bars) response. Also, 54.3% and 22.9% of total respondents had positively replied as their knowledge and understanding had been improved more and little respectively while 22.9% had replied neutrally. From the open-ended item-statements, majority responses received in terms to favor positively about the teaching-learning process, teaching method/style, an instructor, and the way of learning as well about the activities. Thus, it reveals that responses are in positive favor for the developed SOLO based Instructional Strategy implemented for a Chapter-12 Heron's Formula.

As Calculated χ^2 is greater than the critical value (tabled) for both the 0.1 and 0.05 significant levels. Thus, it rejects the null hypothesis H_{12} and it could be conclude as there is highly significant difference in the reactions for the learning experiences gained through the developed SOLO based instructional strategy for a Chapter-12 Heron's Formula by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{12} and significant differences found at Significant levels of 0.1 as well 0.05 for the reactions about the significant effect of progressive learning or understanding in Mathematics of the experimental group

studied through the developed instructional strategy for a Chapter – 12 Heron's Formula.

5.4.1.2 Hypothesis (H_{13}) Testing On The Reactions For A Chapter – 4

***H_{13}**: There will be no significant difference in the reactions for the learning experiences gained for a chapter-Linear Equation In Two Variables by the group studied through the developed instructional strategy.*

Following table-5.16(a) is showing the frequency distribution and the percentages of the responses in the form of reactions received for the corresponding close-ended item-statements about the learning experience for Chapter-4 Linear equation in two variables as experienced through developed instructional strategy by an experimental group. And the said percentages are plotted on a graph shown in figure–5.18 about the responses received with respect to various items of reaction tool for a Chapter-4.

Table – 5.16(a):
Frequency (n) Distribution and Percentages (%) on reaction-responses for Chapter-4
(Total Responses received = 34)

Chapter – 4 Linear Equation In Two Variables				
SOLO Levels	**Item No.**	**Item-Statements About My Learning Experiences and Achievements**	**n**	**%**
	I-1)	**Whether I have participated in an Activity-1 on 'Vegetable Vendor'?**		
	a)	Yes	**31**	**91.2%**
	b)	No as I was absent in school / engaged with other school-activity	**04**	**11.8%**
	I-2)	**How was an Activity-1 (in general)?**		
	a)	Entertaining only	**03**	**09.7%**
	b)	Real life based example/situation to understand the concept of L. E. in two variables	**24**	**77.4%**
●	c)	Easy to understand but not relevant with the said concept/topic	**01**	**03.2%**
	d)	Not appropriate for the grade- IX	**03**	**09.7%**
	I-3)	**How was this Activity-1 for me ?**		
	a)	Interesting & Just enjoyed	**11**	**35.5%**
	b)	Not understood by me	**00**	**00.0%**
	c)	Made easy to understand the topic of L.E. in two variables and its elements	**14**	**45.2%**
	d)	No comments	**06**	**19.4%**
	I-4)	**What I have learnt from this Activity-1 ?**		
	a)	Really, learnt about what the means of	**22**	**71.0%**

		variables, coefficients, solutions of a L. E. within one activity only		
	b)	Just enjoyed the concept/activity of 'sell-purchase'	**08**	**26.0%**
	c)	It was a small group activity so I was just a spectator in my group	**00**	**00.0%**
	d)	Nothing	**01**	**03.2%**
	I-5)	**Whether I have solved a Worksheet given as an Activity – 2 on "Currency Notes"?**		
	a)	Yes	**30**	**88.2%**
	b)	No	**04**	**11.8%**
	I-6)	**What I have learnt or understood from an Activity-2? Let me mark.**		
	a)	Just making the combinations of currency notes given in Set I & II	**02**	**06.7%**
	b)	Learnt to differentiate the Variables & Coefficients	**13**	**43.3%**
	c)	Learnt to frame the Mathematical expressions i.e. L. E. in two variables	**12**	**40.0%**
	d)	Not appropriate activity according to my learning	**03**	**10.0%**
	I-7)	**Whether I did an Activity-3 on "Solving Equations" to find/ understand the various solutions of a L. E. in two variables ?**		
	a)	Yes	**27**	**79.4%**
	b)	No as I was absent in school/engaged with other school-activity	**07**	**20.6%**
	I-8)	**How was an Activity-3 for me ?**		
	a)	Clearly understood by me that what do mean by the solutions of a L. E.	**20**	**74.1%**
	b)	Activity was not appropriate	**00**	**00.0%**
	c)	Difficult Activity and not understood by me	**00**	**00.0%**
	d)	No Comments	**07**	**26.0%**
	I-9)	**Whether I have participated in an Activity-4 on "Plotting Graphs" based on the solutions of a L. E. in two variables ?**		
	a)	Yes	**28**	**82.4%**
	b)	No as I was absent in school/engaged with other school-activity	**06**	**17.6%**
	I-10)	**How I found this Activity-4 for me ?**		
	a)	Appropriate to practise the plotting graphs based on the solutions of a L. E.	**19**	**67.9%**
	b)	I was feeling difficult as things were not clear to me	**01**	**03.6%**
	c)	Confused with the given examples on L.E.	**03**	**10.7%**
	d)	Unable to comment	**05**	**17.9%**
	I-11)	**My Learning experience from Activity-5 & 6 on observing "Graphs" based on the parallel/perpendicular lines as well framing the Linear Equations from the graphs was :**		
	a)	Interesting to learn about to think for the L. E. of given lines on graphs	**15**	**53.6%**

	b)	Non-interesting	**00**	**00.0%**
	c)	Felt difficulties in how to frame L. E. for a straight line given in the graphs	**04**	**14.3%**
	d)	Honestly I succeeded to frame L. E. for the straight lines given on the graphs	**09**	**32.1%**
	I-12)	**'Concepts/topics arrangement through the Hexagonal shapes, helped me to understand thoroughly the concepts of L. E. in two variables**		
	a)	Yes-Innovatively & more than my expectations	**24**	**70.6%**
	b)	I am not clear with this exercise	**03**	**08.8%**
	c)	I feel, it's an useless exercise	**02**	**05.9%**
	d)	Don't' know	**05**	**14.7%**
	I-13)	**Whether my Knowledge/Understanding has been improved?**		
	a)	Yes but little	**06**	**17.7%**
	b)	Yes and more	**20**	**58.8%**
	c)	Unable to say	**07**	**20.6%**
	d)	No/Not much	**01**	**02.9%**
	I-14)	**What I felt about this way of learning & understanding process rather than the regular learning process ?**		
	a)	Total activity based	**15**	**44.1%**
	b)	Traditional/Regular	**01**	**02.9%**
	c)	Innovative	**15**	**44.1%**
	d)	Unable to say	**03**	**08.8%**

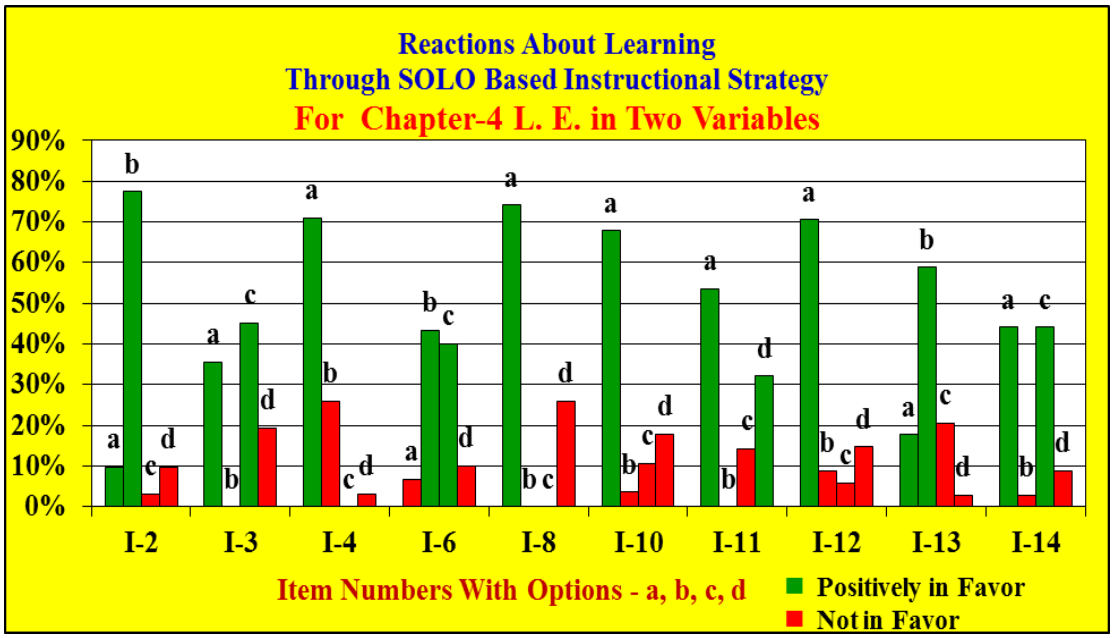


Figure- 5.18: Reactions by an Experimental group about learning of a Chapter – 4

Following table-5.16(b) is showing the outcome of the analysis performed on the data as shown in table-5.16(a) as well in a figure-5.18 using the Chi-Square method.

Table – 5.16(b):
Hypothesis testing by using Chi-Square on Reactions received for Chapter-4

Reactions For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Significant Levels
	Total	**Positive**	**Neutral**	**Non-positive**			
Chapter - 4	**40**	**16**	**05**	**19**	**8.17**	**2**	**H_{13} Rejected at 0.1 and 0.05**

Interpretation

So, from the above table and the graph it was observed as out of total 40 options to response for the reactions, 16 options with positive favor were responded with higher percentages (green bars with high percentages) while 19 options with non-positive favor were responded with lower percentages (red bars) while 05 options were responded with neutral (no bars) response. Also, 58.8% and 17.7% of total respondents had positively replied as their knowledge and understanding had been improved more and little respectively while 20.6% had replied neutrally and 2.9% replied for non-positive option. From the open-ended item-statements, majority responses received in terms to favor positively about the teaching-learning process, teaching method/style, an instructor, and the way of learning as well about all activities. Also, received positive remarks for the teaching-learning was like innovative, creative and amazing. So it reveals about major responses are in positive favor for the developed Instructional Strategy implemented for a Chapter-4 L.E.in two variables.

As Calculated value χ^2 is greater than the critical value (tabled) for both the 0.1 and 0.05 significant levels. Thus, it rejects the null hypothesis H_{13} and it could be conclude as there is highly significant difference in the reactions for the learning experiences gained through the developed SOLO based instructional strategy for a Chapter–4 Linear equation in two variables by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{13} and significant differences found at Significant Levels of 0.1 as well 0.05 for the reactions about the significant effect of progressive learning or understanding in Mathematics of the experimental group

studied through the developed instructional strategy for a Chapter – 4 Linear equation in two variables.

5.4.1.3 Hypothesis (H_{14}) Testing On The Reactions For A Chapter – 8

H_{14}*: There will be no significant difference in the reactions for the learning experiences gained for a chapter - Quadrilaterals by the group studied through the developed instructional strategy.*

Following table-5.17(a) is showing the frequency distribution and the percentages of the responses in the form of reactions received for the corresponding close-ended item-statements about the learning experience for Chapter-8 Quadrilaterals as experienced through developed instructional strategy by an experimental group. And the said percentages are plotted on a graph shown in figure–5.19 about the responses received with respect to various items of reaction tool for a Chapter-8.

Table – 5.17(a):
Frequency (n) Distribution and Percentages (%) on reaction-responses for Chapter-8 (Total Responses Received = 34)

Chapter – 8 Quadrilaterals				
SOLO Levels	**Item No.**	**Item-Statements About My Learning Experiences and Achievements**	**n**	**%**
	I-1)	**Whether I have participated in an Activity-1 on making figures with four sides using given dots ?**		
	a)	Yes	**31**	**91.2%**
	b)	No as I was absent in school / engaged with other school-activity	**03**	**08.8%**
	I-2)	**I found an Activity-1 (in general) is as:**		
	a)	Very basic activity to get idea about various Quadrilaterals	**11**	**35.5%**
	b)	Rubbish activity	**00**	**00.0%**
●	c)	Fun activity but not appropriate for the level of grade-IX	**08**	**25.8%**
	d)	Fun activity but appropriate for introducing such chapter like Quadrilaterals	**12**	**38.7%**
	I-3)	**How was an Activity-1 for me ?**		
	a)	Confused with Dots as how many dots to be used to make figure/s with four sides	**00**	**00.0%**
	b)	Interesting and I was remembering my pre-primary school days	**14**	**45.2%**
	c)	Creative to draw various figures of having four sides, four end points & Rangoli	**03**	**09.7%**
	d)	Learning with fun	**17**	**54.8%**

	I-4)	**Whether I was present for an Activity–2 on "Identifying Types of Quadrilaterals" in a given picture (of hut/house) ?**		
	a)	Yes	**29**	**85.3%**
	b)	No as I was absent in school / engaged with other school-activity	**05**	**14.7%**
	I-5)	**I can say about an Activity-2 (in general) as:**		
	a)	Time-pass activity	**06**	**20.7%**
	b)	Given picture was not appropriate	**03**	**10.3%**
	c)	Known picture given so it became easy to identify the various Quadrilaterals	**14**	**48.3%**
	d)	Suitable for the learning from 'known to unknown' in order to narrow down the focus to the types of Quadrilaterals only from a very familiar picture	**06**	**20.7%**
	I-6)	**The Activity - 2 for me was :**		
	a)	Liked as puzzling way of learning about the types of Quadrilaterals	**10**	**34.5%**
	b)	I was confused with this activity as well with some types of the Quadrilaterals	**03**	**10.3%**
	c)	Just did the activity as I was thorough with all types of Quadrilaterals	**06**	**20.7%**
I	d)	Helped me to make clarity and also learning on various Quadrilaterals as well how such shapes arranged/utilized in a given picture	**10**	**34.5%**
	I-7)	**Whether I did an Activity–3 "Who am I?"–cut & paste activity?**		
	a)	Yes	**30**	**88.2%**
	b)	No	**04**	**11.8%**
	I-8)	**How was an Activity - 3 for me ?**		
	a)	I don't like such cut & paste kind of activity	**00**	**00.0%**
	b)	Not a new for me as I am used to do and learn with such activity	**02**	**06.7%**
	c)	Liked a Crafting way of learning about the properties of various Quadrilaterals	**22**	**73.3%**
	d)	Different approach enjoyed for understanding the properties of Quadrilaterals	**06**	**20.0%**
	I-9)	**Whether I have solved the Class Worksheets–1 & 2 on "Venn Diagrams" to understand the families of Quadrilaterals as well about the Parallelograms & Non-Parallelograms?**		
	a)	Yes	**29**	**85.3%**
	b)	No as I was absent in school/ engaged with other school-activity	**05**	**14.7%**
III	**I-10)**	**What I have learnt or understood from the Class Worksheets ? Let me put tick.**		
	a)	Easy & Venn diagrams helped me to understand the families of Quadrilaterals and also characteristics of the Parallelograms & Non-Parallelograms	**12**	**41.4%**
	b)	Found difficulties in completing the worksheets	**01**	**03.5%**
	c)	Easy & diagrammatic way of learning to	**12**	**41.4%**

		provide ease understanding about the said concept		
	d)	No Comments	**04**	**13.8%**
	I-11)	**Whether I have participated in an Activity-4 "Parallelograms"- a cut & paste activity to differentiate the Quadrilaterals as Parallelograms or Non-Parallelograms?**		
	a)	Yes	**33**	**97.1%**
	b)	No as I was absent in school / engaged with other school-activity	**01**	**02.9%**
	I-12)	**How I found this Activity-4 for me ?**		
	a)	Interesting and practical activity for testing/ differentiate the Parallelograms and Non-Parallelograms	**15**	**45.5%**
	b)	Good activity but it has not given clear understanding on a desired concept	**07**	**21.2%**
	c)	Appreciate such activity which really develops the understanding on desired concept	**10**	**30.3%**
	d)	Unable to comment	**01**	**03.0%**
	I-13)	**Whether I was present for an Activity – 6 that is "Craft Activity" on "Tangram" ?**		
	a)	Yes	**33**	**97.1%**
	b)	No	**01**	**02.9%**
	I-14)	**My Learning experience from an Activity –6 on "Tangram" was :**		
	a)	Non-interesting	**01**	**03.0%**
	b)	I found Very Creative activity & I have enjoyed as a different learning-experience	**23**	**69.7%**
	c)	No clear objectives of this activity and I found non-relevance of it with the concept of the Quadrilaterals	**04**	**12.1%**
	d)	New knowledge for me and helped to develop critical & creative thinking on Quadrilaterals to be utilised as to make/create innovative or creative designs/ figures/patterns	**05**	**15.2%**
	I-15)	**'Concepts / topics arrangement through Hexagonal shapes', I found this exercise in order to understand thoroughly the concepts of Quadrilaterals as:**		
	a)	Don't' know	**05**	**14.7%**
	b)	Its beyond my understanding level	**05**	**14.7%**
	c)	Yes it's a good exercise to summarise the major topics/concepts of a chapter	**14**	**41.2%**
	d)	This arrangement helps to give quick view on the Quadrilaterals and recall the learning	**10**	**29.4%**
	I-16)	**Whether my Knowledge/Understanding on Quadrilaterals have been improved because the way of such teaching-learning ?**		
	a)	Yes but little	**10**	**29.4%**
	b)	Yes and more	**22**	**64.7%**
	c)	Unable to say	**02**	**05.9%**
	d)	No/Not much	**00**	**00.0%**

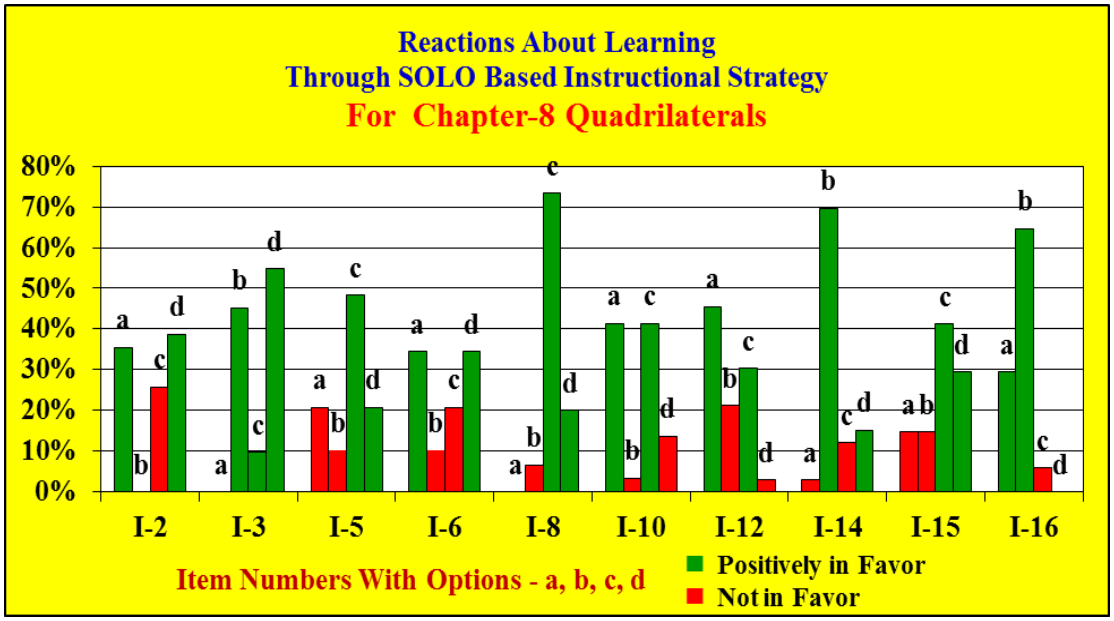


Figure – 5.19: Reactions by an Experimental group about learning of a Chapter – 8

Following table-5.17(b) is showing the outcome of the analysis performed on the data as shown in table-5.16(a) as well in a figure-5.19 using the Chi-Square method.

Table – 5.17(b):
Hypothesis testing by using Chi-Square on Reactions received for Chapter-8

Reactions For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Significant Levels
	Total	**Positive**	**Neutral**	**Non-positive**			
Chapter - 8	**40**	**21**	**04**	**15**	**11.18**	**2**	**H_{14} Rejected At 0.1, 0.05, 0.01**

Interpretation

So, from the above table and the graph it was observed as out of total 40 options to response for the reactions, 21 options with positive favor were responded with higher percentages (green bars with high percentages) while 15 options with non-positive favor were responded with lower percentages (red bars) while 04 options were responded with neutral (no bars) response. Also, 64.7% and 29.4% of total respondents had positively replied as their knowledge and understanding had been improved more and little respectively while 5.9% had replied neutrally. From the open-ended item-statements, majority responses received in terms to favor positively about the teaching-learning process, teaching method/style, an instructor, and the way

of learning as well about all activities. Also received positive remarks were about the teaching-learning as the innovative, creative and interesting. Few responses received not in favor of art and craft or cut and paste based activity. So it reveals about major responses are in positive favor for the developed Instructional Strategy implemented for a Chapter-8 Quadrilaterals.

As Calculated value χ^2 is greater than the critical value (tabled) for both the 0.1, 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_{14} and it could be conclude as there is highly significant difference in the reactions for the learning experiences gained through the developed SOLO based instructional strategy for a Chapter – 8 Quadrilaterals by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{14} and significant differences found at Significant Levels of 0.1, 0.05 as well 0.01 for the reactions about the significant effect of progressive learning or understanding in Mathematics of the experimental group studied through the developed instructional strategy for a Chapter – 8 Quadrilaterals.

5.4.1.4 Hypothesis (H_{15}) Testing On The Reactions For A Chapter – 14

H_{15}: *There will be no significant difference in the reactions for the learning experiences gained for a chapter-Statistics by the group studied through the developed instructional strategy.*

Following table-5.18(a) is showing the frequency distribution and the percentages of the responses in the form of reactions received for the corresponding close-ended item-statements about the learning experience for Chapter-14 Statistics as experienced through developed instructional strategy by an experimental group. And the said percentages are plotted on a graph shown in figure–5.20 about the responses received with respect to various items of reaction tool for a Chapter-14.

Table – 5.18(a):
Frequency (n) Distribution and Percentages (%) on reaction-responses for Chapter-14
(Total Responses Received = 37)

Chapter – 14 Statistics				
SOLO Levels	**Item No.**	**Item – Statements About My Learning Experiences and Achievements**	**n**	**%**
●	**1)**	**Whether I have participated in an Activity-1 which was in small group and with Play-cards ?**		
	a)	Yes	**37**	**100.0%**
	b)	No as I was absent in school / engaged with other school-activity	**00**	**00.0%**
	2)	**I found an Activity-1 (in general) as:**		
	a)	It was like funny and kid's activity but was having the practical aspect for learning	**12**	**32.4%**
	b)	Good Activity to introduce the concept of Statistics with a small set of play-cards	**24**	**64.9%**
	c)	No relevance of this activity of play-cards with Statistics	**01**	**02.7%**
	d)	Not suitable for the level of grade-IX	**00**	**00.0%**
	3)	**How was an Activity-1 for me ?**		
	a)	I was just a spectator in a group so I don't know much about an activity	**02**	**05.4%**
	b)	Simple activity of play-cards made easy to learn the concepts / terms of Statistics	**25**	**67.6%**
	c)	Boring activity as I don't like play-cards	**01**	**02.7%**
	d)	Appropriate activity to learn with play-cards but I don't like to do in a group	**09**	**24.3%**
▌	**4)**	**I did a small-group Activity–2 "Frequency Distribution" or not?**		
	a)	Yes	**37**	**100.0%**
	b)	No as I was absent in school / engaged with other school-activity	**00**	**00.0%**
	5)	**I can say about this Activity-2 (in general) as:**		
	a)	Interesting activity	**26**	**70.3%**
	b)	Pictures of group of 'Smiley' & 'Bank-clients' were quite relevant with the concept/s	**01**	**02.7%**
	c)	Picture based data were appropriate to differentiate two types of frequency distribution	**10**	**27.0%**
	d)	Don't like to do such activity in a group as not getting chance to learn/solve activity	**00**	**00.0%**
	6)	**The Activity - 2 for me was :**		
	a)	Enjoyed an activity as given in a small-group	**20**	**54.1%**
	b)	Really helped me to learn about the meaning of frequency as well two type of Frequency Distribution i.e. Ungrouped & Grouped	**13**	**35.1%**
	c)	Just did the activity as other group members were actually doing it	**01**	**02.7%**
	d)	No Comments	**03**	**08.1%**

	7)	**Whether I was present for an Activity – 3 about "A.M. Food / Breakfast Habits" – the Survey kind of activity ?**		
	a)	Yes	**35**	**94.6%**
	b)	No	**02**	**05.4%**
	8)	**How was an Activity - 3 for me ?**		
	a)	Actually, not understood the activity	**00**	**00.0%**
	b)	Very appropriate for learning about and through the Survey - the way for 'Collection of Data' in a very practical manner	**21**	**60.0%**
	c)	Different kind of approach enjoyed for understanding the concepts of Statistics like Collection, Organisation & Presentation of the data as well about the Tally marks	**14**	**40.0%**
	d)	I don't know what I have learnt	**00**	**00.0%**
	9)	**Whether I have participated in an Activity-4 for learning about the "Statistical Graphs" ?**		
	a)	Yes	**36**	**97.3%**
	b)	No as I was absent in school / engaged with other school-activity	**01**	**02.7%**
	10)	**How I found this activity for me ?**		
	a)	Experienced different way of depicting a Bar-graph , Histogram & Frequency Polygon	**19**	**52.8%**
	b)	Appreciate the easy way of putting data to build the pillars of the graphs which really develops understanding on desired concept	**13**	**36.1%**
	c)	Such exercises are suitable for primary level and not for the secondary classes	**04**	**11.1%**
	d)	Unable to comment	**00**	**00.0%**
	11)	**Whether I have solved a 'Class / Practice Worksheet'?**		
	a)	Yes	**36**	**97.3%**
	b)	No as I was absent in school / engaged with other school-activity	**01**	**02.7%**
	12)	**What I have learnt from a Practice Worksheet ?**		
	a)	Different kind of examples to solve and Statistical graphs to prepare	**27**	**75.0%**
	b)	I was confused and found difficulties in solving a worksheet	**04**	**11.1%**
	c)	Easy Exercises but felt very tedious task to do	**05**	**13.9%**
	d)	Nothing	**00**	**00.0%**
	13)	**Whether I did an Activity – 5 on "What is my learning style?" ?**		
	a)	Yes	**36**	**97.3%**
	b)	No	**01**	**02.7%**
	14)	**My Learning experience about the Statistics, from Activity –5 is :**		
	a)	I found it as meaningless activity	**02**	**05.6%**
	b)	Appropriate exercise was given to understand the concepts of Analysis and Interpretation of the Data	**23**	**63.9%**

	c)	Activity was not understood by me	**02**	**05.6%**
	d)	Different way of learning for the essential concepts of Statistics	**09**	**25.0%**
	15)	**According to me an exercise on 'Concepts/topics arrangement through Hexagonal shapes', helps to:**		
	a)	Give complete view for the content of a chapter	**17**	**47.2%**
	b)	Unable to say	**04**	**11.1%**
	c)	Yet I haven't understood the purpose of doing this exercise	**05**	**13.9%**
	d)	Gain overall understanding about a chapter with a quick reference	**10**	**27.8%**
	16)	**Whether my Knowledge / Understanding on Statistics have been improved because of the way of teaching - learning ?**		
	a)	Yes but little	**13**	**35.1%**
	b)	Yes and more	**21**	**56.8%**
	c)	Unable to decide	**00**	**00.0%**
	d)	No comment	**03**	**08.1%**

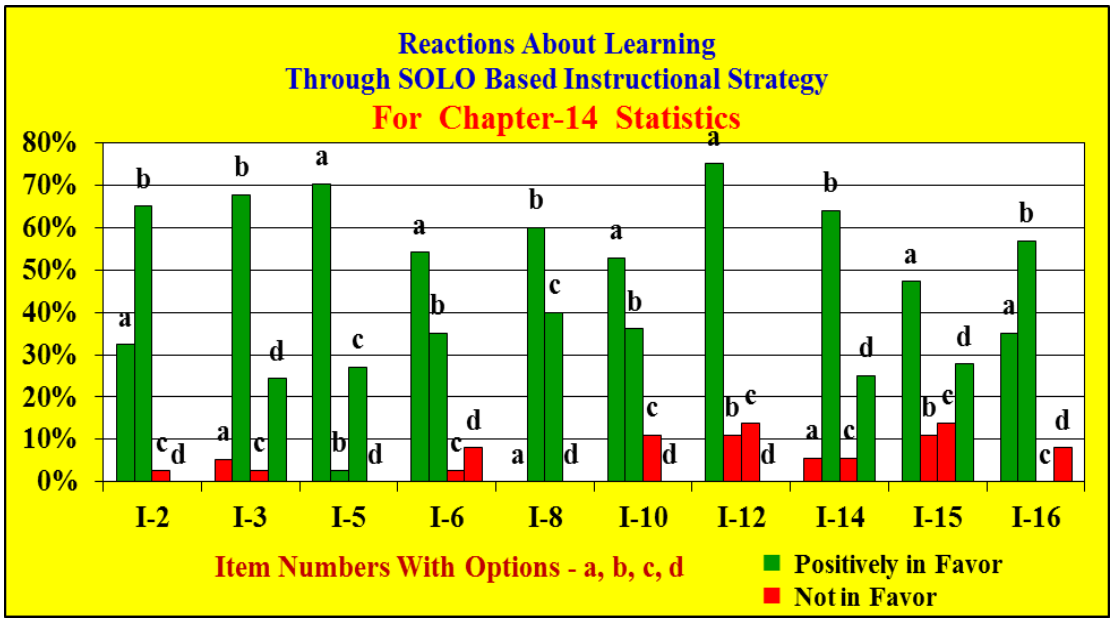


Figure-5.20: Reactions by an Experimental group about learning of a Chapter – 14

Table – 5.18(b):
Hypothesis testing by using Chi-Square on Reactions received for Chapter-14

Reactions For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Significant Levels
	Total	**Positive**	**Neutral**	**Non-positive**			
Chapter - 14	**40**	**20**	**07**	**13**	**6.37**	**2**	**H_{15} Rejected At 0.1 and 0.05**

The above table-5.18(b) is showing the outcome of the analysis performed on the data as shown in table-5.18(a) as well in a figure-5.20 using the Chi-Square method.

Interpretation

So, from the above table and the graph it was observed as out of total 40 options to response for the reactions, 20 options with positive favor were responded with higher percentages (green bars with high percentages) while 13 options with non-positive favor were responded with lower percentages (red bars) while 07 options were responded with neutral (no bars) response. Also, 56.8% and 35.1% of total respondents had positively replied as their knowledge and understanding had been improved more and little respectively while 8.1% had replied for non-positive option. From the open-ended item-statements, majority responses received in terms to favor positively about the teaching-learning process, teaching method/style, an instructor, way of learning and about all activities. Few responses received not in favor of too many activities. So it reveals about major responses are in positive favor for the developed Instructional Strategy implemented for a Chapter-14 Statistics.

As Calculated value χ^2 is greater than the critical value (tabled) for both the 0.1 and 0.05 significant levels. Thus, it rejects the null hypothesis H_{15} and it could be conclude as there is highly significant difference in the reactions for the learning experiences gained through the developed SOLO based instructional strategy for a Chapter – 14 Statistics by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{15} and significant differences found at Significant Levels of 0.1 as well 0.05 for the reactions about the significant effect of progressive learning or understanding in Mathematics of the experimental group studied through the developed instructional strategy for a Chapter – 14 Statistics.

5.4.1.5 Hypothesis (H_{16}) Testing On The Reactions For A Chapter – 15

H_{16}: *There will be no significant difference in the reactions for the learning experiences gained for a chapter-Probability by the group studied through the developed instructional strategy.*

Following table-5.19(a) is showing the frequency distribution and the percentages of the responses in the form of reactions received for the corresponding close-ended item-statements about the learning experience for Chapter-15 Probability as experienced through developed instructional strategy by an experimental group. And the said percentages are plotted on a graph shown in figure–5.21 about the responses received with respect to various items of reaction tool for a Chapter-15.

Table – 5.19(a):
Frequency (n) Distribution and Percentages (%) on reaction-responses for Chapter-15 (Total Responses Received = 30)

Chapter – 15 Probability				
SOLO Levels	**Item No.**	**Item – Statements About My Learning Experiences and Achievements**	**n**	**%**
●	**1)**	**Whether I was present in a Power Point Presentation (PPT) given on Probability ?**		
	a)	Yes	**25**	**83.3%**
	b)	No as I was absent in school / engaged with other school-activity	**05**	**16.7%**
	2)	**I found the PPT on Probability as:**		
	a)	Enriching with all the aspects for learning such as with examples, diagrams and exercises	**12**	**48.0%**
	b)	Boring Presentation as it was not up to the mark of level of learning	**03**	**12.0%**
	c)	Presentation was having the new content for learning and presented innovatively	**05**	**20.0%**
	d)	Appropriate presentation to the level of class IX	**05**	**20.0%**
	3)	**Whether I have participated in an Activity-1 which was based on to arrange the sentences on Probability Line ?**		
	a)	Yes	**27**	**90.0%**
	b)	No	**03**	**10.0%**
	4)	**How was an Activity-1 ?**		
	a)	Very innovative way for practising and understating the English with Mathematics and vice versa with the help of a Probability line	**22**	**81.5%**
	b)	Confused activity and difficult to understand the concept of Probability line with English and Mathematics together	**02**	**07.4%**
	c)	Inappropriate or Irrelevant activity	**03**	**11.1%**
	d)	Such an activity should be given in a group	**00**	**00.0%**
▌	**5)**	**Whether I did an Activity – 2 on "Probability" ?**		
	a)	Yes	**29**	**96.7%**
	b)	No as I was absent in school / engaged with other school-activity	**01**	**03.3%**
	6)	**I can say about an Activity-2 (in general) as:**		

	a)	I found it of lower level activity and it should be of more higher or difficult level activity	**08**	**27.6%**
	b)	Picture based examples in an activity was appropriate and relevant for the said concept	**12**	**41.4%**
	c)	I found it as practical type of activity to understand the concept of Probability easily.	**09**	**31.0%**
	d)	Only two examples in an activity are not enough to understand the Probability, but more such examples should be given for the better practice.	**00**	**00.0%**
	7)	**The Activity – 1 and Activity - 2 for me was :**		
	a)	Interesting & enjoyed the learning while doing it	**15**	**51.7%**
	b)	I understood the basics of Probability easily by doing these activities.	**08**	**27.6%**
	c)	Activities were not up to my level of understanding, it should be of more higher level	**05**	**17.2%**
	d)	Activities were not up to my level of understanding, it should be of little lower level	**01**	**03.5%**
	8)	**Whether I did an Activity – 3 about "Doing Experiment" for the Probability and an Activity – 4 on "Probability Tree"?**		
	a)	Yes	**27**	**90.0%**
	b)	No	**03**	**10.0%**
	9)	**How was an Activity - 3 for me ?**		
	a)	Enjoyed the Activity in a small group and I learnt about all the terms of the Probability	**21**	**77.8%**
	b)	I can learn more if such activity given at an individual level	**01**	**03.7%**
	c)	I liked as traditional activity given in a different manner	**03**	**11.1%**
	d)	I am unable to say about my learning	**02**	**07.4%**
	10)	**An Activity - 4 for me was :**		
	a)	I learnt about new topic "Probability Tree" which is not available in our textbook	**19**	**70.4%**
	b)	I don't like to do such activity in a group	**02**	**07.4%**
	c)	I don't found it is very useful for me to learn about the Probability	**04**	**14.8%**
	d)	I haven't understood how to draw the Probability Tree for any event	**02**	**07.4%**
	11)	**Whether I have participated in an Activity-5 for learning about the "Types of Events" ?**		
	a)	Yes	**25**	**83.3%**
	b)	No as I was absent in school / engaged with other school-activity	**05**	**16.7%**
	12)	**How I found this activity for me ?**		
	a)	Two simple and same examples given in the form of Probability tree was quite easy for me to understand the difference between the Independent and Dependent Events.	**09**	**36.0%**
	b)	Two same kind of examples made me confused and not understood by me clearly.	**01**	**04.0%**

	c)	Good exercise experienced by me for calculating the Probabilities for each event and then to verify all the calculations for/with the calculation of total Probability	**13**	**52.0%**
	d)	I felt difficulties in calculating the Probabilities for various events	**02**	**08.0%**
	13)	**Whether I did an Activity – 6 on "Probability & Statistics" ?**		
	a)	Yes	**27**	**90.0%**
	b)	No	**03**	**10.0%**
	14)	**How was an Activity - 6 for me ?**		
	a)	Appreciate its interdisciplinary aspects which helped me to relate or associate the concept of Probability with Statistics as well with English grammar with the help of Probability Scale	**16**	**59.3%**
	b)	I found it as higher level activity for me	**03**	**11.1%**
	c)	I found it as irrelevant activity for me	**01**	**03.7%**
	d)	No Comments	**07**	**25.9%**
	15)	**My Learning experience about a chapter of Probability is :**		
	a)	I understood the concepts of Probability and the full chapter thoroughly.	**15**	**50.0%**
	b)	I found additional content (Probability tree, scale, types of events etc) as useless for me and no need to learn it. It was beyond my understanding level.	**04**	**13.3%**
	c)	All Activities and exercises were helped me to learn easily and to think for the real life applications of Probability as well the additional content were quite good.	**07**	**23.3%**
	d)	Only few Activities were I found appropriate for me to learn and understand.	**04**	**13.3%**
	16)	**Whether my Knowledge /Understanding on Probability have been improved because of the way of teaching - learning ?**		
	a)	Yes but little	**06**	**20.0%**
	b)	Yes and more	**15**	**50.0%**
	c)	Unable to decide	**03**	**10.0%**
	d)	No comment	**06**	**20.0%**

Table – 5.19(b):
Hypothesis testing by using Chi-Square on Reactions received for Chapter-15

Reactions For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Significant Levels
	Total	**Positive**	**Neutral**	**Non-positive**			
Chapter - 15	**40**	**21**	**02**	**17**	**15.09**	**2**	**H_{16} Rejected At 0.1, 0.05, 0.01**

The above table-5.19(b) is showing the outcome of the analysis performed on the data as shown in table-5.19(a) as well in a figure-5.21 using the Chi-Square method.

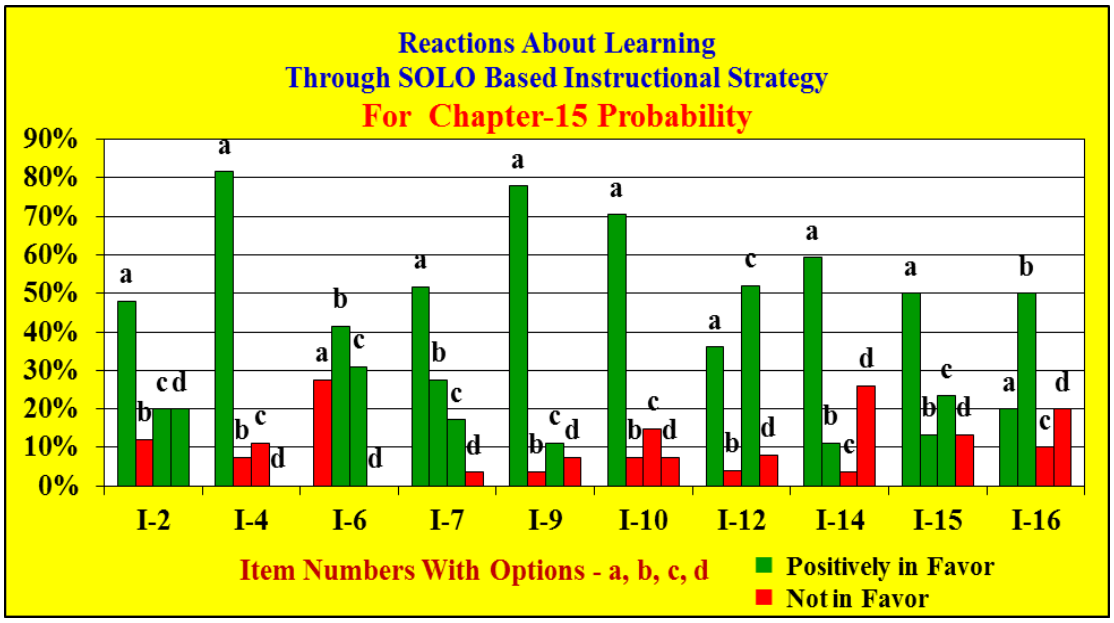


Figure – 5.21: Reactions by an Experimental group about learning of a Chapter – 15

Interpretation

So, from the above table and the graph it was observed as out of total 40 options to response for the reactions, 21 options with positive favor were responded with higher percentages (green bars with high percentages) while 17 options with non-positive favor were responded with lower percentages (red bars) while 02 options were responded with neutral (no bars) response. Also, 50% and 20% of total respondents had positively replied as their knowledge and understanding had been improved more and little respectively while 10% had replied neutrally and 20% felt not to comment. From the open-ended item-statements, majority responses received in terms to favor positively about the teaching-learning process, teaching method/style, an instructor, way of learning and about all activities. Few responses received not in favor of too many activities. So it reveals about major responses are in positive favor for the developed Instructional Strategy implemented for a Chapter-15 Probability.

As Calculated value χ^2 is greater than the critical value (tabled) for both the 0.1, 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_{16} and it could be conclude as there is highly significant difference in the reactions for the learning experiences gained through the developed SOLO based instructional

strategy for a Chapter-15 Probability by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{16} and significant differences found at Significant Levels of 0.1, 0.05 as well 0.01 for the reactions about the significant effect of progressive learning or understanding in Mathematics of the experimental group studied through the developed instructional strategy for a Chapter-15 Probability.

5.4.2 Analysis And Interpretations On The Overall Reactions With Respect To Objective – 7 And Hypothesis - H_{17}

Objective – 7: To study the effectiveness of the developed SOLO Taxonomy based instructional strategy with respect to the overall reactions of the group studied through developed instructional strategy.

***H_{17}**: There will be no significant difference in overall reactions received for the developed instructional strategy by the group studied through the developed instructional strategy.*

An Overall Reaction Scale was developed intended to collect responses about the overall experience gained through the entire intervention program constituted with the components like SOLO based Instructional Strategy, Achievement tests and reflecting about own learning. This tool consists of three sections as: (a) Section – I: About You In Mathematics; (b) Section – II: About The Achievement Tests and (c) Section – III: Your Learning Experience Throughout NewIntervention Program (SOLO Based Instructional Strategy).

Data collected from this tool are majorly of quantitative and analysed using a method of 'Frequency distribution and Percentages' and then using Chi-Square test method while qualitative data were analysed by using Content analysis and Frequency method and accordingly interpretations were made are reported here as follows.

Analysis On The Reactions Received In Section - I

In this section-I, there are eleven item-statements where each item-statement consists of five relevant options to choose.

Table – 5.20:
Frequency (n) Distribution & Percentage (%) for responses received on Section-I of Overall/Final Reaction Scale
(Responses received from Control Group = C; Experimental Group = E; Total = C + E = T)

Section – I : About You In Mathematics						
Item No.	**Item - Statements**		**Frequency (n)**			**Percent % Of T=Total**
			C (57)	**E (34)**	**T (91)**	
A1)	**I like Mathematics,**					
	a)	Very much	05	11	**16**	**17.6%**
	b)	Its my most favorite subject from all the subjects	06	02	**08**	**08.8%**
	c)	Don't like at all	04	01	**05**	**05.5%**
	d)	Unable to say, sometimes I like and sometimes I don't like	29	17	**46**	**50.6%**
	e)	No comments	13	03	**16**	**17.6%**
A2)	**I like Mathematics period,**					
	a)	Always I like	12	11	**23**	**25.3%**
	b)	Never I like	03	02	**05**	**05.5%**
	c)	Depends on the areas (Arithmetic, Algebra, Geometry…) or topic/s of Mathematics	10	08	**18**	**19.8%**
	d)	Depends on my mood for learning Mathematics	19	04	**23**	**25.3%**
	e)	Depends on the teaching of a teacher	13	09	**22**	**24.2%**
A3)	**My interest in Mathematics is because of,**					
	a)	The nature of the subject-Mathematics	19	15	**34**	**37.4%**
	b)	The teaching of my school Mathematics teacher	04	08	**12**	**13.2%**
	c)	The teaching of my tuition-class tutor	08	04	**12**	**13.2%**
	d)	As it is a compulsory subject of the curriculum and necessary to study	14	02	**16**	**17.6%**
	e)	No comments	12	05	**17**	**18.7%**
A4)	**The most motivational factor that help to enhance or to retain my interest in Mathematics is,**					
	a)	My inner drive to learn the Mathematics	11	10	**21**	**23.1%**
	b)	My school is providing good facilities through Mathematics laboratory, Mathematics club as well exposures through more curricular events or activities or competitions based on Mathematics	03	05	**08**	**08.8%**

	c)	My peers/friends are good in Mathematics and always getting help from them	13	04	**17**	**18.7%**
	d)	Competitions within a class for better performance in Mathematics	10	10	**20**	**22.0%**
	e)	Support from my parents as well as the suitable culture and environment at home	20	05	**25**	**27.5%**
A5)	**My achievements in Mathematics on an average is about (throughout all the examinations)**					
	a)	High – 70% & above	16	19	**35**	**38.5%**
	b)	Above Average – 60% to 70%	11	08	**19**	**20.9%**
	c)	Average – 50% to 60%	24	04	**28**	**30.8%**
	d)	Below Average – 40% to 50%	04	00	**04**	**04.4%**
	e)	Below 40%	02	03	**05**	**05.5%**
A6)	**I am doing special efforts to strengthen my self in Mathematics by,**					
	a)	Regular practices and revisions of only textbook examples and exercises	16	10	**26**	**28.6%**
	b)	Apart from textbook, regularly referring other Mathematics practice books to solve or practice variety of examples	24	13	**37**	**40.7%**
	c)	Regularly playing Mathematical games like solving puzzles, crosswords, other logical & reasoning based games, video games or games on computer/internet	07	03	**10**	**11.0%**
	d)	Preparing and participating in competitive exams based on Mathematics like Mathematics Olympiads, Talent search exams, quizzes, Mathematics fairs etc.	02	03	**05**	**05.5%**
	e)	Regularly chatting/ discussing/ talking about Mathematics with my peers, friends & elders	08	05	**13**	**14.3%**
A7)	**My learning style for Mathematics is,(select one option which is most relevant to your learning)**					
	a)	Proper understanding of the concepts and logic behind it	27	17	**44**	**48.4%**
	b)	Proper understanding of procedures or step-wise derivations for solution of any example or theorem	08	10	**18**	**19.8%**
	c)	By rote memorization only	03	01	**04**	**04.4%**
	d)	Drill / practices and revisions more than two-three times	08	04	**12**	**13.2%**
	e)	Unable to say	11	02	**13**	**14.3%**
A8)	**I develop my understanding in Mathematics through my Mathematics textbook/s in a manner,**					
	a)	First I would like to read the whole chapter including content-theory as well the solved examples of any chapter from Mathematics textbook	21	17	**38**	**41.8%**
	b)	I never like to read content-theory given in the chapters of a textbook	03	04	**07**	**07.7%**

	c)	I would like to read only the solved examples and illustrations and to apply the same procedures to solve the exercises of respective chapters of a textbook	12	03	**15**	**16.5%**
	d)	I always feel that content-theory given in any chapter of a Mathematics textbook is not enough to understand a respective chapter properly, so I take support of other reference material to understand	07	06	**13**	**14.3%**
	e)	I read the chapters but I always need to ask teachers, peers or others to explain it again	14	04	**18**	**19.8%**
A9)	**Generally I take support from the following reference materials apart from my Mathematics textbook**					
	a)	Practice books, Practice workbooks, Guides etc	40	19	**59**	**64.8%**
	b)	Materials downloaded from internet or the websites like 'Meritnation'	08	05	**13**	**14.3%**
	c)	Readymade CDs and Software-Applications	01	03	**04**	**04.4%**
	d)	Various assignments collected from my tuition class or other tuition classes	05	07	**12**	**13.2%**
	e)	Mathematics textbooks of lower standards	03	00	**03**	**03.3%**
A10)	**I like and learn the most if home-works or self-exercises should be given in the form of,**					
	a)	Assignments to practice same kind of examples	10	10	**20**	**22.0%**
	b)	Internet and information based projects	12	06	**18**	**19.8%**
	c)	Discovery or survey method based projects	08	04	**12**	**13.2%**
	d)	Worksheets	04	02	**06**	**06.6%**
	e)	Various question papers to solve	23	12	**35**	**38.5%**
A11)	**I believe that my achievement in Mathematics could be increase more by:**					
	a)	Through tuition class only as it takes personal care for proper practices & understanding Mathematics	14	05	**19**	**20.9%**
	b)	If proper understanding on the concepts of Mathematics should be provided in school	14	07	**21**	**23.1%**
	c)	If more time and practices provided in school by increasing number of periods for Mathematics subject	07	11	**18**	**19.8%**
	d)	If it is taught by different or non-conventional (non-traditional) methods like games, practical activities, field-visits, on computers or other learning by doing manner	09	07	**16**	**17.6%**
	e)	If number of same kind and relevant examples for the practices given as home-work or self exercises	13	04	**17**	**18.7%**

The Section-I of an Overall Reaction Tool is majorly focusing on to how respondents deal with the discipline/subject – Mathematics. The purpose of this section was to get the insights in brief the about respondents' thoughts for the Mathematics. With this reference, 11 item-statements framed to get specific replies in terms to have views on the present trends or scenario for learning the Mathematics. Responses collected in frequencies are converted into percentages are plotted on a graph as shown in figure-5.22. Five coloured bars present the five options of an item-statement. Thus interpretations could be made on for which option has received maximum or most of the responses.

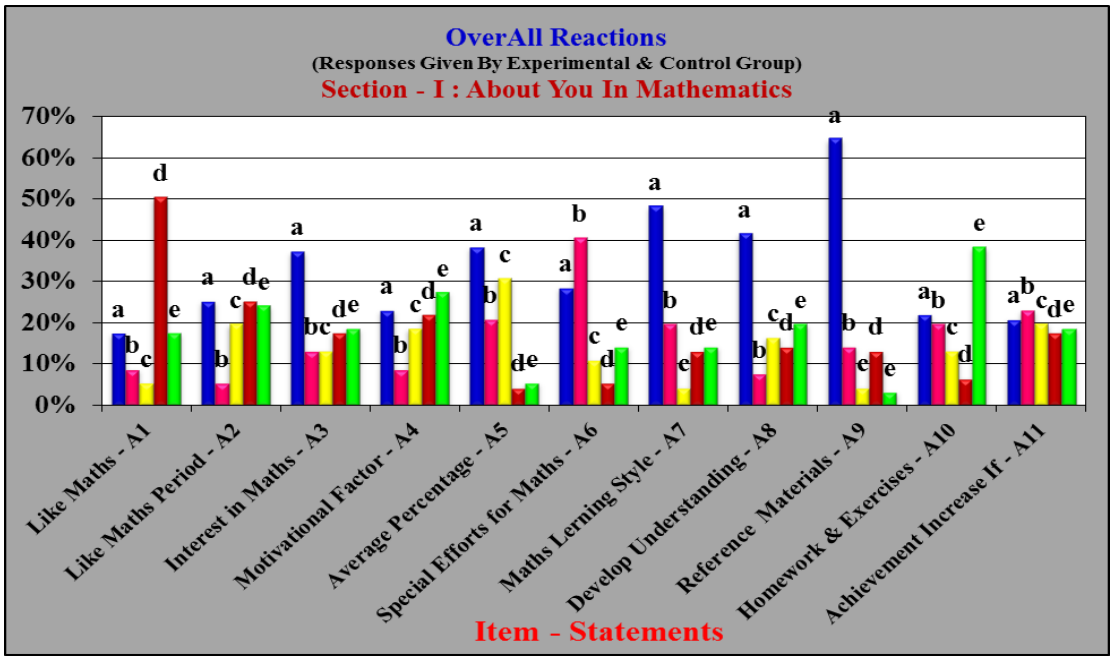


Figure-5.22: Reaction-responses by both the groups about self in Mathematics

Looking at some item-statements like as: For an Item-1, Whether I Like Mathematics, then only about 17.6% of the total respondents replied as they like it very much where about 8.8% replied as it is a most favorite subject out of all subjects and about 50.6% respondents replied as 'Unable to say, sometimes they like and sometimes they don't like the Mathematics'. Mixed responses received on an Item-2 on 'Whether they like Mathematics period or not' and only 5.5% replied as they never like. On an Item-3 about the reason for their interest in Mathematics, maximum 37.4% replied as 'the nature of the subject-Mathematics' is a reason. On querying about the most motivational factor that help to enhance or retain their interest in Mathematics, then maximum 27.5% replied as the support from their parents as well suitable

environment at home and least responses 8.8% replied as because of school is providing various facilities and opportunities relevant to Mathematics. While on a statement-6 about what special efforts making to strengthen the Mathematics, 40.7% responded for regular usage of practice-books apart from textbook and 28.6% responded for regular revisions of textbook examples and exercises that is bookish approach. Hence, 11%, 5.5% and 14.3% responded for various exposures based resources using to strengthen the Mathematics.

Moreover asking through item-statement-7 about the learning style of respondents for Mathematic then 48.4% accepted for proper understanding of concepts and logics but 19.8% accepted as understanding of procedural or step-wise derivations for solutions, 13.2% believe in drill/practice and revisions while 4.4% believe in rote memorization.

When questioned through statement-8 to know about how respondents make usage of a textbook for Mathematics then 41.8% would like to read the whole chapter including theory and illustrations, 19.8% also would like to read whole chapter but always need help from teachers or peers or others to understand it properly while 16.5% would like to read solved examples only as well 7.7% never like to read theory and 14.3% feel that content-theory of any chapter is not enough to understand the chapters properly. Most of that is 64.8% respondents take the support of various practice books, workbooks and guides/digests. Respondents specified about the preference for home-works or self-exercise then 38.5% prefer various question papers to solve and 22% prefer various assignments to practice while 19.8% and 13.2% prefer internet and discovery based projects respectively, only 6.6% prefer worksheets.

However, when querying about how the achievements in Mathematics could be increased then 23.1% and 19.8% responded for the proper understanding of the concepts and more time/periods as well practices should be provided by/in schools only, 17.6% favors non-conventional methods while 18.7% favors to have more home-work and 20.9% responded for the tuition-class as to increase achievements in Mathematics.

Interpretations derived from the above responses reveal about belief for the Mathematics is that it is theoretical subject and studied with exam-centered

approach only. Thus, also as believed that Mathematics could be mastered with only drills and practices of the examples. But 48.4% of respondents accepted for proper understanding of concepts as for their learning style as well 23.1% and 19.8% responded for the proper understanding of the concepts and more time/periods as well practices should be provided by/in schools, which is required to improve Mathematics.

Analysis On The Reactions Received In Section - II

The Section – II of the Overall Reaction Scale was attempted by both the Control and Experimental group. So total 91 responses were received from both the Control group (57 responses) as well from Experimental group (34 responses) and the respective responses as the frequencies derived for each of the reactions are converted to the percentages (%) of the total responses as shown in the following table-5.21. This section of the Overall Reaction Scale was designed to collect reactions of the participants/respondents about the experience for appearing in achievement tests and about the achievement test was.

The Section-II consist of 30 item-statements framed with five point Likert scale as A=Very Unhappy/Upset, B=Unhappy/Upset, C=Normal/Neutral, D=Happy and E=Very Happy. The frequencies with respective item-statements were converted to percentages are presented in a table-5.21. At later stage, this five point scale was converted into three point scale as A+B=Unhappy/Upset, C=Normal, D+E=Happy and same are plotted on a graph as shown in figure-5.23(a & b).

Table – 5.21:
Frequency (n) Distribution & Percentage (%) for responses received on Section-II of Overall/Final Reaction Scale

Section – II : About The Achievement Tests						
Item No.	**Item – Statements About Reactions**	**Percentages (%) of Frequencies**				
						
1)	All the chapter-wise Achievement Tests were conducted on time.	**18.68%**	**25.27%**	**26.37%**	**18.68%**	**10.99%**
2)	I liked the achievement tests that were conducted after completion of each chapter to know about our learning.	**06.59%**	**21.98%**	**21.98%**	**35.16%**	**14.29%**
3)	Time duration given with respect to the	**14.29%**	**24.18%**	**25.27%**	**19.78%**	**16.48%**

	total marks of the respective Achievement tests were appropriate.					
4)	Every time proper guidelines and instructions were provided before conducting the Achievement tests.	**07.69%**	**09.89%**	**24.18%**	**29.67%**	**28.57%**
5)	I liked all the test-papers were designed as Question cum Answer paper/book.	**14.29%**	**10.99%**	**29.67%**	**24.18%**	**20.88%**
6)	I found the style/format of the questions/ test-papers were totally different from our regular/conventional question/ test-papers.	**14.29%**	**23.08%**	**24.18%**	**23.08%**	**15.38%**
7)	I have realised that questions were arranged from lower to higher level of difficulties as it seems to follow some hierarchical manner.	**17.58%**	**17.58%**	**19.78%**	**19.78%**	**25.27%**
8)	I have observed as maximum questions were framed in a very different manner and can be distinguished from questions given in a textbook or asked in our regular/conventional question-paper.	**27.47%**	**16.48%**	**23.08%**	**14.29%**	**18.68%**
9)	I found, most of the questions were based on the respective chapters but most were out of all the exercises of respective chapter of our Mathematics textbook.	**10.99%**	**20.88%**	**25.27%**	**21.98%**	**20.88%**
10)	Majority of the questions were based on the real life applications and relevant to the concepts of the respective chapters.	**15.38%**	**16.48%**	**28.57%**	**16.48%**	**23.08%**
11)	Most of the questions were based on logic, reasoning, higher order thinking and thought provoking.	**06.59%**	**19.78%**	**18.68%**	**35.16%**	**19.78%**
12)	All the questions were easy to understand.	**23.08%**	**06.59%**	**25.27%**	**17.58%**	**27.47%**
13)	All the questions were difficult to understand.	**23.08%**	**26.37%**	**15.38%**	**16.48%**	**18.68%**
14)	I found many questions were very interesting and I liked to write the answers for the same.	**12.09%**	**09.89%**	**30.77%**	**16.48%**	**30.77%**
15)	I felt more practical aspects rather than theoretical aspects in the questions of all the test-papers.	**08.79%**	**20.88%**	**29.67%**	**21.98%**	**18.68%**
16)	Most of the questions were based on the applications rather than knowledge or theory based.	**10.99%**	**17.58%**	**29.67%**	**18.68%**	**23.08%**
17)	Questions were easy to understand but I was facing difficulties in the ways of writing the answers.	**13.19%**	**20.88%**	**21.98%**	**25.27%**	**18.68%**
18)	I liked the questions based on the Graphical Organiser (hexagonal shapes) asked for the concept arrangements of the respective chapters.	**14.29%**	**14.29%**	**32.97%**	**14.29%**	**24.18%**
19)	I felt short of time in terms to complete	**18.68%**	**15.38%**	**15.38%**	**26.37%**	**24.18%**

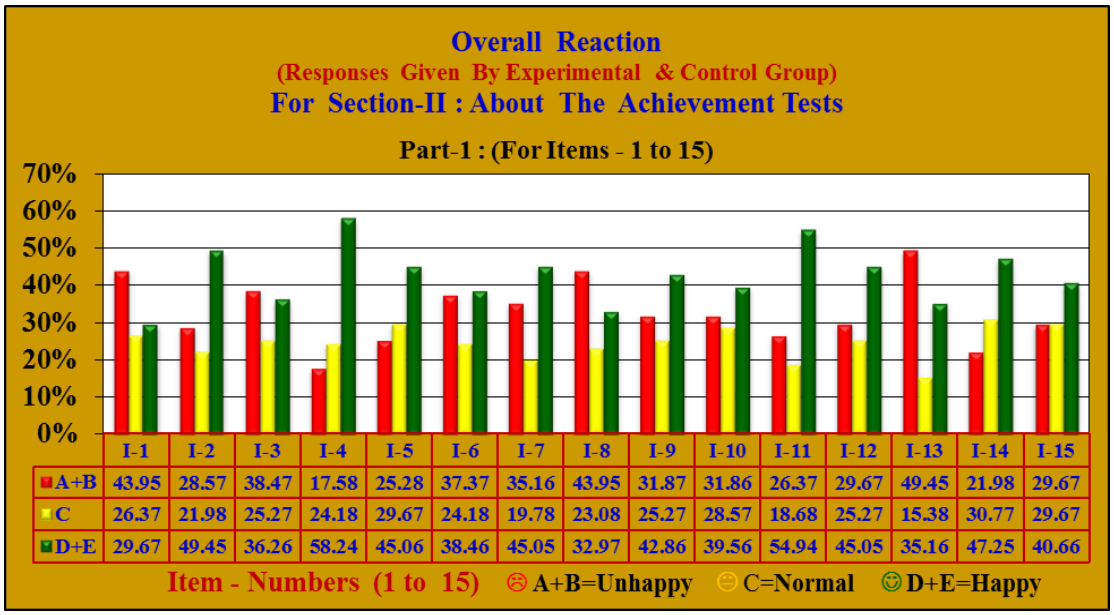
	the test-papers.					
20)	Overall, I have enjoyed myself while attempting the questions of all chapter-wise test-papers.	**06.59%**	**23.08%**	**25.27%**	**20.88%**	**24.18%**
21)	I have also learnt many new things from these test-papers.	**12.09%**	**14.29%**	**12.09%**	**34.07%**	**27.47%**
22)	I liked the pattern of these test/question papers and I feel that our conventional/ regular question papers also should be framed in this new manner.	**13.19%**	**24.18%**	**26.37%**	**13.19%**	**23.08%**
23)	The Printing quality, Visibility and Readability of the question papers.	**06.59%**	**15.38%**	**29.67%**	**24.18%**	**24.18%**
24)	Application type of questions and the way questions were framed.	**12.09%**	**14.29%**	**28.57%**	**27.47%**	**17.58%**
25)	Language used in questions	**04.40%**	**19.78%**	**23.08%**	**24.18%**	**28.57%**
26)	Pictures were used to understand the questions	**13.19%**	**15.38%**	**18.68%**	**25.27%**	**27.47%**
27)	Space provided for writing the answers	**16.48%**	**15.38%**	**17.58%**	**26.37%**	**24.18%**
28)	Rough space provided at the bottom of each page of question papers	**17.58%**	**18.68%**	**21.98%**	**15.38%**	**26.37%**
29)	Overall content in the test-papers	**09.89%**	**08.79%**	**31.87%**	**28.57%**	**20.88%**
30)	Overall pattern of the test/question papers	**10.99%**	**16.48%**	**26.37%**	**20.88%**	**25.27%**

Following figure-5.23(a & b) is a graphical presentation of the data mentioned in a table-5.21. The graphical presentation for the same is divided into two parts as below. Part-1 of a graph consist of presentation of item-statement from 1 to 15 while from 16 to 30 are plotted on a Part-2.

The graphs are plotted mainly with three coloured bars represent the three options for each item-statement, where red bar presents ‘Upset/Unhappy’ reaction, yellow bar presents ‘Neutral/Normal’ reaction while green bar shows the ‘Happy’ reaction. But to note that red or green bar not always express as unhappy or happy reactions respectively as it depends on the meaning of respective item-statement. That is, item-statement may be framed in a non-positive manner which may increase the non-positive responses but actually it may reveal strongly the positive favor about the study or the relevant component. For instance, an item-statement-13 is ‘All the questions were difficult to understand’ having more number of unhappy reactions which could be visible in graph in figure-5.23(a & b) too where height of a red bar is

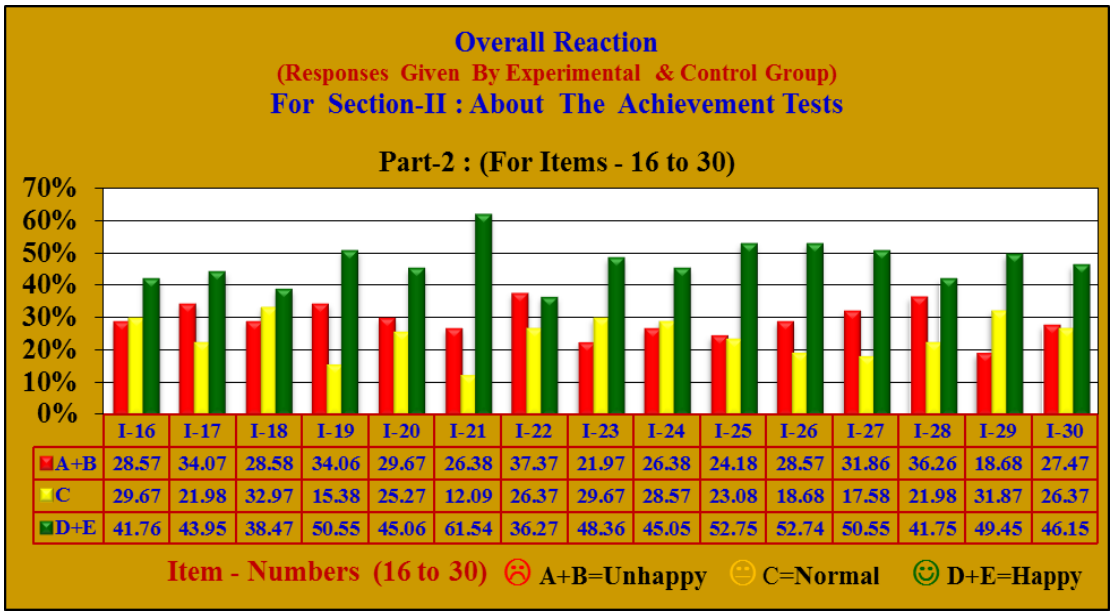
more than a green bar, but it reveals the meaning that the questions were simple and easy, so it may be considered as positive favour.

As here, it could be seen the marginal differences among the heights of three bars of the respective item-statements of both the Part-1 and 2 of a graph. But significant differences have been observed for the item-statement numbers – 5, 11, 14, 15, 16, 21, 24, 25, 26, 29 and 30 as have received reasonably more 'Happy' reactions, it means to showing positive favor on such kind of SOLO based developed Achievement tests.



	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14	I-15
A+B	43.95	28.57	38.47	17.58	25.28	37.37	35.16	43.95	31.87	31.86	26.37	29.67	49.45	21.98	29.67
C	26.37	21.98	25.27	24.18	29.67	24.18	19.78	23.08	25.27	28.57	18.68	25.27	15.38	30.77	29.67
D+E	29.67	49.45	36.26	58.24	45.06	38.46	45.05	32.97	42.86	39.56	54.94	45.05	35.16	47.25	40.66

Figure-5.23(a): Reactions by both the groups for the Achievement tests (Items 1-15)



	I-16	I-17	I-18	I-19	I-20	I-21	I-22	I-23	I-24	I-25	I-26	I-27	I-28	I-29	I-30
A+B	28.57	34.07	28.58	34.06	29.67	26.38	37.37	21.97	26.38	24.18	28.57	31.86	36.26	18.68	27.47
C	29.67	21.98	32.97	15.38	25.27	12.09	26.37	29.67	28.57	23.08	18.68	17.58	21.98	31.87	26.37
D+E	41.76	43.95	38.47	50.55	45.06	61.54	36.27	48.36	45.05	52.75	52.74	50.55	41.75	49.45	46.15

Figure-5.23(b): Reactions by both the groups for the Achievement tests (Items 16-30)

Also received 'Unhappy' reactions on items-1 and 3 that all the chapter-wise achievement tests were not conducted on time as well on the time duration given of the tests. Hence, overall reasonably satisfactory reactions received for all the Achievement tests.

Table – 5.22(a):
Summary for Frequency (n) Distribution & Percentage (%) on Reactions About Achievement tests (Section-II of Overall Reaction Scale)

Reactions	Total Responses	Percentage/s	Total Percentage/s
Very Unhappy	365	13%	**31%**
Unhappy	477	17%	
Normal	664	24%	**24%**
Happy	615	23%	**45%**
Very Happy	609	22%	
TOTAL	**2730**	**100%**	**100%**

Following table-5.22(b) as well a figure-5.24 are showing the outcome of the analysis performed on the data as shown in table-5.22(a) using the Chi-Square method.

Table – 5.22(b):
Analysis on Overall Reactions Using Chi-Square Test For Section-II (About Achievement tests) of Overall/Final Reaction Scale

Reactions	Frequency Total Responses	χ^2	df	Hypothesis Testing At Levels
Unhappy	842	**179.96**	2	$\mathbf{H_{17}}$ Rejected At 0.1, 0.05 and 0.01
Normal	664			
Happy	1224			
TOTAL	**2730**			

Above table-5.22(a & b) and the graphical presentation shown in figure-5.24, is a presentation in terms of frequencies and percentages of the responses received on the five Reactions like Very unhappy, Unhappy, Normal, Happy and Very happy which are further termed into three reactions as Unhappy, Normal and Happy. From these presentations, significant difference could be seen between the reactions received for the experiences with the Achievement tests and it is favorably positive.

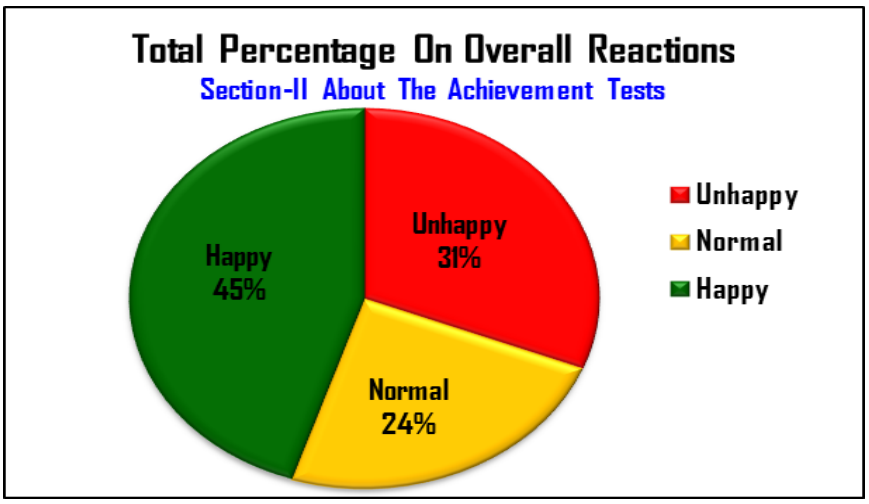


Figure-5.24: Percentage Differences for Reactions on Overall Achievement Test

Analysis on the Reactions received in Section - III

The Section – III of the Overall Reaction Scale was attempted by an Experimental group only. So total 34 responses were received from an Experimental group and the respective responses as the frequencies derived for each of the reactions are converted to the percentages (%) of the total responses as shown in the following table-5.23. This section was designed to collect reactions of the participants/respondents about the new learning experience gained from the SOLO based developed Instructional Strategy.

The Section-III consist of 25 item-statements framed with five point Likert scale as A=Very Unhappy/Upset, B=Unhappy/Upset, C=Normal/Neutral, D=Happy and E=Very Happy. The frequencies with respective item-statements were converted to percentages are presented in a table-5.23. At later stage, this five point scale was converted into three point scale as A+B=Unhappy/Upset, C=Normal, D+E=Happy and same are plotted on a graph-5.25.

In the graph shown in figure-5.25, mainly three coloured bars represent the three options for each item-statement, where red bar presents 'Upset/Unhappy' reaction; yellow bar presents 'Neutral/Normal' reaction while green bar shows the 'Happy' reaction. But to note that red or green bar not always express as unhappy or happy reactions respectively as it depends on the meaning of respective item-statement. That is, item-statement may be framed in a non-positive manner which may increase the non-positive responses but actually it may reveal strongly the positive favor about the

study or the relevant component. For instance, an item-statement-13 is 'I liked some of the activities only' having more number of unhappy reactions which could be visible in figure-5.25 too where height of a red bar is more than a green bar, but it reveals the meaning that they liked all the activities, so it may be considered as positive favour.

Table – 5.23:
Frequency (n) Distribution & Percentage (%) for responses received on Section-III of Overall Reaction Scale

Section – III : Your Learning Experience Throughout New Intervention Program (SOLO Based Instructional Strategy)						
Item No.	**Item – Statements About Reactions**	**Frequencies & Percentage**				
						
1)	I have experienced a non-conventional way of teaching-learning process in Mathematics that never had been experienced by me in the present class-IX.	**17.65%**	**14.71%**	**17.65%**	**14.71%**	**35.29%**
2)	I felt it was student-centred-approach rather than teacher-centred-approach throughout the process of teaching-learning	**02.94%**	**26.47%**	**20.59%**	**32.35%**	**17.65%**
3)	I can say it was an innovative way of teaching and learning.	**02.94%**	**11.76%**	**44.12%**	**23.53%**	**17.65%**
4)	Teaching – learning process was majorly based on the Conceptual Understanding of Mathematical concepts rather than Skill & Drill kind of practices.	**05.88%**	**14.71%**	**17.65%**	**32.35%**	**29.41%**
5)	The teaching and learning of the five selected chapters of Mathematics were conducted through various activities and worksheets only.	**08.82%**	**08.82%**	**14.71%**	**32.35%**	**35.29%**
6)	Explanations provided by the instructor during the whole intervention program were appropriate.	**05.88%**	**08.82%**	**17.65%**	**52.94%**	**14.71%**
7)	I found the instructor played the role of a facilitator during the teaching and learning processes rather than a lecturer.	**02.94%**	**11.76%**	**35.29%**	**26.47%**	**23.53%**
8)	Instructor has provided only instructions and guidelines time-to-time with respect to the activities and worksheets.	**08.82%**	**20.59%**	**14.71%**	**35.29%**	**20.59%**
9)	All the concepts of the respective chapters were covered by the instructor during the intervention program.	**17.65%**	**05.88%**	**32.35%**	**23.53%**	**20.59%**
10)	Appropriate examples, illustrations and demonstrations relevant to the respective concepts were provided.	**05.88%**	**20.59%**	**17.65%**	**23.53%**	**32.35%**

11)	All the activities along with the worksheets were very interesting and were assigned to do by ourselves as well many of were to do in pairs or groups.	**11.76%**	**11.76%**	**35.29%**	**26.47%**	**14.71%**
12)	I liked all the activities given along with the worksheets.	**23.53%**	**14.71%**	**17.65%**	**26.47%**	**17.65%**
13)	I liked some of the activities only.	**29.41%**	**23.53%**	**17.65%**	**20.59%**	**08.82%**
14)	I liked working with the worksheets.	**05.88%**	**26.47%**	**32.35%**	**14.71%**	**20.59%**
15)	Additional content apart from the Mathematics textbook were given in the form of 'learning through activities'.	**05.88%**	**14.71%**	**14.71%**	**44.12%**	**20.59%**
16)	All the real life based simple examples & activities were helped me to learn and understand the respective concepts of Mathematics.	**08.82%**	**17.65%**	**20.59%**	**29.41%**	**23.53%**
17)	Most of the activities were of practical kind.	**08.82%**	**08.82%**	**20.59%**	**17.65%**	**44.12%**
18)	My experience of working and learning with group/s.	**08.82%**	**02.94%**	**23.53%**	**23.53%**	**41.18%**
19)	My experience of working and learning in pair.	**08.82%**	**11.76%**	**23.53%**	**23.53%**	**32.35%**
20)	My experience of working and learning individually.	**17.65%**	**14.71%**	**14.71%**	**29.41%**	**23.53%**
21)	Summarization of a chapter based on the Concept arrangement method through the hexagonal-shape based Graphical organiser.	**14.71%**	**14.71%**	**17.65%**	**35.29%**	**17.65%**
22)	My experience for understanding the relevance of the concepts by arranging it through a Graphical Organiser.	**02.94%**	**17.65%**	**38.24%**	**20.59%**	**20.59%**
23)	Overall teaching-learning process of Mathematics	**05.88%**	**02.94%**	**14.71%**	**29.41%**	**47.06%**
24)	Overall performance of an instructor	**02.94%**	**05.88%**	**14.71%**	**29.41%**	**47.06%**
25)	Overall my understanding and experience of the learning though this intervention program	**02.94%**	**05.88%**	**14.71%**	**20.59%**	**55.88%**

In a graph given below , it could be seen the marginal differences among the heights of three bars of the respective item-statements in a graph. Also significant differences have been observed for the item-statement numbers – 1, 2, 4, 5, 6, 10, 15, 16, 17, 21, 22, 23, 24 and 25 as have received reasonably more 'Happy' reactions, it means to showing positive favor on such kind of SOLO based developed Instructional Strategy. Also received 'Normal/Neutral' reactions more on item-3 that whether it is found as innovative teaching-learning or not. Hence, overall reasonably satisfactory reactions received for the SOLO based developed Instructional Strategy.

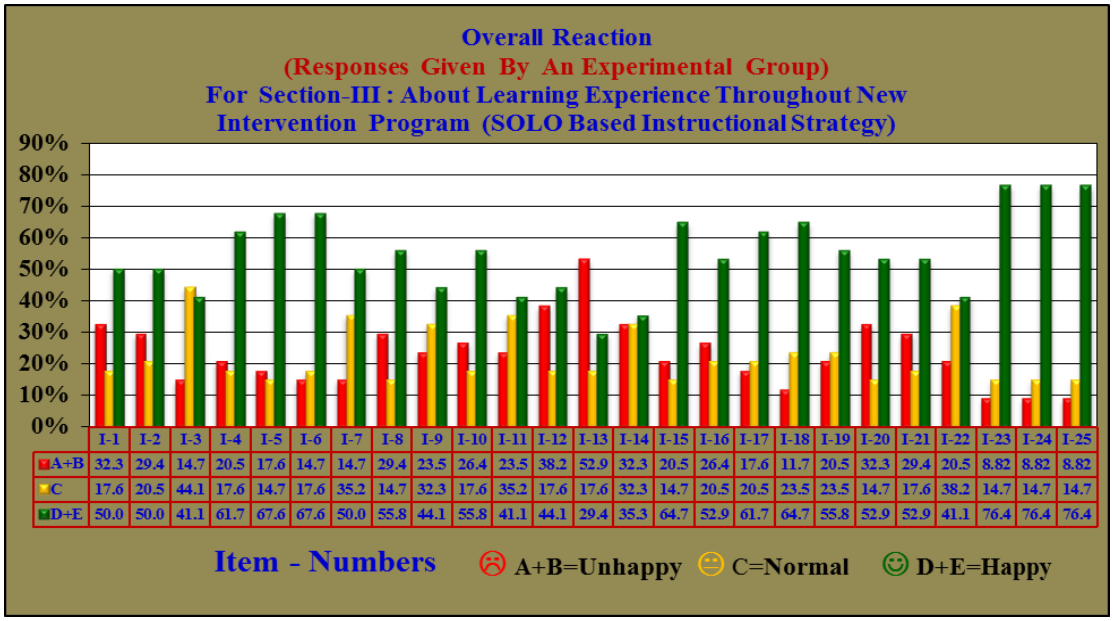


Figure-5.25: Graph on Reactions of Experimental group for new learning experiences

Also, there was one open-ended item-statement about 'the general comments' to write about more experiences of the participants. And participants responded with the comments as: Like the teaching of a teacher, nice method of teaching, innovative, amazing work by the instructor, good teaching style, good explanation and content.

Table – 5.24(a):
Summary for Frequency (n) Distribution & Percentage (%) on Reactions About Developed Instructional Strategy (Section-III of Overall Reaction Scale)

Reactions	Total Responses	Percentage	Total Percentage
Very Unhappy	81	10%	**23%**
Unhappy	115	14%	
Normal	188	22%	**22%**
Happy	234	28%	**55%**
Very Happy	232	27%	
TOTAL	**850**	**100%**	**100%**

Table – 5.24(b):
Analysis on Overall Reactions Using Chi-Square Test for Section-III (About Developed Instructional Strategy) of Overall/Final Reaction Scale

Reactions	Frequency Total Responses	χ^2	df	Hypothesis Testing At Levels
Unhappy	196	**176.78**	2	**H_{17}** Rejected At 0.1, 0.05 and 0.01
Normal	188			
Happy	466			
TOTAL	**850**			

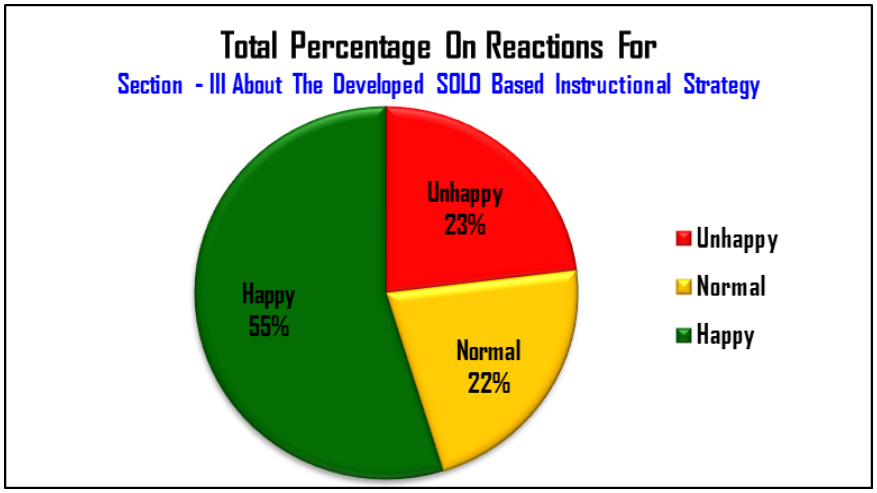


Figure-5.26: Percentage Differences for reactions on developed Instructional Strategy

Above table-5.24 and the graphical presentation figure-5.26, is a presentation in terms of frequencies and percentages of the responses received with reference the learning experiences through developed SOLO based on the five Reactions like Very unhappy, Unhappy, Normal, Happy and Very happy which are further termed into three reactions as Unhappy, Normal and Happy. From these presentations, significant difference could be seen between the reactions received for the experiences with the Achievement tests and it is favorably positive.

Interpretation

Thus, could be concluding as an experimental group has shown satisfactory and positive reactions towards the SOLO based developed Instructional Strategy. So this shows the rejection of the relevant null hypotheses and tends to the positive remarks for the effectiveness of the said Instructional Strategy. Thus, looking to the interpretations made section-wise of the Overall Reaction Tool, it reveals the satisfactory and reasonably positive reactions towards the SOLO based developed Instructional Strategy.

As Calculated value χ^2 is greater than the critical value (tabled) for all the 0.1, 0.05 and 0.01 significant levels. Thus, it rejects the null hypothesis H_{17} and it could be conclude as there is highly significant difference in the reactions for the overall experiences of learning gained through the developed SOLO based instructional strategy by the group studied through the developed instructional strategy.

This signifies that the developed SOLO based instructional strategy was effective with reference to the testing of hypothesis - H_{17} and significant differences found at the significance levels of 0.1, 0.05 as well 0.01 for the reactions for the overall intervention program implemented for the SOLO based developed Instructional Strategy as majority had shown a positive favor about the significant effect of progressive learning or understanding in Mathematics of the experimental group studied through the developed instructional strategy.

5.5 ANALYSIS AND INTERPRETATION BASED ON RASCH MODEL

The explanation and interpretation is drafted here based on the learning from the document of the **Yu (2013)** as prepared for novices in terms to get some insights about the Item Response Theory (IRT) as well Rasch Modeling. As the researcher of the present research study had intended for the further analysis of the data collected for the present research study as Rasch Modeling is mean to get view of the measurements with reference to the persons' or students' abilities and test-items' difficulties. Also, this method is an iterative as well complex method to do manually that is without using any software. Looking to such aspects, the researcher had not used the entire components like "Best fit or misfit" or "Item Calibration" of the said method. Only simple calculations of this method is presented here as per the knowledge and understanding of the researcher of a present research study.

According to Yu (2013), unlike the classical test theory, in which the test scores of the same examinees may vary from test to test, depending upon the test difficulty, in IRT item parameter calibration is sample-free while examinee proficiency estimation is item-independent. As one cannot judge a person's ability just based on the number of correct items a learner has obtained. Rather, the item attribute should also be taken into account.

In the context of the present experimental research study, following scale had been framed as Six Point Understanding Scale by the researcher for the present research study as shown in table-5.25 and to distribute it over the achievement test-scores gained by the groups at all the five levels of the SOLO Taxonomy which is shown in the further tables.

Table – 5.25:
Understanding Scale-Points on the intervals of percentages

Sr. No.	Percentage Intervals	Points Of Scale	Understanding Scale/Level
1.	**0% (0 score or Not attempted)**	**0**	**No Understanding**
2.	**00(.1)% - 20%**	**1**	**Little Understanding**
3.	**20(.1)% - 40%**	**2**	**Some Understanding**
4.	**40(.1)% - 60%**	**3**	**Fair Understanding**
5.	**60(.1)% - 80%**	**4**	**Good Understanding**
6.	**80(.1)% - 100%**	**5**	**Full/Complete Understanding**

Further, following table was prepared to show the Test-scores distributions with respect to the Six Point Understanding Scale are shown here. For this procedure, only test-scores of the Overall or Final Achievement test had taken for the analysis and all the achievements achieved according to the levels of SOLO taxonomy were considered to proceed for the analysis using Rasch Model/Analysis. Overall Achievement test was designed by researcher and it carries maximum of 75 marks distributed through the SOLO level-wise sections which are given on the Points/Scales of Understanding as below.

Table – 5.26:
Distribution of maximum scores of each SOLO levels of Overall Achievement test on Understanding Scale

TEST-SCORE DISTRIBUTIONS		
Section No. In Question Test Paper	**Intervals On Test-scores**	**Rating Scale For Understanding**
Prestructural Level (Maximum Mark – 5)		
I	0	**0**
	0.1 → 1.0	**1**
	1.1 → 2.0	**2**
	2.1 → 3.0	**3**
	3.1 → 4.0	**4**
	4.1 → 5.0	**5**
Unistructural Level (Maximum Mark – 10)		
II	0	**0**
	0.1 → 2.0	**1**

	2.1 → 4.0	**2**
	4.1 → 6.0	**3**
	6.1 → 8.0	**4**
	8.1 → 10.0	**5**
Multistructural Level (Maximum Mark – 15)		
III	0	**0**
	0.1 → 3.0	**1**
	3.1 → 6.0	**2**
	6.1 → 9.0	**3**
	9.1 → 12.0	**4**
	12.1 → 15.0	**5**
Relational Level (Maximum Mark – 20)		
IV	0	**0**
	0.1 → 4.0	**1**
	4.1 → 8.0	**2**
	8.1 → 12.0	**3**
	12.1 → 16.0	**4**
	16.1 → 20.0	**5**
Extended Abstract Level (Maximum Mark – 25)		
V	0	**0**
	0.1 → 5.0	**1**
	5.1 → 10.0	**2**
	10.1 → 15.0	**3**
	15.1 → 20.0	**4**
	20.1 → 25.0	**5**

For the analytical study here, only the Overall/Final Achievement test-scores of the groups had been taken to observe the progressive learning and Understanding through the five levels of SOLO taxonomy using the Rasch Model. Also, to study the progressive learning and Understanding with reference to the abilities of the subjects (students) of both the groups and the difficulty levels of items (questions) of test-paper.

Following are the table-5.27 and 5.28 were prepared with the achievements of both groups in terms of measuring the scores with respect the rating points of Understanding Scale as shown in a table-5.26. This procedure is partially based on the Rasch Model and did proceed further according to the learning or understanding of the researcher of this present research study.

Table – 5.27:
Understanding (Rating) scale distribution on Overall achievement test-scores of the experimental group

Matrix For Rating On Overall Test-scores of Experimental Group								
Sr. No.	Students	Pre structure	Uni structure	Multi structure	Relational	Extended Abstract	Proportion	
							Correct (Ability)	Incorrect (Lacking)
1	E – S01	3	4	4	3	4	0.72	0.28
2	E – S02	3	5	5	4	5	0.88	0.12
3	E – S03	4	5	4	4	3	0.80	0.20
4	E – S04	4	5	5	4	5	0.92	0.08
5	E – S05	5	5	5	4	3	0.88	0.12
6	E – S06	4	5	5	3	3	0.80	0.20
7	E – S07	5	5	4	2	3	0.76	0.24
8	E – S08	5	5	4	3	3	0.80	0.20
9	E – S09	0	5	5	3	3	0.64	0.36
10	E - S10	5	5	4	3	3	0.80	0.20
11	E - S11	5	4	5	3	4	0.84	0.16
12	E - S12	3	5	4	4	3	0.76	0.24
13	E - S13	5	4	4	3	3	0.76	0.24
14	E - S14	3	5	5	4	3	0.80	0.20
15	E - S15	5	5	4	4	3	0.84	0.16
16	E - S16	3	5	5	4	4	0.84	0.16
17	E - S17	5	5	5	3	3	0.84	0.16
18	E - S18	4	5	5	4	4	0.88	0.12
19	E - S19	4	5	4	4	3	0.80	0.20
20	E - S20	3	5	5	4	3	0.80	0.20
21	E - S21	5	5	4	4	4	0.88	0.12
22	E - S22	5	5	5	5	4	0.96	0.04
23	E - S23	4	5	4	3	3	0.76	0.24
24	E - S24	5	5	4	3	3	0.80	0.20
25	E - S25	5	5	5	4	3	0.88	0.12
26	E - S26	5	4	5	4	3	0.84	0.16
27	E - S27	4	4	5	5	4	0.88	0.12
28	E - S28	5	4	5	4	5	0.92	0.08
29	E - S29	5	4	4	2	3	0.72	0.28
30	E - S30	5	5	5	4	3	0.88	0.12
Proportion		↓	↓	↓	↓	↓		
Correct		0.84	0.95	0.91	0.72	0.69		
Incorrect (Lacking) (Item Difficulty)		0.16	0.05	0.09	0.28	0.31		

Table – 5.28:
Understanding (Rating) scale distribution on Overall achievement test-scores of the control group

Matrix Table For Rating On Overall Test-scores of Control Group								
Sr. No.	Students	Pre structure	Uni structure	Multi structure	Relational	Extended Abstract	Proportion	
							Correct (Ability)	Incorrect (Lacking)
1	C – S01	3	4	4	1	0	0.48	0.52
2	C – S02	2	3	4	3	1	0.52	0.48
3	C – S03	4	3	2	2	1	0.48	0.52
4	C – S04	3	3	3	2	1	0.48	0.52
5	C – S05	3	2	2	0	0	0.28	0.72
6	C – S06	5	4	2	1	2	0.56	0.44
7	C – S07	4	3	1	0	0	0.32	0.68
8	C – S08	3	4	4	0	0	0.44	0.56
9	C – S09	4	4	3	2	1	0.56	0.44
10	C - S10	3	4	2	0	0	0.36	0.64
11	C - S11	4	4	3	0	0	0.44	0.56
12	C - S12	2	3	2	2	1	0.40	0.60
13	C - S13	3	2	2	0	0	0.28	0.72
14	C - S14	2	4	2	0	0	0.32	0.68
15	C - S15	3	4	3	2	0	0.48	0.52
16	C - S16	3	4	3	0	0	0.40	0.60
17	C - S17	2	3	2	2	1	0.40	0.60
18	C - S18	4	4	2	1	2	0.52	0.48
19	C - S19	2	3	3	2	0	0.40	0.60
20	C - S20	2	4	2	0	0	0.32	0.68
21	C - S21	2	4	3	0	0	0.36	0.64
22	C - S22	1	5	4	2	0	0.48	0.52
23	C - S23	2	4	3	2	1	0.48	0.52
24	C - S24	3	3	2	0	0	0.32	0.68
25	C - S25	4	2	2	0	0	0.32	0.68
26	C - S26	5	3	2	0	0	0.40	0.60
27	C - S27	2	4	2	0	0	0.32	0.68
28	C - S28	5	4	3	1	0	0.52	0.48
29	C - S29	2	4	2	0	0	0.32	0.68
30	C - S30	3	3	3	1	1	0.44	0.56
Proportion		↓	↓	↓	↓	↓		
Correct		0.60	0.70	0.51	0.17	0.08		
Incorrect (Lacking) (Item Difficulty)		0.40	0.30	0.49	0.83	0.92		

In both the above table-5.27 and 5.28, a 5x30 two dimensional matrix-table had been developed with Rating points of Understanding scale assigned to the test-scores achieved in Overall Achievement test by each of the subjects of both the experimental and control group respectively. All the test-scores assigned with the rating points were segregated through the five levels of the SOLO Taxonomy as shown in the above tables. The Understanding, if attained then rated from 1 to 5 points and if not then 0 rating point assigned as it indicates 'No Understanding' or 'Non-attempted'.

Further, calculations were conducted on rating points of understanding scale in terms to get the values for 'Abilities' of the subjects (last column of a table) and 'Difficulty level' (bottom or last row of a table) for both the groups separately. In the context of the present research, Abilities of the subjects are mean to the "Understanding" (level) of the subjects of the sample. A table-5.27 presenting the data related to the achievements of the subjects from an experimental group. The ability that is 'Understanding' of the subjects are ranging from 0.72 to 0.96 means 72% to 96%.

Looking to the difficulty level of the items, it shows in increasing manner through Unistructure to Extended Abstract level and the values obtained as 0.95, 0.91, 0.72 and 0.69. So, for an experimental group, the items of an Overall Achievement test were most difficult at the Extended Abstract level of SOLO Taxonomy while the items at Unistructure level were comparatively easy. The same effect could be seen in the case of the control group also in table-5.28. Here, proportional averages were calculated at SOLO levels as each level was consist of As the Prestructure level is refer to the previous knowledge or learning. Further, differentiation on the item difficulty has shown in the following table-5.29.

In terms to draw the interpretations from this matrix table is considered as: If value calculated for the ability of a respondent is greater than the respective value calculated for the item/level difficulty then it term as respondent has considerably better understanding that is respondent is smarter than an item otherwise if value for ability is lesser than the item difficulty then item is smarter than a respondent. Here, item difficulty had calculated at SOLO levels of an Overall Achievement test and not at each item level. And each SOLO level of an Overall Achievement test consists of

five main questions or items which were framed based on the aspects of the understanding and difficulty-wise increasing order.

Table – 5.29:
SOLO Level-wise measure of Item-difficulty for Overall Achievement test

No.	SOLO Levels	Proportion Average For Items Of Overall Achievement Test At SOLO Levels			
		Experimental Group		Control Group	
		Correct	Incorrect (Item Difficulty)	Correct	Incorrect (Item Difficulty)
1	Prestructure	**0.84**	**0.16**	**0.60**	**0.40**
2	Unistructure	**0.95**	**0.05**	**0.70**	**0.30**
3	Multistructure	**0.91**	**0.09**	**0.51**	**0.49**
4	Relational	**0.72**	**0.28**	**0.17**	**0.83**
5	Extended Abstract	**0.69**	**0.31**	**0.08**	**0.92**

Thus, in the case of experimental group of the present research study, the calculated value of ability (that is Understanding) of all the subjects are measurably greater than the value of difficulty calculated for each of the SOLO Levels. It estimates and signifies that each subject of the experimental group has shown considerably better Understanding ability at each of the SOLO levels. Thus, an experimental group has shown better performance in an Overall Achievement test.

5.6 CONCLUSION

The complete report regarding the data analyses were presented in this Chapter-V to explain it in details about the study to observe the effectiveness of the SOLO based developed and implemented Instructional Strategy. The data for the present experimental research study were collected through the major tools developed for achievement tests and reaction tools in a way as: (a) chapter-wise achievement post-tests; (b) final/overall achievement test; (c) chapter-wise reaction-reflection tools and (d) overall reaction tool were examined through several data analysis method or techniques. Basically, data were analytically studied through the graphical presentations, descriptive statistics, inferential statistics and using Rasch Model for the significance and the efficacy of the present research study. Based on these

analytical studies, the inferences or interpretations were drawn out and highlighted in this chapter.

The resultant outcomes obtained from all the analyses shown the rejection of the relevant null hypotheses and indicated for the satisfactory and reasonably positive favor of SOLO based developed Instructional Strategy. The effectiveness or the impact of the said strategy had been observed or assessed from the achievements of the experimental group that is a group studied through the new or developed SOLO based instructional strategy and also it had revealed satisfactorily as well positively for the better performance than compare to a control group-the group studied through the conventional teaching-learning process. Thus, it concludes as overall the SOLO based developed and implemented Instructional Strategy was measurably effective.

The next Chapter-VI is about the summary of the present experimental research study as well discussions and justifications on major findings derived from the analyses conducted on the data collected for the present study are reported. Then, further suggestions are also stated for the further research studies.

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