CHAPTER - VI

CHAPTER – VI
SUMMARY AND IMPLICATIONS

6.0 INTRODUCTION

This Chapter-VI is developed to summarize the report of the present research study conducted for SOLO Taxonomy for the area of Mathematics and to highlight the findings of the present research study followed by the discussions as well with further suggestions and implications. In the context of summary, the important points and contents are taken from previous chapters of this study report are briefed here as below. Following is the overview of the basics of the present research study.

6.1 AN OVERVIEW ON METHODOLOGY OF THE STUDY

Statement Of The Problem

Developing And Implementing Instructional Strategy On The **S**tructure Of **O**bserved **L**earning **O**utcomes (SOLO) Taxonomy For Mathematics Of Class–IX

Objectives Of The Study

(1) To develop the SOLO Taxonomy based instructional strategy for Mathematics of Class-IX.

(2) To implement the developed SOLO Taxonomy based instructional strategy in Mathematics of Class-IX.

(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.

(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.

(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.

(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.

(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.

Hypotheses

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

Diagrammatic Overview Of The SOLO Based Instructional Strategy

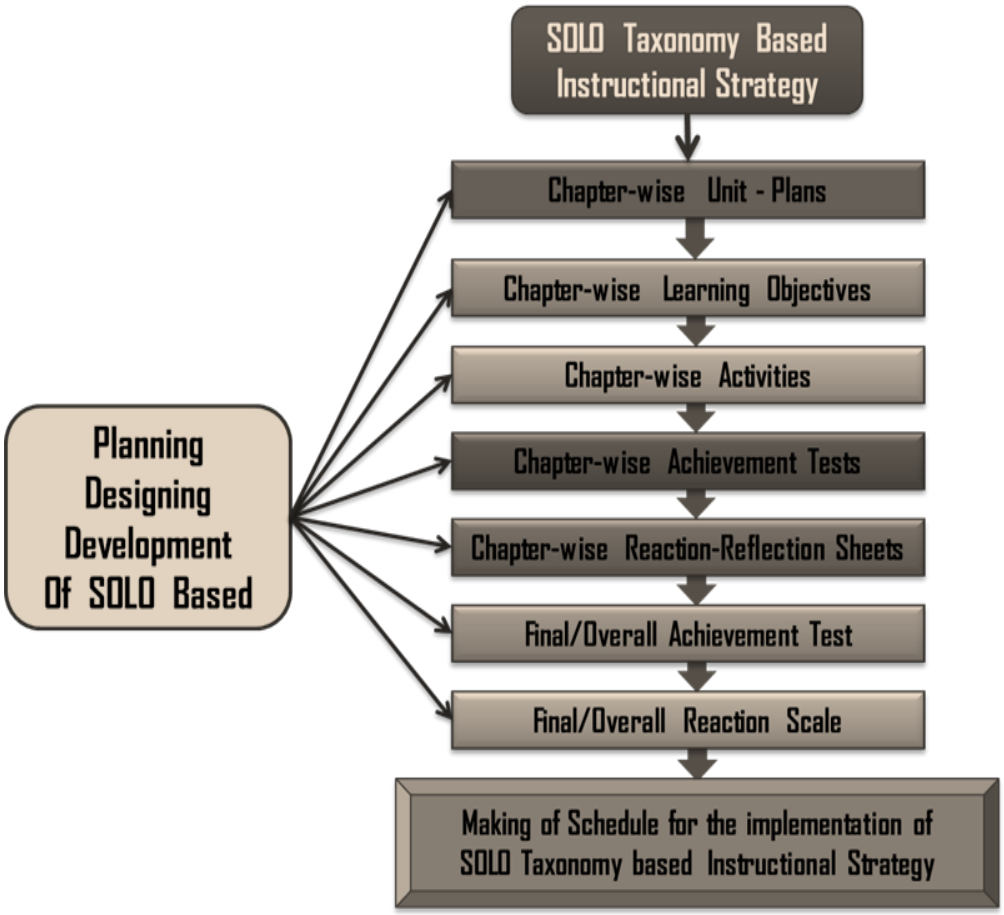


Figure – 4.2: Overview of SOLO based (complete) Instructional Strategy

Population And Sample

The students of the thirty CBSE English medium secondary schools of the Vadodara city were constituted as the Population for the present research study, (source: CBSE website on 10/01/2013-some were affiliated and some were in pipeline to affiliation).

Two schools out of thirty CBSE English medium secondary schools were selected random-purposively with respect to the permissions of the schools in terms to be a sample of the said research study. Those two schools were selected as sample for the

present experimental research study based on the following criterions as the researcher had set according to the need of the study: (a) Selected CBSE schools having secondary section that is at least having Class-IX. (b) A School whoever ready and permit to conduct experiments for the said research study for the longer duration as well to provide flexibility, liberty and necessary facilities as per the requirements of the research study. (c) After matching process, at least to get or have 25-40 students for a sample of the study.

Tools For Data Collection

Mainly two tools as, (i) Achievement tests and (ii) Reaction Scale were designed and developed by the researcher as well taken for the actual analysis in terms to draw out the findings and to make conclusions from it for this research study. Other tools were used as Field notes; Observation notes and the Reflection notes.

Techniques Of Data Analysis

For the Data-analysis, various techniques were used as: (i) Descriptive Statistics; (ii) Graphical Presentations; (iii) Non-Parametric Method-MWW U Test; (iv) Rasch Analysis; (v) Frequency and Percentage; (vi) Chi-Square Test and (vii) Content Analysis

6.2 MAJOR RESULTS AND CONCLUSIONS OF THE STUDY

Following is the summary on various outcomes derived from several analyses as reported in previous chapter/s. Here, mentioned tables are carrying the same table numbers as assigned in the respective chapters.

Results And Conclusions Based On The Analyses Of The Achievement Tests

Table – 3.10: (Reference to Chapter-III)
Measures of Central Tendency on Post-test Scores of sample for Class-IX Mathematics

Measures	Group	MEAN	MODE	MEDIAN	SD	VARIANCE
Chapter – 12	C	8.23	6	7.25	4.92	24.22
	E	18.34	18	18.50	3.80	14.43
Chapter – 4	C	13.47	20	12.38	4.70	22.14
	E	17.96	16	17.25	2.33	5.45
Chapter – 8	C	11.99	8.5	12.38	4.78	22.88

	E	**18.01**	**18.5**	**18.50**	**1.87**	**3.49**
Chapter – 14	**C**	**8.92**	**8**	**8.75**	**2.50**	**6.23**
	E	**18.84**	**18**	**18.88**	**1.86**	**3.44**
Chapter – 15	**C**	**12.33**	**16**	**12.50**	**2.58**	**6.66**
	E	**20.67**	**22.5**	**21.00**	**2.20**	**4.85**
Overall (Final)	**C**	**19.71**	**23.5**	**19.25**	**5.90**	**34.85**
	E	**53.80**	**50**	**52.25**	**6.26**	**39.16**

- This indicates that the developed SOLO based instructional strategy was effective with reference to the Measures of the Central Tendency as observed on 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.

Table – 6.1:
Summary of Chapter-wise Data Analysis On Overall Test-scores Using MWU-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	**Chapter - 12**	**1306**	**524**	**1306**	**59**	**H_1 Rejected**	**H_1 Rejected**
2	**Chapter - 4**	**1168.5**	**661.5**	**1168.5**	**196.5**	**H_2 Rejected**	**H_2 Rejected**
3	**Chapter - 8**	**1275**	**555**	**1275**	**90**	**H_3 Rejected**	**H_3 Rejected**
4	**Chapter - 14**	**1362.5**	**467.5**	**1362.5**	**2.5**	**H_4 Rejected**	**H_4 Rejected**
5	**Chapter - 15**	**1355**	**475**	**1355**	**10**	**H_5 Rejected**	**H_5 Rejected**
6	**Overall/Final**	**1365**	**465**	**1365**	**0**	**H_6 Rejected**	**H_6 Rejected**

- This signifies that the developed SOLO based instructional strategy was effective with reference to the hypotheses testing H_1 to H_6 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.

Table – 5.13: (Reference to Chapter-V)
Mean and SD calculated on Overall Test-scores for each of 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

- 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.

Table – 5.14: (Reference to Chapter-V)
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

- 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.

Results And Conclusions Based On The Analyses Of The Reaction Tools

Table – 6.2:
Summary on testing Hypotheses framed for the Chapter-wise and Overall Reactions by using Chi-Square method

Sr. No.	Reaction Tools For	Frequency on Options for Reactions (in favor of)				χ^2	df	Hypothesis Testing At Levels
		Total	Positive	Neutral	Non-positive			
1	**Chapter - 12**	48	22	08	18	**6.50**	2	H_{12} Rejected**
2	**Chapter - 4**	40	16	05	19	**8.17**	2	H_{13} Rejected**
3	**Chapter - 8**	40	21	04	15	**11.18**	2	H_{14} Rejected*
4	**Chapter - 14**	40	20	07	13	**6.37**	2	H_{15} Rejected**
5	**Chapter - 15**	40	21	02	17	**15.09**	2	H_{16} Rejected*
		Total	**Happy**	**Normal**	**Unhappy**			
6	**Section-II of Overall Reaction**	2730	1224	664	842	**179.96**	2	H_{17} Rejected*
7	**Section-III of Overall Reaction**	850	466	188	196	**176.78**	2	

***Rejected at Significance levels of 0.1, 0.05 and 0.01**
****** Rejected at Significance levels of 0.1 and 0.05**

- As Calculated value χ^2 is greater than the critical value (tabled) for at least both the 0.1 and 0.05 significant levels. Thus, it rejects all the null hypotheses H_{12} to H_{17} and it could be conclude as there is highly significant difference in the reactions received for the chapter-wise as well overall learning experiences 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.

Results And Conclusions Based On The Analysis Using Rasch Model

Table – 5.29: (Reference to Chapter-V)
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**

- 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.

From all the above results of the data analyses, it could be conclude that developed SOLO based Instructional Strategy had shown positive favour towards its effectiveness. Also, it was found as SOLO Taxonomy is useful framework to practice with Mathematics in terms to fulfill the desired objectives to enhance the levels of Understanding.

Following are the discussions and thoughts of the researcher of the present research study at several crucial points as identified by the researcher and some suggestive aspects are presented here.

6.3 DISCUSSIONS

Learning of Mathematics is necessary as it is relevant with the development of the logic and reasoning. And these are the criteria to understand the world or to understand the other discipline too. With this learning, concerns were established for how to improve or strengthen the learning as well as teaching of the Mathematics. So, with such concerns, this present research study was taken up to investigate about the approaches or attributes or criteria that help to address the said concerns. During this research studies, many learning and experiences learnt by the researcher, from which some were identified as crucial points are taken here to share as well to discuss.

6.3.1 Conceptual Understandings And Misunderstandings In Mathematics

The Education Commission (1964-66) that "In the teaching of Mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations".

Even, Worldbank (2009) mentioned that the National Curriculum Framework (NCF) of 2005 provides a set of guidelines for secondary education across the country, while leaving the states to determine their curricula and examination content within its broad direction and parameters. The NCF aims to lighten the overloaded curriculum in India's schools and to shift emphasis from rote memorization to **conceptual understanding,** synthesis, and application through an integrated and/or thematic

approach to teaching and learning. Its approach accords with the worldwide trends in curricula, and is a very important reference point to build from.

As major concern with to improve the Mathematics learning was intend to improve Conceptual understanding in terms to minimize the misconceptions. And it was the main objective of the present experimental research study. Through the present research study, the researcher had also made emphasis on to encourage for the Conceptual Understanding rather than procedural Understanding. With these objectives, the researcher had developed and implemented the SOLO based Instructional Strategy where learning strategies were developed with the focus of Conceptual understandings to be stimulated through several concepts based activities. All the activities whichever were implemented are enclosed in the Appendices-A to E of this thesis report along with the unit-plans.

6.3.2 Reviews On Selected Chapters Of Class-IX Mathematics Textbook

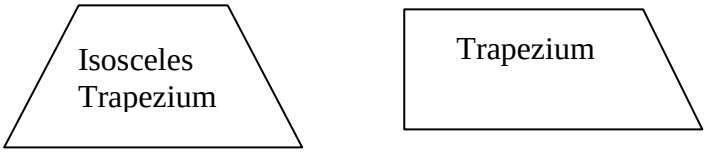
During the period of this present research study, the researcher had studied the Class-IX Textbook (CBSE) for the Mathematics in terms to observe at what extent this textbook is providing or lacking in assistance to learn Mathematical concepts thoroughly and appropriately. As for the present research study, only five chapters were selected to study, so very few comments with reference to the observations with only the selected chapters are pointed here.

From the point of view of the researcher of the present research study about the selected chapters in the textbook of Mathematics for Class-IX is that chapters in textbook itself are based on the procedural learning of the several Mathematical concepts of the chapters rather than providing more Conceptual explanations and its relevance with real life with sense of 'How' and 'Why'.

For example, in the chapter on Heron's Formula, conceptual explanation is lacking about the need of Heron's formula because ii is not just mean to say that having another formula to find the area of a triangle using its three sides in the case when measure of height of a triangle has not given. Also, explanation on the heights of a triangle has not given or elaborated which is required to learn and understand the concept Heron's Formula at this point of learning. This lacking aspects were covered

by the instructional strategy developed for the present research study with the help of activities. Where, detailed explanations on various type of heights were learned by the participants of the research study, also realized that when or in what circumstances/ situations it's difficult to measure the height/s and realized when to use the measure of sides of a triangle to apply the Heron's Formula.

Similarly, in the chapter of Quadrilaterals, figures on types of quadrilaterals were assigned with numbers instead of labels which may leads to misunderstandings or improper learning of the relevant concepts. Also, it is used at many places the word 'Trapezium' as one of the type of quadrilateral but actually it is an 'Isosceles Trapezium' as one of the type of trapezium. It is important to note as it may differ in terms of the properties or characteristics. It is shown in the following figure of Trapezium.



Such learning carries to misconception at further levels or learning. Also, content of chapters were not well organised and at many places sentences were not giving the clear meanings. So, to conclude as it need to take care to provide content in the textbooks which should not create or lead to misunderstandings or misconceptions. And, in the textbook only, need to give more emphasis on the Conceptual Understandings and explanations on the connectivity/relativity of the Mathematical concepts with the real life situations.

6.3.3 SOLO Hexagon: Graphical Organiser For Concept Arrangements

For the present research study, the researcher had practiced with SOLO Hexagon – a Hexagonal-shaped Graphical Organiser in terms to organise the several key-concepts/topics of a chapter according to their conceptual-relevancies with each other. During the implementation of the developed instructional strategy, it was practiced with each of the selected chapters and it was found very interesting in a manner to recapitulate at the point of accomplishment of a respective chapter. Also, it was found useful device in terms to address and practice the criteria of "Conceptual Understanding" and lessen the "misconceptions" at great extent. From the responses

and observations within a class during the implementation, it was found that all the participants of the study/students were actively participated in this activity and fruitful discussions were conducted during this activity. Photographs related with this activity are given in Photo-gallery-1 and 2 in Appendix-H.

6.3.4 Practical Approach In Mathematics Through Activities

As per the **Sensarma (2007),** Mathematics has occupied a central place in curriculum since antiquity but mathematical pedagogy has not. And **NCERT (2006),** as stated that at the secondary stage, a special emphasis on experimentation and exploration is given. Mathematics laboratories are a recent phenomenon, which hopefully will expand considerably in future. Activities in practical mathematics help students immensely in visualisation

In the context of the present research study, various hands-on and worksheet based activities were developed and implemented in terms to practice the Mathematics teaching-learning processes in a practical manner. From the verbal feedbacks given by the participants of the research study were found as participants were motivated and responded positively at all the stages of such activity based practices during the implementation of the SOLO based developed Instructional Strategy. More on hands-on activities are briefed in the next sub-point.

6.3.5 Reviews On Hands-on Activities Conducted During The Study

The researcher of the present experimental research study made fair efforts to bring practical approach in Mathematics teaching as well learning with the help of hands-on activities during the implementation of the developed SOLO based instructional strategy for the Mathematics of the Class-IX. With this approach, the present research was succeeded at great extent to fulfil the objectives as (i) To teach and learn Mathematics in a practical manner; (ii) Full participations, (iii) Learning at individual level, (iv) Understanding based approach rather than procedural or mechanical approach, (v) Conceptual understanding that is understanding the concepts with logic and reasoning is more important rather than to understand to solve the numerical examples. With these purposes, all the activities and even other components of the SOLO based instructional strategy had been developed and implemented for the present experimental research study.

For example, in the chapter of Heron's formula, activities with practical approach were developed for the participants to do, practice, understand, learn and practise about how to measure a height and three sides of the given triangle (instead of giving numerical figures about the said measures), identify the type of the heights, to calculate the area using Heron's formula and to identify as well to realise about the situations where it is difficult to measure the height of a triangle and need to apply Heron's formula.

In the case of a chapter on Linear equation in two variables, "Vegetable vendor" was a practical approach based activity and performed by all the students/participants and then learning about several components/concepts of the chapter on linear equation in two variables were addressed through this activity and further learning and practises were given through worksheets relevant with the said chapter to learn more.

While for the chapter on Quadrilaterals, several art and craft as well cut and paste based activities were developed by the researcher in terms to give scope for the participants to learn the various concepts, topics and properties of the quadrilaterals in a practical manner.

To learn a chapter on Statistics, the researcher had developed small-research based activities which were conducted by the students / participants and through such activities learning and understandings were attained by the students for the said chapter.

For the chapter of Probability, various balls, dice, play-cards based activities were developed by the researcher for students to conduct in a practical manner. Also Power Point Presentation had given in terms to understand the entire concept of Probability. Chart-based activity on "Probability Line" and "Probability scale" were conducted within a class in order to understand the concept Probability.

These all activities are enclosed in the Appendices-A to E and relevant photographs are enclosed in Photo-gallery -1 and 2 of Appendix-H of this thesis report.

6.3.6 Students' Learning Experiences

The students' learning experiences matters in terms to derive the perceptions about the teaching as well about the entire teaching-learning process and students' style of learning. For the present research study also, observations were noted down by the researcher about the attitude of the students for learning, their readiness, behavioural aspects, level of interest and motivation. And, especially in the discipline of Mathematics it is very important when the concern is to improve Mathematics learning.

At all stages of the implementation of the developed instructional strategy, it was found excitement and enthusiasm among the participants towards the learning through activities. Interests of the participants were remained maintained throughout the intervention program (implementation).

6.3.7 Reflections On The Practices With SOLO Taxonomy Based Instructional Strategy

The researcher as teacher, initially it was little difficult to design the lesson/plans for the said Instructional strategy using the platform of SOLO taxonomy as having the pre-mind-set of preparing it by using Bloom's taxonomy. So, shifting approach from Bloom's to SOLO taxonomy was the major concern to justify but gradually, it was learnt by the researcher. Major concern was how to practice it in the class-rooms and what impact or effect will get as well how to justify it. The researcher agrees that more learning in an actual manner were taken during the implementation of the SOLO based developed instructional strategy. Also, many insights were gained during the phase of implementation about SOLO Taxonomy and these insights are presented as an idea or perceptions in the section – 6.6 of this chapter.

6.3.8 Rasch Model For The Measurement

Peter & Yeen (1996) had investigated on 'Rasch Analysis of Math SOLO Taxonomy Levels Using Hierarchical Items in Testlets'. This study attempted to estimate Structure of Learning Outcome (SOLO) levels in mathematics using the Partial Credit and Rating Scale models. Serow (2007) integrated SOLO model and Rasch model to gain insight into students' understanding of class inclusion concepts in geometry. UNICEF (2007) conducted a research study based on SOLO Taxonomy and drafted a

'Report of the East Asia Learning Achievement Study (EALAS)'. To record and analyze findings, SOLO taxonomy was coupled with Rasch modeling, a data analysis tool for creating multi-item scales.

For the present research study, Rasch Model has been used for the data analysis which is presented in Chapter-V. It was learnt by the researcher from many research reviews that had employed Rasch Model and found as majorly in the SOLO taxonomy based research studies. It is found as complex and iterative method compare to other data analysis technique to perform it manually. Otherwise, it is useful to provide effective strategies to study the data and to conclude. Here, for the present study, a simple form of Rasch Model has been used. But, that simple form of measuring the two dimensional aspects were found very significant for the present study in terms to justify with the person's ability in accordance with item-difficulty. For the present research study, the abilities were considered as the 'Understanding Abilities' to measure. Such aspects are really needed to implement in educational examination systems/settings in terms to measure the abilities of the students with reference to the items of the achievement tests.

6.3.9 SOLO Taxonomy Based Assessment And Evaluation

Killen & Hattingh (2004) stated as descriptions of the difference between high-quality and low-quality achievement of complex outcomes should be in words rather than numbers can provide criteria by which to judge the quality of students' learning. From this quality perspective, `understanding (rather than memorisation), creativity (rather than reproduction), diversity (rather than conformity), initiative (rather than compliance) and challenge (rather than blind acceptance) should become the yardsticks by which we need to measure, describe and report student learning.

The achievements in the present experimental research study are meant to the proceedings for the progressive hierarchy for Understanding from surface to deeper aspects as attaining through five levels of SOLO Taxonomy viz. Prestructure, Unistructure, Multistructure, Relational and Extended-abstract. Hence, looking to the SOLO level-wise analysis as well assessing the achievements of an experimental group, the conclusion drawn in general as the outcomes of the learning of a said group in terms of progressive Understanding had been observed positively. Therefore,

finally it could be state as the SOLO based developed and implemented Instructional Strategy had succeeded as an Understanding centered approach.

In terms of to assess the learners with reference to the SOLO level-wise, then accordingly need to develop the assessment test. Need to ensure that the framed test-items should consist of or address the understanding aspects of learning. Further, it could be clubbed with Rasch model to assess the achievements of the learners. Further, as per the Yu (2013), one could predict the Probability of answering a particular item correctly given or not, gives the measure for Proficiency/Ability (understanding) of an examinee/subject/ respondent by the following equation:

$$\text{Probability} = 1/(1+\exp(-(\text{proficiency} - \text{difficulty})))$$

These are the ideas that one could implement further to observe the improvement in terms of effectiveness as well the quality aspects.

6.4 IMPLICATIONS OF THE PRESENT RESEARCH STUDY

Mathematics is a discipline which deals with the logic and reasoning which are the significant components that one needs to learn to learn problem-solving. And that is why Mathematics has key place in curriculum of any school education system. As it is given such emphasis to study Mathematics from the beginning of the educational studies but still many are having fear for the Mathematics due to imaginary nature of this discipline. Even in the classes also, it is taught with such aspects and very few are connecting the Mathematical aspects with the practical or real life. For the primary education of Mathematics, there are now many examples or real life applications have been established but as growing towards higher learning of Mathematics, it always focuses on the procedural learning of the Mathematical concepts rather than to establish it with the practical or real life applications. Perhaps, it is a need to set the appropriate connections or relativity of Mathematical concepts with several real-life contexts or applications at every stage of Mathematical learning. This tends towards to develop better understanding to understand the Mathematics in an appropriate and correct manner. And for better understanding, practical approach is necessary to give realization to the learning of Mathematics.

This present research study was also conducted with aforesaid concerns of how to develop better understanding among the learners and how it could be addressed with practical approach or in a practical manner. With this sense, the researcher of the present research study, had designed and incorporated many practical based activities in the new Instructional strategy developed and implemented by the researcher. And for this processes, the researcher had opted SOLO Taxonomy as it is mean to a framework to practice to develop better understanding (that is from surface to deeper understanding). Thus, it could be conclude with the though as there is a need to establish Mathematics Laboratories and practical activities in terms to learn practically the Mathematical concepts of any primary to higher level.

6.5 SUGGESTIONS

Following are the suggestions as per thoughts of the researcher of present research study as given below:

Suggestions For The Further Improvement Of Mathematics Education

- More researches needed in the area of pedagogy for Mathematics
- Practices with SOLO Taxonomy
- Content of higher level as well relevant with the present context should require to be in the textbook of Mathematics in terms to enrich the learners Mathematically
- Interactive activities needed to develop in terms to inculcate the practical approach for learning the Mathematics
- Needed to improve teaching for Mathematics in terms to address the individual learning within a heterogeneous group at a time.
- Constructive or Structuring approach should be practiced more in terms to encourage 'Student-centered approach'
- Sharpen the Mathematical skills

Suggestions For The Mathematics Education Based Research Study

- Research study can be conducted for the aspects of Mathematics in an affective domain of Bloom's taxonomy
- Research study can be conducted for the aspects of Mathematics in a Psychomotor domain of Bloom's taxonomy
- Research study can be conducted to identify more Mathematical skills

Suggestions for the Further SOLO Taxonomy Based Research Study

- ❖ Similar kind of study can be conducted for other school subjects
- ❖ Similar kind of study can be conducted for any grade level of school education
- ❖ Similar kind of study can be conducted for higher level education
- ❖ Research can be conducted to prepare training module or program to train the pre-service teachers to practice teaching-learning with SOLO taxonomy
- ❖ Research can be conducted to prepare training module or program to train the In-service teachers to practice teaching-learning with SOLO taxonomy
- ❖ Similar kind of study can be conducted to compare the implications of SOLO taxonomy and Bloom's taxonomy
- ❖ Similar kind of study can be conducted to compare the Assessment or Evaluation criteria based on SOLO taxonomy and Bloom's taxonomy

6.6 PERSPECTIVES TO PRACTICE WITH S.O.L.O. TAXONOMY

The diagrammatic presentations about the 'Levels of the SOLO Taxonomy' as well the 'Integrated SOLO-Bloom Taxonomy' is shown in the following figure-6.1 and 6.2 in terms to understand the SOLO Taxonomy in a clearer manner. These diagrams are developed by the researcher of the present experimental research study based on the understanding and learning experience of the researcher. This understanding had been developed during the implementation of the developed SOLO based Instructional strategy. The researcher had studied SOLO Taxonomy theoretically and thoroughly but during the development and implementation of the said Instructional Strategy, many empirical aspects of the said taxonomy came to learn as well many queries were raised in mind. To meet with those queries at some extent, following diagrams are developed as an idea to understand the said taxonomy and to implement it practically in an easy manner.

The figure-6.1 is depicted with all the five levels of the SOLO taxonomy in a hierarchical manner and progressing for the understanding from abstract to concrete manner or shaping the knowledge from raw to finest form.

Following is the diagrammatic presentation about Understanding for the SOLO Taxonomy as understood by the researcher of present research study is given as:

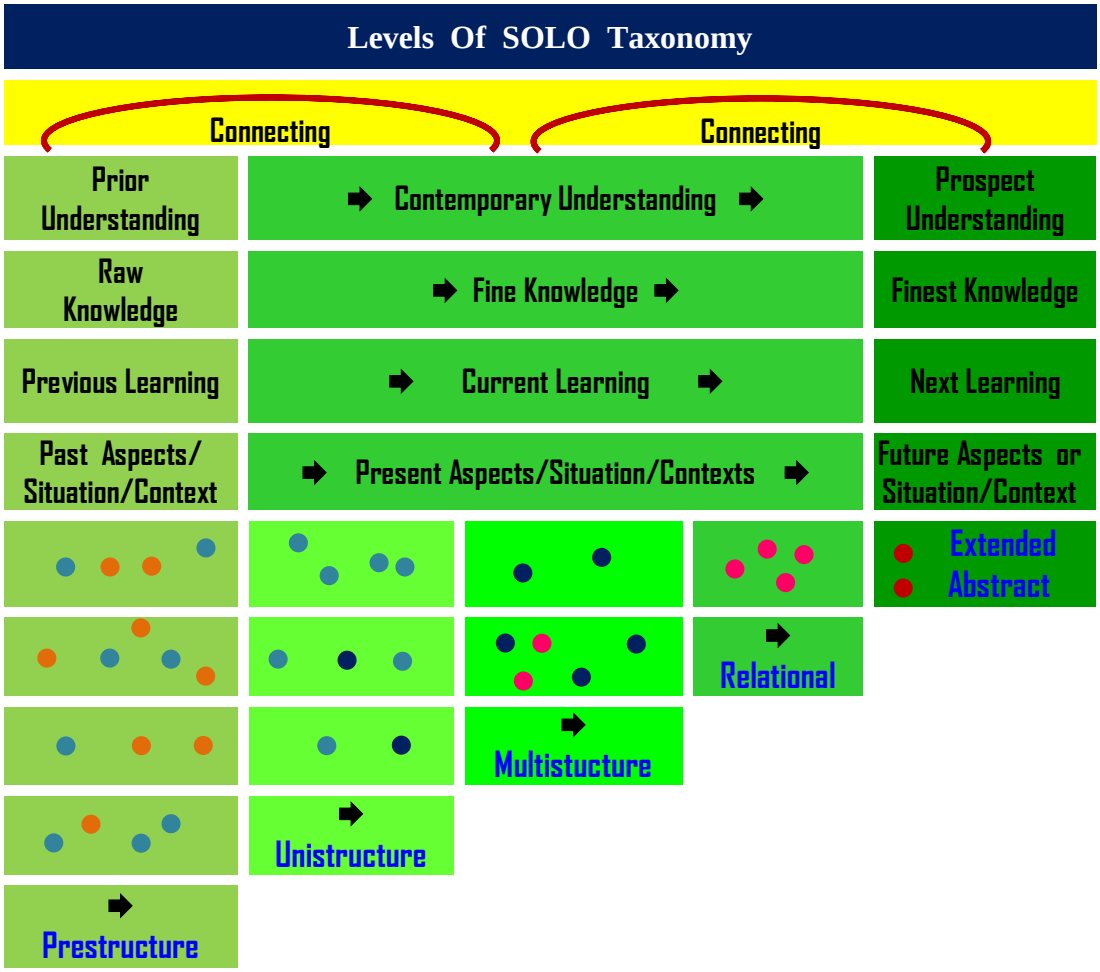


Figure-6.1: SOLO Levels: Connecting Previous ➜ Current ➜ Next

6.6.1 Understanding: Connecting Or Relating The Contexts

Understanding is means to ability to connect or relate the learning or experiences or knowledge form past to present context and then relate to the future context. And intelligence leads with how smartly, appropriately and correctly one can connect or relate the contexts which exhibit in terms of understandings. Hence, each level of the SOLO taxonomy follows with the same criteria of relating the learning from previous to current and current to the next learning. Such criteria could be established or practiced through appropriate instructional strategies with constructive approach.

6.6.2 Integrated SOLO – Bloom Taxonomy

As the SOLO Taxonomy consists of five levels as prestructure, unistructure, multistructure, relational and extended abstract are mean to attain one by one with the help of 'Understanding'. The continuity is maintained by applying the same criteria as

'Connecting Previous ➜ Current ➜ Next'. That is 'next' of first level-prestructure becoming the 'previous' for the second level-unistructure and thus it continues till to reach the fifth level-extended abstract. Thus, theoretical it is easy to understand this flow but when it comes to the empirical manner, many times it was felt by the researcher while planning for the teaching that how to jump or proceed from level to level of the SOLO taxonomy. Such things might be felt by other educational practitioners if they are not thorough with the component or concept of 'Constructive alignment' of the SOLO Taxonomy. Though, such gaps could be bridged by other methodology or taxonomy. Hence, the thought rose by the researcher of the present research study for the new aspect of integrating the SOLO Taxonomy with Bloom's Taxonomy in terms to fulfill the objectives of teaching-learning processes in a practical manner. This idea or thought is presented in a diagram that is in figure-6.2.

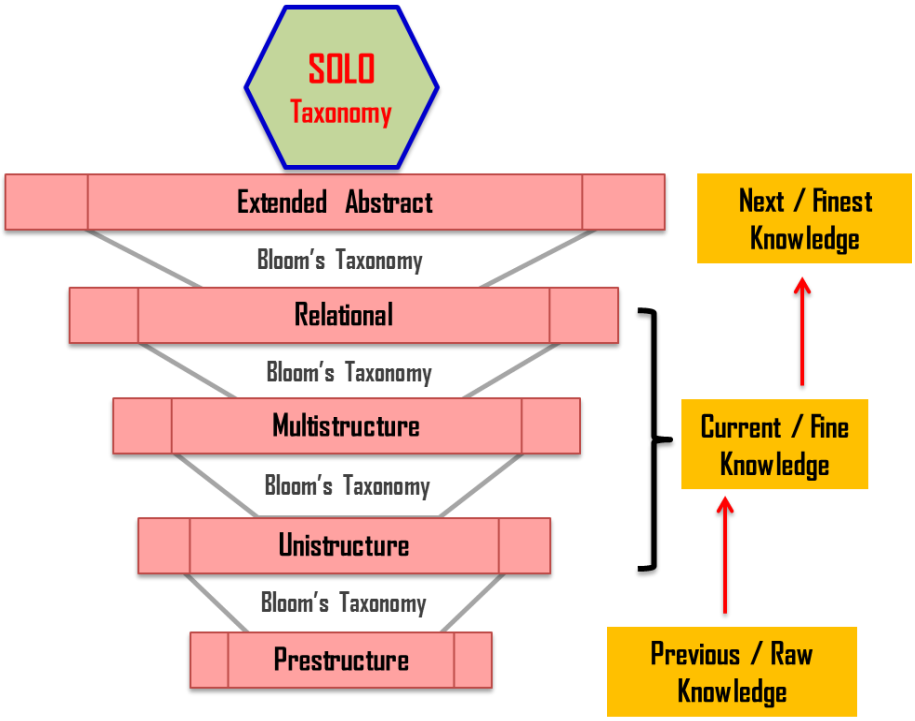


Figure-6.2: Diagram for the integration of SOLO and Bloom's Taxonomy

As SOLO Taxonomy is the framework which mainly deals with the cognitive aspects of the learning and also simultaneously to practice with the 'Constructive' approach. As this SOLO taxonomy gives autonomy to incorporate or utilize other relevant aspects to deal with constructive approach within the levels of SOLO Taxonomy and also to use other 'Verbs' to formulate the learning objectives in terms to fulfil the

goals for attainment of learning. As looking to the learning in practical manner, the researcher felt lacking of affective and psychomotor aspects to practice with SOLO taxonomy. In such terms, the researcher felt to take support of Bloom's taxonomy in order to strengthen the teaching-learning processes.

6.7 CONCLUSION

Mathematics could be learn by better understanding was the main goal while thought to conduct a research study and then the concern to improve Mathematics learning by improving understanding abilities became the problem for this present experimental research study. And thus, SOLO Taxonomy was found as tool to proceed further for the aforesaid concerns. This SOLO Taxonomy was practiced through Mathematics teaching-learning processes by the researcher for the present experimental research study and analytically it was proved that SOLO taxonomy had shown efficacy in terms to improve understanding abilities for the Mathematics learning. Entire research study has explained in this thesis report divided into six chapters.

This thesis report consists of total six chapters including this chapter also. The Chapter-I is presenting the conceptual framework shaped in the context of the present experimental research study, Chapter-II is focusing on the reviews related with the literatures, Chapter-III is explaining about the methodology of the present research work, while Chapter-IV is describing about the SOLO based instructional strategy that is developed and implemented for the experimentation of the present research study, Chapter-V is elaborating the data analyses conducted to study and the measure the present research study in terms of effectiveness and this Chapter-VI is on the brief summary of the overall research study.

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