CHAPTER - IV

CHAPTER – IV
INSTRUCTIONAL PLANNING AND DELIVERY

4.0 INTRODUCTION

Instructional strategy is meant to the complete plan of the teaching-learning processes to proceed systematically in terms to fulfill the determined objectives as well to attempt to achieve the desired learning. For the present research study too, the researcher was intend to experiment with newly developed SOLO Taxonomy based (S.O.L.O. or SOLO based) Instructional Strategy and to study the effects.

SOLO Taxonomy as a framework had taken up by the researcher in terms to develop an instructional strategy using the said taxonomy and implement it to observe the consequences as aimed by this taxonomy. The detailing of the planning and about the developed instructional strategy is presented in this Chapter – IV. As the SOLO based Instructional Strategy had been developed for the selected five chapters of Class-IX Mathematics for CBSE Board and it comprised with all the components of the teaching-learning process as like SOLO level-wise objectives, content points, activities, blueprints, assessment tools and feedback tools. Following further sections are mentioned with detailed Lesson plans along with all the activities in a manner as it was implemented. Scheduling for the implementation of this developed Instructional Strategy or Overall Intervention Program has been also covered in this chapter.

In terms to develop an instructional strategy based on the SOLO Taxonomy for the Mathematics of Class-IX, the researcher had planned it in three phases. First phase was about to study the current status of the teaching-learning processes practiced for the Mathematics of Class – IX in the CBSE secondary schools of the Vadodara city and to prepare a report to utilize it for the next tasks of the second and third phase. In the First phase, the Filed visits were conducted to collect the data in terms to support and to justify with the Objectives-1 and 2 as framed and concerned with the development as well implementation of an instructional strategy for the present research study. The Second phase was about the designing as well development of SOLO Taxonomy based instructional strategy, validation as well modifications and to

conduct a pilot study as a trial. And the Third phase was about the scheduling and implementation of the developed SOLO taxonomy based instructional strategy for the actual experimentation of the present research study. Here, processes of all the phases are elaborated in further sections.

4.1 PLANNING OF S.O.L.O. BASED INSTRUCTIONAL STRATEGY

The SOLO Taxonomy had been developed with the objectives that to proceed for the learning or understanding from surface to deeper level through the five levels of a said taxonomy. Fundamentally it focuses on the concept of "Constructive Alignment" as well Progressive Understanding for the intended learning.

As it is a new theory for the researcher also in terms to shift from the Bloom's taxonomy based teaching-learning practices to the SOLO Taxonomy based practices with appropriate justifications. With such concerns and before to develop an instructional strategy, the researcher was driven first to conduct a survey to study the status of the teaching-learning practices exercised for the Mathematics at the secondary level of education and also to identify or study the strengths, weaknesses, gaps in the practices. Hence, Field Visits for the class-observations were conducted in order to witness the teaching-learning processes of Mathematics for the Class-IX in several CBSE schools of Vadodara city. And accordingly, SOLO Taxonomy based Instructional Strategy was designed and developed with purpose to experience the new way of teaching-learning practices; to address the issues at possible extent; to experiment the teaching-learning for the quality improvement and to justify with the outcome based learning. Further sub-sections are presenting more about the Field Visits and about the findings derived from such Field Visits.

4.1.1 Field Visits For The Class-Observations

In the First phase of the present research study, Field Visits for the observation of the Mathematics teaching-learning process of Class-IX were conducted by the researcher in nine of the CBSE secondary English medium schools of the Vadodara city in order to prepare the field-notes which were useful in the planning, designing, development and the implementation of SOLO based Instructional Strategy. During the academic year 2013 – 2014, list of about 30 CBSE secondary schools of Vadodara city were collected by the researcher. Out of which 50% schools meant to total fifteen schools

were randomly selected through Lottery method by the researcher for the survey-field visits intended for the class-observations. The researcher visited all the 15 schools but only 10 schools had given a permission in terms to observe the classes for the Mathematics of Class-IX. Finally, only 09 schools were visited by the researcher for the class observations as other 01 school was permitted but was not able to provide the time schedule due to reasonable reasons. Further, in all the 09 schools, the researcher had observed on an average of 05 class-periods (with 35-40 minutes per class-period) per school and thus overall total 44 class-periods were observed for the teaching-learning process for the Mathematics of Class-IX.

Class Observations followed by the casual talk or interactions with the Mathematics teachers as well with students were carried out with the purpose to get more information about the current trends generally practiced by the schools for the teaching and learning process for the Mathematics of Class-IX. The following criterions were adopted by the researcher for the class observations and field notes were prepared in terms to utilize it for the development as well as for the implementation of an instructional strategy. Following are the points were kept in mind by the researcher during the field visits for the class observations.

.

- ► Infrastructural aspects of a classroom: Sitting arrangements, furniture within a classroom, facilities and gadgets available within a classroom, other teaching-learning materials (like charts, posters, flash cards or models) within a classroom, overall classroom environment retained during (from beginning to end period) the Mathematics teaching-learning.

- ► The Mathematics Teacher/s: Qualification of a teacher, experience of Mathematics teaching, work load carrying for Mathematics teaching-learning, content mastery, efforts of a teacher for any additional work or input for Mathematics teaching-learning, strategies practiced by a teacher to maintain the environment for learning Mathematics, frequent initiatives made for innovative approaches or methodologies or integration of technology in Mathematics teaching-learning, other disciplinary aspects and challenges relevant with the said processes, assessment and evaluation aspects.

- The Students of Class-IX: Number of students in a classroom, behavioral and disciplinary aspects followed by the students in a Mathematics class-period, readiness for learning the Mathematics and readiness for the responses

- Mathematic teaching-learning process: Lesson planning of a teacher, the content delivered, casual interactions/conversations between teacher and students, the strategies or method or approach exercised by a teacher to teach the concepts of Mathematics as well for solving the examples or exercises, questions posed by a teacher as well the responses given by the students, usage of a Mathematics textbook by a teacher and the students, participation of the students throughout the Mathematic class-period, students' way of keeping themselves with a flow of Mathematics teaching-learning.

- Innovative approach: About the use of various media within a classroom or usage of available Audio-visual room, practices out of the classroom, usage of varieties of methodologies, usage of manipulative, additional content or inputs provided apart from a textbook.

- Level of Thinking, Learning or Understanding: Focus was on to note down about the derivation of a concept, means of the conceptual understanding, higher order thinking, level of learning and understanding that is from surface to deep.

- Talk with Mathematics teachers and students outside the class: Casual talk or interactions were conducted with the Mathematics teachers and the students of Class-IX by the researcher in order to collect the information about

The report developed based on the above points was utilized for the next phase of development and important findings from this report are also incorporated in the part of discussions of a Chapter-VI. Following is the schedule followed for the Field Visits to the schools and further is the major findings derived from the Filed Visits.

4.1.2 Schedule Of Field Visits For The Class Observations

Following is the schedule (table-4.1) which was prepared and followed for the field-visits that is for Class-observations. It presenting the duration and the components observed as the teaching-learning process for Mathematics of Class-IX.

Table – 4.1:
Overview on Schedule for Class observations

Sr. No.	Date	Day	Time (Morning to Noon)	Topics Observed / Details
1.	20/11/2013	Wed	11:30 – 12:10	Project – PPT presentation based on Statistics
2.	27/11/2013	Wed	11:30 – 12:10	Explanation about Test based on new scheme 'Open book text assessment'
3.	30/11/2013	Sat	11:30 – 12:10	---- do ------
4.	19/12/2013	Thurs	09:45 – 10:30	Started new chapter Ch-4 Linear equation in two variables & Ex. 4.2, 4.3
5.	21/02/2014	Fri	11:30 – 12:10	Ch-10 Circle – explanation & examples
6.	22/02/2014	Sat	11:30 – 12:10	Ch-10 Circle – Solving exercises of TB
7.	28/11/2013	Thurs	09:15 – 10:00	Ch-8 Quadrilaterals–Theorem(sum of ∟ are 360° & Examples, Types of it)
8.	03/12/2013	Tue	12:20 – 12:50	Ch-8 Quadrilateral-Theorems proved (mid-point) & Exercise 8.2 solved
9.	03/12/2013	Tue	12:50 – 01:30	Ch-8 Quadrilateral-learning through 'Educomp' on TV screen-Smart class
10.	05/12/2013	Thurs	11:45 – 12:25	Ch-8 Solving problems & exercise 8.2
11.	06/12/2013	Fri	12:50 – 01:30	Lab (book) activity/project no. 16 on diagonals of ∥gm bisect each other
12.	07/12/2013	Sat	10:30 – 11:10	Ch-8 Area of ∥gm and ∆s & Theorems
13.	03/12/2013	Tue	08:30 – 09:30	Ch-10 Circle – Solving exercise (5 examples solved)
14.	05/12/2013	Thurs	08:30 – 09:10	Ch-11 Construction using Geo. box
15.	09/12/2013	Mon	08:30 – 09:10	Ch-11 Examples
16.	21/02/2014	Fri	08:30 – 09:10	Ch-11 Exercise – 11.1
17.	22/02/2014	Sat	08:30 – 09:15	Ch-11 Exercise – 11.2
18.	19/11/2013	Tue	10:00 – 11:00	Interaction- interview with Math Tr.
19.	20/11/2013	Wed	11:25 – 12:00	Not attended due to clash
20.	29/11/2013	Fri	11:25 – 12:00	Ch-10 Circle – Solving Examples /Ex.
21.	07/01/2014	Tue	10:30 – 11:05	Ch-13 Surface area & volume – solving exercises of textbook

22.	07/01/2014	Tue	11:40 – 12:30	Ch-13 – solved Ex 13.4
23.	07/01/2014	Tue	01:10 – 01:50	Ch-13 – solved Ex 13.2 (Div C)
24.	10/01/2014	Fri	01:10 – 01:40	Ch-13 – solved Ex 13.2 (Div E)
25.	11/01/2014	Sat	09:15 – 09:50	Ch-13 – solved Ex 13.2 (Div D)
26.	29/01/2014	Wed	11:45 – 12:15	Ch-10 Circle – Solving Assignment
27.	29/01/2014	Wed	12:20 – 12:55	Ch-14 Statistics – Graphs explanation & solving Ex 14.3
28.	30/01/2014	Thurs	08:00 – 08:30	Ch-14 Exercise 14.3
29.	30/01/2014	Thurs	08:00 – 09:10	Ch-14 – Measure of Central tendency
30.	30/01/2014	Thurs	12:55 – 01:40	Construction
31.	05/02/2014	Wed	10:40 – 11:15	Revision – syllabus for the exam – on Circle, Quadrilateral, LE in two variable
32.	05/02/2014	Wed	11:15 – 11:50	Revision – syllabus for the exam - Area & volume – Solving examples
33.	06/02/2014	Thurs	10:45 – 11:15	Revision – Formulas recitation
34.	06/02/2014	Thurs	11:15 – 11:45	Revision - type of questions – MCQ, subjective, descriptive etc
35.	07/02/2014	Fri	11:20 – 11:40	Examination
36.	10/04/2014	Thurs	10:25 – 11:00	Ch-1 Number system – explanation on type of numbers (Div C)-Ex 1.1, 1.2
37.	10/04/2014	Thurs	12:00 – 12:30	Ch-1 – solving Ex 1.3, 1.4 (Div C)
38.	11/04/2014	Fri	08:15 – 08:50	Ch-1 – explanation Ex 1.1, 1.2(Div B)
39.	11/04/2014	Fri	10:25 – 11:05	Ch-1 – solving Ex 1.2, 1.3, 1.4 (Div A)
40.	11/04/2014	Fri	12:00 – 12:35	Ch-1 – solving Ex 1.5, 1.6 (Div C)
41.	25/04/2014	Fri	08:30 – 09:10	Ch-1-Number system, simplification, example-17 & Ex 1.5, 1.6 (Div B)
42.	28/04/2014	Mon	09:30 – 10:10	Ch-5-Euclid Geometry-Revision prev. knowledge, Explain Example-6 (Div C)
43.	29/04/2014	Tue	09:30 – 10:10	Ch-5 Solving examples (Div B)
44.	29/04/2014	Tue	10:10 – 10:50	Ch-5 Exercises & Test

4.1.3 Findings Based On The Field Visits For The Class Observations

Data collected through Field Notes which were prepared by the researcher based on the Field Visited for class observations and based on the talks (interactions) with Mathematics teachers as well as with students outside the class-room. Total 44 class-observation-report-sheets as well total 8 interaction-report-sheets were prepared for the analyses. The data collected from these field visits were analyzed by using the Content Analysis and Frequency-Percentage method. The findings derived from this analysis are highlighted as follows.

- Hundred percent of the Class-observations were found with the Bloom's Taxonomy (BT) based Instructional Strategy and practicing within Cognitive domain and only 2% of the practices found within Psychomotor domain of BT.

- About 95% of the teaching-learning processes in Mathematics were found to be followed by the conventional or traditional approach only.

- Only in 4 classes out of 44 class-observations found that opportunities were provided as pace for the students to learn at their own learning level or with student-centered approach.

- About in 95% of the class observations it was found that, very few time (on an average about 1-7 minutes out of 35-40 minutes of class-period) had given for the explanations on the concepts or topics or theory by the teachers and majority time or rest of the period had utilized for solving the examples or exercises through chalk or white board.

- It was observed that on an average, teachers had solved 4-8 examples or completed 1 to 3 exercises of a textbook within a class-period. While in this process, it was also found as very less interactions between teachers & students and major was of one way communication or lecture by the teachers only. In such process, it was observed as possibly teachers had tried to solve the examples orally (verbally) or by discussions (of more lecture and less interactions) with students, and if it was realized about some difficulties than only it was solved on the board.

- About the questioning and probing, it was found in 98% of the observations that teachers had raised very basic questions like based on asking formulas that learnt in the previous years or lesson or class; calculations related or theory based questions. 'Why' type of or logical thoughts based questions were not found in any of the class-observation. Only in one class out all classes observed by the researcher that the real-life applications based questions were discussed by a teacher with the students and all the students participated in that learning process.

- It was noticed in 95% of the class-observations that only few students that is about 2 to 6 out of on an average of 30-45 students were able to manage the speed of their learning along with the teaching of a teacher and such students had only were responding. Other students of a class generally found remained busy with copying the content to their notebook either from chalk-board or from neighboring students' note-books. In such situations, it was found difficulties for the researcher in determining about the level of learning or understanding of non-responding students.

- While solving the examples, it was observed as teachers wrote the major or important steps of the solutions on the chalk-board and only the part of calculations based on basic-operations (like addition, multiplications etc.) were given to the students to do in a class with the 'belief' of using the concept of 'Student centered approach'.

- Belief for the achievements among teachers and students about the learning Mathematics was observed as to get the correct answers at the end of solution of the examples. In 99% of the class-observations, Mathematics teaching-learning was found with the belief and approach of 'Examination oriented'.

- In 99% of the Mathematics teaching-learning processes, it was observed as major of the focuses were given on "Understanding the step-wise proceedings for a solution of the examples" or the mechanical way of deriving the solutions by using step-by-step Mathematical statements rather than "Understanding the Concept as well the logic or reasoning behind it". It was meant to lacking to understand the logic behind deriving the one-by-one steps to get the final solution.

- From the casual talks with the Mathematics teachers, it was revealed and Teachers stated that they don't found any other way or method to teach the Theorems except only it should be explained by a lecture method or through writing all the steps on a chalk/white board.

- It was revealed from interactions with the teachers and the students in the context about the usage of ICT or technology or computer in Mathematics teaching-learning process that they are using ready-made lessons based software-packages provided by the schools and it's used occasionally or according to the schedules assigned by the schools. Also it was learnt that, all the chapters of IX Mathematics available in the packages but only few concepts or topics are well explained with demonstrations and animations which sometimes help to generate interest of the students while rest of the topics are explained in a lecture manner only which could be used as a substitute or alternative of the teacher during the absenteeism or non-availability of the Mathematics teachers. Also, the softwares which are having interactive aspects of learning were occasionally used as such learning could be possible only in a computer laboratory in terms to provide individualized learning at the level of the learners.

  It is observed that instead of such few or rare class-periods, there is a need to develop such computers based Mathematics laboratory to fulfill at some extent the objectives of the desired Mathematics teaching-learning.

- It is learnt from the observations that the 'Visibility' factors play important role for learners' learning and to be legging behind in Mathematics. The other possible factors need to take into considerations those responsible to affect the visibility like position of the board, reflections due to inside or outside lights; position and movement of a teacher while writing on a board, handwritings of the teachers.

  In many cases, the researcher had found that white boards are giving better visibility rather than chalk-boards. But surface should be of mate-finished instead of shining surface.
- Another point noticed by the researcher during the observations was concern with the strength of classes. On an average, class-strength found was of 45 students.

And it was observed as the challenging matter for the teachers to manage and address many things within 35-40 minutes with such strengths. "Individual or personal attentions" which is essential in Mathematics were ignored many times due to stressed to accomplish the planned activities or syllabus.

- Higher level learning or learning carried to a higher level were found only in two class-observations out of forty class-observations. Activities based learning was observed only in one class. And rests of the learning found were of bookish or pure-theoretical type.

These were the major observations perceived in the First phase and learnt many traits to consider while developing an Instructional Strategy like in terms (a) to make more activities based teaching-learning processes, (b) exposure on application based problems that teach the concept of Mathematics meaningfully, (c) to improve the quality of questions, (d) to emphasize mainly on "Student-centered approach" as well for full participation, (e) to encourage more logical proceedings rather than mechanical proceedings in the learning and (f) to thought about quality outcomes rather than quantity outcome based assessment. The researcher made efforts to These all traits were comprised in the SOLO Taxonomy based Instructional Strategy with the focus to encourage the 'Understanding centered learning practices' rather than the 'Memory centered learning practices'. Further sections are dealing with the development and implementation of the SOLO based Instructional Strategy.

4.2 DEVELOPMENT OF S.O.L.O. BASED INSTRUCTIONAL STRATEGY

In Second Phase, mainly three tasks were accomplished by the researcher as: (i) Designing and Development of SOLO based Instructional Strategy; (ii) Reviews by the Experts, Researchers as well Teachers on the developed Instructional Strategy and then valuable remarks suggested by the Experts, Researchers as well by the teachers were incorporated; and then (iii) Conducted Pilot Study.

4.2.1 Designing Of SOLO Based Instructional Strategy

Instructional Strategy was the inclusive of Lesson Plans, lesson based activities, Assessment as well Evaluation test and other needed tools were prepared by the

researcher which were included in the study report. In efforts to develop an instructional strategy, the researcher referred to a report prepared in Phase-I based on the class-observations and interactions with teachers as well the students to get insight about the general learning difficulties, several and general activities exercised by the teachers, annual planning, total curriculum, textbooks and other reference books followed by the teachers and students. The Researcher also had referred CBSE Mathematics textbooks of class VI to X in terms to get complete idea about the objectives as well the content designed in a spiral manner that meant to a tall-shaped class-wise Mathematics education. Also, did refer various reference materials, handbooks provided by the NCERT as well as other practice books of Mathematics.

An instructional strategy for Class-IX Mathematics was developed based on the curriculum and syllabus as designed for same class. Five chapters that is one chapter from each area (areas like arithmetic, algebra, geometry, mensuration, and statistics) were selected from a Mathematics Class-IX textbook. Some examples were collected from various sources as handbook for teachers by the NCERT, various learning and practice manuals provided by CBSE and textbook. These reference materials were used to remain and maintain the flow of education system. Many of the examples were created by the researcher according to the need of the SOLO based developed Instructional Strategy.

The SOLO Taxonomy has been developed to follow hierarchical order to practice the progressive learning or understanding in educational settings. With such references, **Teaching as well Teaching method** plays very significant role and have a key place in an instructional strategy in terms to address each and every individual either the learners are 'Academically Committed' or not. **Academically committed or 'Academic'** learner/s is mean to learner is showing interest and motivated to learn as well such learner works hard for the achievements. But, in case of **'Nonacademic' or Academically Less Committed** learners are mean to not giving proper responses to the learning. Perhaps, as **Biggs & Tang (2011)** stated as, Nonacademic or 'Unmotivated' students are in higher proportion in today's classes. They need help if they are to reach acceptable levels of achievement. All it means is that such students are not responding to the methods that work for the Academic students. The challenge for the teachers is to teach so that Academically Less Committed learners learn more

in the manner of Academically Committed learners. Though, the following diagram suggests that the present differences between Academic and Nonacademic learners (point A) may be lessened by appropriate teaching (point B). **Three factors are operating: (i) the students' levels of engagement in relation to the level of learning activity required to achieve the intended learning outcomes (ranging from 'describing' to 'theorizing', as between the dashed lines in a diagram 4.1); (b) the degree of learning-related activity that a teaching method is likely to stimulate; and (c) the academic orientation of the students.** (see figure-4.1).

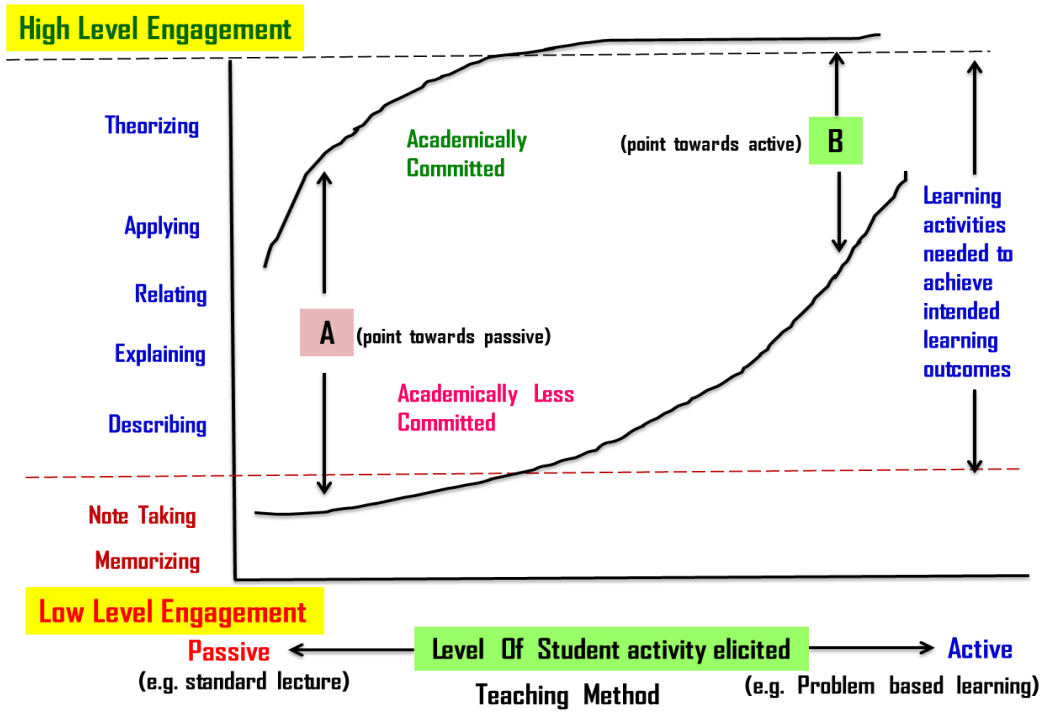


Figure – 4.1: Student Orientation, Teaching method and level of engagement
(Source: Biggs & Tang (2011))

In a diagram, Point A is towards the 'passive' end of the teaching method continuum, shows the large gap between the level of engagement. A lecture would be an example of such passive teaching. At point B, towards the 'active' end of the teaching method continuum where gap could be seen as is not so wide. Problem based learning would be an example of an active teaching method, because it requires students to question, to speculate, to generate solutions so that Nonacademic learner is encouraged to use the higher order cognitive activities that academic learner uses spontaneously. The teaching has narrowed the gap between their ways of going about learning and

between their respective performances. This is because the teaching environment requires the students to go through learning activities that are designed to help them to achieve the intended outcomes. With such understandings as explained in this paragraph as well shown in the diagram (figure-4.2&4.3), an Instructional Strategy for present research study had been developed which is based on the SOLO Taxonomy.

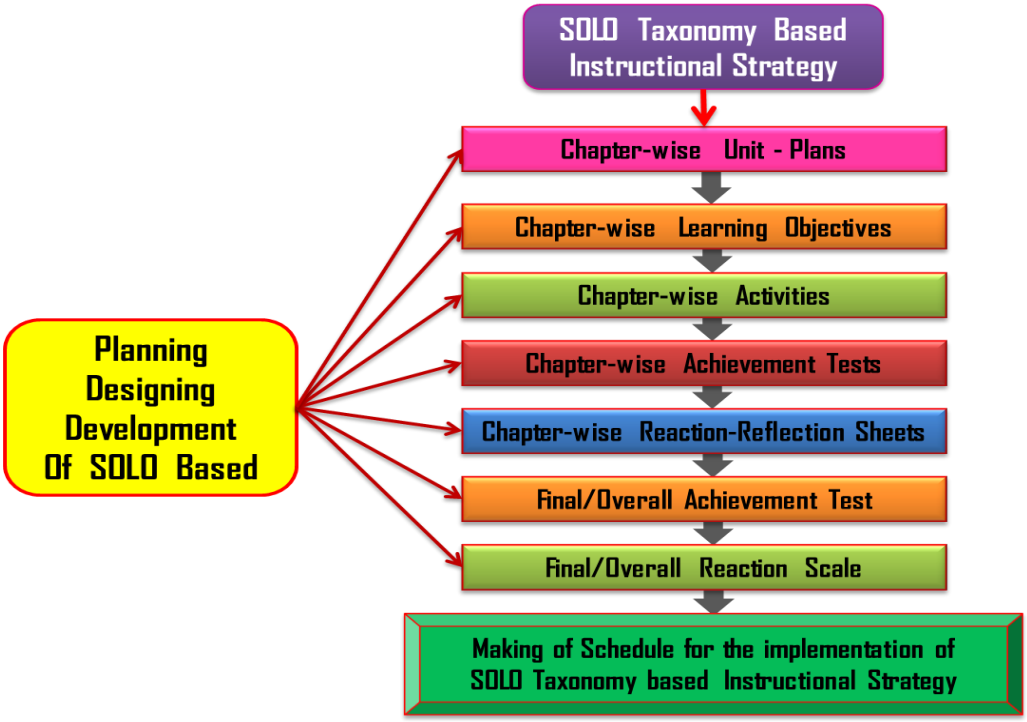


Figure – 4.2: Overview of SOLO based (complete) Instructional Strategy

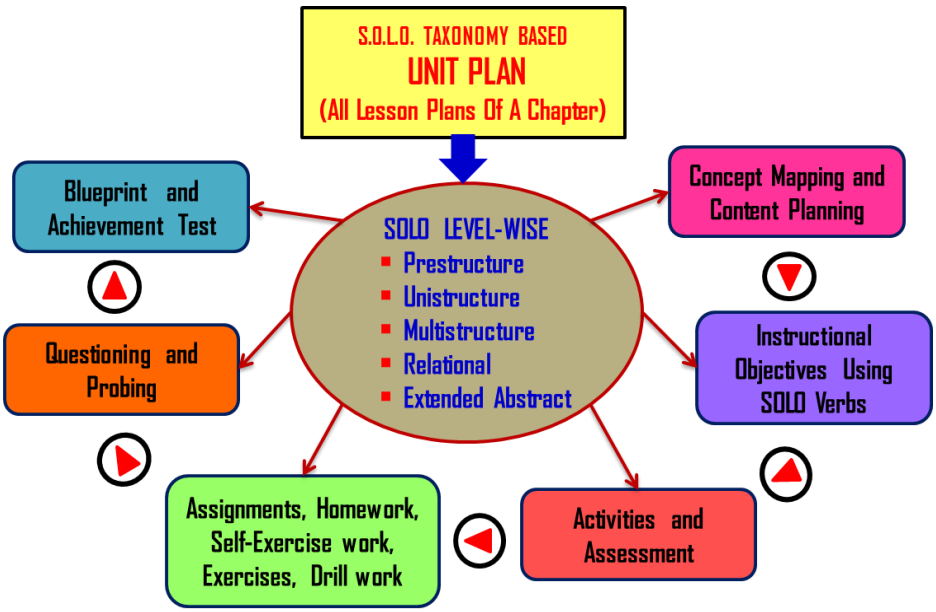


Figure-4.3: Overview Of SOLO Levels Based Unit Plan

At each stage of the development of SOLO based Instructional Strategy, efforts were made by the researcher to be based on the SOLO taxonomy. Like the topics or content of each chapter, learning objectives for the chapter as well as the activities, examples, questions or queries for the interactions (questioning and probing), blueprint for the tests were designed based on the SOLO levels by the researcher. Following diagram is showing the overview about the planning, designing and development of SOLO based components of Instructional Strategy. The complete chapter-wise lesson plans are enclosed in the Appendices - A to E.

With the said strategies shown in the figures – 4.1 to 4.3, the SOLO based Instructional Strategy had been designed and developed in terms to justify with the concept of SOLO Taxonomy. With this learning, Unit plans for each of the selected chapter had been prepared are presented below. Following tables-4.2 to 4.11 are presenting brief of Unit Plans (Complete Unit Plans are enclosed in the Appendices-A to E) that is only consist of SOLO Level-wise concept mapping or content planning as well plans for all activities designed for a chapter. Unit Plans are means to that is comprised with all the Lesson Plans of respective chapters that is constituted with all the instructional components designed according to SOLO Levels.

4.2.1.1 Brief Of Unit Plan For Chapter – 12 Heron's Formula

Table-4.2:
SOLO Level Based Concept Mapping For A Chapter–12 Heron's Formula

SOLO Levels	Learning Points / Concepts / Topics
● Pre-structural	➢ Previous knowledge about basic geometrical shapes (□, ▯, △, ○) as well how to find areas and perimeters of these shapes ➢ To find the area of Triangle - △ (I) using the concept of number of block squares - 1cm^2 area covered by the Triangles and (ii) using basic formula as A = ½ × base × height ➢ Examples /Activities
▮ Uni-structural	➢ To understand equilateral triangles and to find its area / perimeter ➢ To understand isosceles triangles and to find its area / perimeter ➢ Examples / Activities

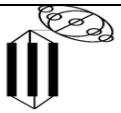
 Multi-structural	➢ Differentiating Scalene triangles from Isosceles or Equilateral triangles ➢ To understand Scalene triangles and to find its area/perimeter ➢ Understanding on heights/altitudes of a scalene triangle from all the vertices of the triangle ➢ To find the area of scalene Triangles by using Heron's Formula o Brief about Heron o Examples / Exercises / Activities
 Relational	➢ Triangle based Tangram ➢ Application of Heron's formula for finding the area of quadrilaterals ➢ Examples / Activities
 Extended Abstract	➢ Some more higher level applications of Heron's Formula ➢ Understanding on Pyramid-structures having triangular faces/sides ➢ Activity / Examples

Table-4.3:
SOLO Level-wise Activities For A Chapter – 12 Heron's Formula

SOLO Levels	Name of Activities	Topics Covered
 Pre-structural	♣ Activity – 1 : Counting Blocks(1 cm^2)	Basic Geometrical shapes, its area & perimeter, both the methods as counting blocks and using formula used for calculating the areas and perimeters
 Uni-structural	♣ Activity – 2 : Types of the Triangles (Based on the sides)	Learning of triangles based on sides like equilateral, isosceles, scalene and finding the areas / perimeters
 Multi-structural	♣ Activity – 3 : Heights and altitudes of a triangle ♣ Practice work	Knowing heights and altitudes of a triangle from all its vertices; Finding area and perimeter of triangles using Heron's formula

 Relational	♣ Practice work ♣ Application of Heron's Formula to Quadrilaterals	Triangles based Tangram; Finding area or perimeter of various quadrilaterals using Heron's formula
 Extended Abstract	♣ Activity – 4 : Pyramids (Slide presentation) ♣ Activity – 5 : Concept Arrangement (on chart)	Exploration with Pyramids – the shapes made from triangles; Synthesizing all learning points

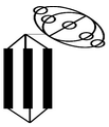
4.2.1.2 Brief Of Unit Plan For Chapter–4 Linear Equation In Two Variables

Table-4.4:
SOLO Level Based Concept Mapping For A Chapter – 4 L. E. In Two Variables

SOLO Levels	Learning Points / Concepts / Topics
 Pre-structural	➢ Previous knowledge about Linear equation in one variable, expressions for the said equation ➢ To get/find the solution of the Linear equation in one variable, ➢ Examples /Activities
Uni-structural	➢ To understand the problem to formulate the Linear equation with two variables ➢ To understand the elements of the equation such as Variables, Coefficients, Constants. ➢ More Examples / Activities to formulate the L. E. in two variables
 Multi-structural	➢ Understanding on finding solutions from single L.E. in two variables ➢ More Examples / Exercises / Activities for finding solutions of various equations
 Relational	➢ Understanding on plotting Graph of a Linear Equation in two variables ➢ Learning on equations of Lines Parallel / Perpendicular to x-axis and y-axis ➢ Examples / Exercises / Activities

 Extended Abstract	➢ Making equations from graph ➢ Graph of two linear equations – Getting unique solution at intersecting point of two lines - Discussions ➢ Activity / Examples

Table-4.5:
SOLO Level-wise Activities For A Chapter – 4 L. E. In Two Variables

SOLO Levels	Name of Activities	Topics Covered
 Pre-structural	♣ Activity -1 (Class Activity) : Vegetable Vendor	Understanding Linear equation in one variable
 Uni-structural	♣ Activity – 1 (Class Activity) : Vegetable Vendor (continue) ♣ Class Worksheet-1 : Framing Equations ♣ Activity -2 : Currency Notes ♣ Class Worksheet-2: Standard Form	Understanding Linear equation in two variables Framing Linear equation in two variables Identify variables, coefficients, constants Converting Linear equation to Standard Form
 Multi-structural	♣ Activity-3 : Solving An Equation	Finding solutions of a L. E. in two variables
 Relational	♣ Activity-4: Plotting Graph ♣ Activity-5: Graphs (continue…)	Drawing graphs from the solutions of a L.E. in two variables Type of lines generated from an equation and identifying a L.E. from the graphs
 Extended Abstract	♣ Activity-5: Graphs ♣ Activity-6: Equations from graphs ♣ Class-Activity: Concept Arrangement	Identifying a L.E. from the graphs Framing L.E. in two variables from the graphs Recap of a chapter

4.2.1.3 Brief Of Unit Plan For Chapter – 8 Quadrilaterals

Table-4.6:
SOLO Level Based Concept Mapping For A Chapter – 8 Quadrilaterals

SOLO Levels	Learning Points / Concepts / Topics
 Pre-structural	➢ Previous knowledge about Triangles as diagram made from three points, properties of Triangles ➢ To get the ideas about various diagrams made by using four end points, four straight lines and having four angles as well sum of the measure of all the angles is 360° ➢ Examples /Activities
 Uni-structural	➢ To identify the Quadrilateral as closed figure made with four vertices, four sides and four angles. ➢ To learn about various types of Quadrilaterals ➢ More Examples / Activities
 Multi-structural	➢ To get more understanding on various types of Quadrilaterals based on various Properties of sides, diagonals and angles ➢ To differentiate the Quadrilaterals as family of Parallelogram and Non-Parallelogram– with the statements of Theorems 8.1 & 8.8 ➢ More Examples / Exercises / Activities
 Relational	➢ To Understand the Theorems - 8.2 to 8.10 ➢ To Calculate the areas of Square & Rhombus ; Rectangle & Parallelogram etc. ➢ Examples / Exercises / Activities
 Extended Abstract	➢ To understand the area-differences of Square & Rhombus ; Rectangle & Parallelogram etc ➢ Quadrilaterals based Tangrams ➢ To know about other Quadrilaterals like Concave and Crossed Quadrilaterals ➢ Activity / Examples

Table-4.7:
SOLO Level-wise Activities For A Chapter – 8 Quadrilaterals

SOLO Levels	Name of Activities	Topics Covered
 Pre-structural	♣ Activity-1: Diagrams with four lines	Closed figures with four lines-Quadrilaterals
 Uni-structural	♣ Activity – 2: Identifying Quadrilaterals ♣ Activity-3: Who am I?	Various types of Quadrilaterals Properties of various quadrilaterals
 Multi-structural	♣ Activity-4: Is it Parallelogram? ♣ Class worksheet-1: Venn Diagram1 ♣ Class worksheet-2: Venn Diagram2	Testing Quadrilaterals as parallel-grams and non-parallelograms Diagonals of the Quadrilaterals Differentiating parallelogram and non-parallelogram Families of Quadrilaterals
 Relational	♣ Class worksheet-2: Venn Diagram2 (continue) ♣ Activity-5: Comparisons ♣ Class work – Finding Areas and Perimeter	Families of Quadrilaterals More about Quadrilaterals based on properties and Theorems Area differences of same sized square & rhombus as well rectangle & parallelogram
 Extended Abstract	♣ Class work – Finding Areas (continue) ♣ Activity-6: Craft Activity ♣ Class-Activity: Concept Arrangement	Area differences of same sized square & rhombus as well rectangle & parallelogram Activity on 'Tangram' Summarizing a chapter

4.2.1.4 Brief Of Unit Plan For Chapter – 14 Statistics

Table-4.8:
SOLO Level Based Concept Mapping For A Chapter – 14 Statistics

SOLO Levels	Learning Points / Concepts / Topics
	➢ The meaning as well means of Information and Various sources for collecting Information (TV, Newspapers, Internet, Phones,

Pre-structural	Books, Magazines, Social interactions etc...) ➢ Meaning of Datum and the Data as well Data Handling ➢ Meaning of Ascending or Descending Order, identifying the Minimum or Maximum values, Calculations for Total Sum and Average value ➢ Examples /Activities
 Uni-structural	➢ To understand the meaning of Information, Datum and Data in the context of Statistics ➢ To understand the meaning of Statistics as well as Singular and Plural sense of Statistics ➢ Learning with Numerical Data about the terms like Range, Mean (as average), Median (middle/central value), Mode(as Repeated numbers), Frequencies & Class-intervals ➢ Examples / Activities
 Multi-structural	➢ Understanding about the Collection of meaningful Data ➢ Understanding on the means of Primary and Secondary Data/sources ➢ Knowing about Organization as well Presentation of Data, Ungrouped as well Grouped Data and also the use of Tally Marks ➢ Examples / Activities
 Relational	➢ Understanding the Graphical Representations of Data - Bar Graph, Histogram and Frequency Polygon ➢ Examples / Activities ➢ Understanding the meaning and Practice with Measures of Central Tendency – Mean, Median, Mode ➢ Examples / Activities
 Extended Abstract	➢ Few Research based Applications of Measures of Central Tendency ➢ Activity / Examples

Table-4.9:
SOLO Level-wise Activities For A Chapter – 14 Statistics

SOLO Levels	Name of Activities	Topics Covered
 Pre-structural	♣ Activity-1: With Play-cards (continue)	Introduction with terms like range, mean, median, mode

 Uni-structural	♣ Activity-1: With Play-cards ♣ Activity-2: Frequency distribution	Calculation with range, mean, median, mode; Frequencies & Class-intervals
 Multi-structural	♣ Activity-2: Frequency distribution (continue) ♣ Activity-3: A.M. food / Breakfast habits	Understanding on ungrouped & grouped frequency distribution; Collection of meaningful data and organization of data, tally marks
 Relational	♣ Activity-4: Statistical graphs ♣ Class/Practice Worksheet	Graphical presentation of Statistical data (Bar graph, histogram and frequency polygon); Practice for Measures of Central tendency & for graph
 Extended Abstract	♣ Activity-5: What is my learning style? ♣ Class-Activity: Concept Arrangement	Means of collection of data, frequency calculations, drawing percentages and conclusion/ predictions based on percentages Recapitulation of a chapter

4.2.1.5 Brief Of Unit Plan For Chapter – 15 Probability

Table-4.10:
SOLO Level Based Concept Mapping For A Chapter – 15 Probability

SOLO Levels	Learning Points / Concepts / Topics
 Pre-structural	➢ The meaning of commonly used words like Choices, Chances, Certainly, Doubt, Probably, Most Probably etc.. ➢ The meaning of the keywords like Random Selection, Sample, Space, Events, Trials, Outcomes, Favourable & Unfavourable Outcomes ➢ Examples /Activities
 Uni-structural	➢ To understand the meaning of the word Probability ➢ To understand the Concept of the Probability – An Experimental Approach ➢ Understanding of Probability with Probability Line, Probability

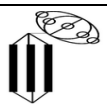
	Scale & Probability Tree ➢ Examples / Activities
 Multi-structural	➢ More Understanding about the Concept of the Probability using Probability Tree ➢ Experimental Probability and Theoretical Probability ➢ Knowing the means of the Events, Trials and Outcomes ➢ Experimental Examples / Activities
 Relational	➢ More Learning on Types of Events – Independent, Dependent & Mutually Exclusive Event/s ➢ Examples / Activities
 Extended Abstract	➢ Understanding the relevance of Probability with the Statistics ➢ Interdisciplinary Learning – Probability Scale and English Grammar ➢ Activity / Examples

Table-4.11:
SOLO Level-wise Activities For A Chapter – 15 Probability

SOLO Levels	Name of Activities	Topics Covered
 Pre-structural	♣ PPT presentation ♣ Activity-1: Probability Line	Given understanding on the topics of Probability Identifying the words giving indications about Probability
 Uni-structural	♣ Activity-1: Probability Line (continue) ♣ Activity-2: Probability ♣ Activity on Chart paper – 'Choices & Chances'	Arranging statements showing Probability aspects on a Probability line Understanding a meaning of Probability, Probability tree
 Multi-structural	♣ Activity-3: Doing Experiment ♣ Activity-4: Probability Tree	Understanding more terms like trials, events, outcomes, experimental probability Theoretical probability, tree-diagram to show probabilities
 Relational	♣ Activity-5: Types of Events	Independent and Dependent Events and about their Probabilities

 Extended Abstract	♣ Activity-6: Probability and Statistics ♣ Class-Activity: Concept Arrangement	Use of Probability in Statistics Overview on a chapter

The complete instructional strategy was validated by the experts and essential modifications were incorporated and final version is enclosed here in this thesis-report in chapter-wise Appendix-A to E

4.2.2 Validation Of SOLO Based Instructional Strategy

The developed Instructional Strategy was validated by the Experts which were from the field of Mathematics and Education. Also, the forum for the discussion on the SOLO taxonomy based Instructional Strategy was conducted and it was discussed among the thirteen research-scholars. In the forum also, received valuable remarks in terms to strengthen the Instructional Strategy and its several components in terms to practice in a practical manner. Then, the suggested corrections were made and overall, it was validated with the favorable remarks as appropriate with the said SOLO Taxonomy.

4.2.3 The Pilot Study For The Developed SOLO Based Instructional Strategy

Pilot study is generally intended to have a small try-out. For the present research study also a Pilot study was conducted before the actual experimental study in terms to check out and study the matter with the implementations. During this phase of Pilot study, one school was randomly selected to implement SOLO based instructional strategy for only one chapter for Class-IX Mathematics. The school selected for the Pilot study was having only one section of Class-IX with 55 students. Only one Chapter -'Linear Equation In Two Variables' was chosen to experiment and to experience about the teaching-learning processes in a real settings with the new developed SOLO based instructional strategy.

4.2.3.1 Schedule For The Pilot Study

Following table – 4.12 is presenting a schedule for a Pilot study.

Table – 4.12:
Overview on Schedule for a Pilot Study

Sr. No.	Date	Time (pm)	Activity / Task	Topics covered
1	13/08/2014	03:50 - 04:50	Role play on 'Vegetables vendor & customers'	Variables, constants, solutions & expression
2	14/08/2014	01:20 – 02:20	Puzzle with 'Patterns with sticks'	Derivation / formation of Linear equation from the values
HOLIDAYS - 15/08/2014 to 18/08/2014				
3	19/08/2014	03:20 – 04:20	'Currency Notes'	Practice worksheet for the variables, constant & standard form of Linear equation
4	20/08/2014	03:50 - 04:50	'Plotting Graphs'	Making graphs from the Linear equations in two variables
5		5:00 – 5:30	Achievement Test For Chapter on Linear Equation in two variables	

As the SOLO based developed instructional strategy was comprised with many practical and worksheets based activities. So in this phase of pilot study, it was learnt by the researcher that how to manage with the time, the materials to provide as well how to deal with the learners during the various activities. Even there were many unexpected or unwanted situations came to face and it was learnt by the researcher that how to control some threats at what extent. Many observations were noted by the researcher and then accordingly modifications were made to minimize the expected difficulties for the actual experimental study.

4.2.3.2 Observations Drawn From The Pilot Study

During the Pilot study, it was observed that students' readiness towards the real-life based activities and actively involved with enthusiasm, interest as well shown the positive attitude to learn Mathematics. Majority of the students were interactively participated in the overall teaching-learning process and every time responded with

appropriate answers. Interaction though various activities helped researcher to frame or reframe the questions in terms to measure or judge about the levels of Understanding of the learners as well as about their learning. Following is a small example of how inductive approach practiced with questions for the attainment of a concept to learn.

For Example:

- **Traditional teaching-learning:** It is generally introduced or it is asked to find the solutions of an equation in two variables as:

  Solve ➔ $4(x) + 3(y) = 24$ **OR** $4x + 3Y = 24$

- **SOLO Based Instructional Strategy:** While in new developed instructional strategy, it was introduced and the queries were framed in a manner as:

  A vegetable is vendor having following items given with (rates) prices to sale. If you have to purchase only one or two items in ₹.100 (this is for an example given, while in activity different amount were assigned to different groups), then how you do the selection? Why?

Items	**Rates**
Lemon	**₹. 10/kg**
Onion	**₹. 40/kg**
Tomato	**₹. 60/kg**

  So, notation should be like,

  ? (?) + ?(?) = 100

  So, in this situation,

  i) Which are the components remained unchanged? Why?

  ii) Which are the components keep changing? Why?

  Thus, at this point, the learners were given an opportunity to make decisions along with to learn and understand about the means of Coefficients, Variables and meaning of the Solutions.

The SOLO based Instructional Strategy developed on one chapter was implemented with ease for the pilot study. Major concern and challenge faced was about the class-

management and to maintain the discipline while conducting the activities. Such problem was mostly faced during the group-activities of the Pilot study, where some students were sincerely engaged with the activities while some were noticed as the disturbing factors or as individualized learners.

Such observations helped the researcher to redesign or alter the activities accordingly and also other possible modifications were made in an Instructional Strategy after the Pilot study. Then the completely developed SOLO based Instructional Strategy was actually implemented for the experimentation of the present research study and here details are presented in the next section.

4.3 IMPLEMENTATION OF DEVELOPED INSTRUCTIONAL STRATEGY

This research aims at designing and developing an Instructional strategy based on the levels of SOLO Taxonomy and determining the effectiveness of the developed Instructional strategies. The process for the implementation of developed SOLO based Instructional Strategy was followed with other research activities were accomplished in this Third Phase of the present experimental research study are reported here.

In the same regards, the researcher first visited all the targeted schools to take formal permission by providing Permission Letter of the department and collected necessary data of primary stage as semester-wise planning of the schools, time-table, number of class-IX with divisions, results of Mathematics for previous Class-VIII, holidays during the academic year etc. in terms to make appropriate plans and schedules to conduct the several research activities and also to implement the SOLO based developed Instructional Strategy. Following are the various schedules which were followed by the researcher to accomplish the research activities of this research study.

4.3.1 Schedule For Implementation Of SOLO Based Instructional Strategy

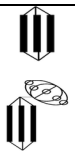
Following is the schedule (table-4.13) presenting the details about the implementation of the developed instructional strategy. It was actually implemented during the academic year 2014-2015 between the August-2014 to March-2015. The time-durations shown in the following schedule was followed by the researcher as per the school (chosen for the experimentation) had provided the class-periods according to

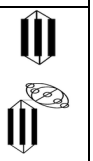
the scope and space were available in the annual planning of the school for the said academic year. If there are gaps or breaks found in the (schedule) continuity of the implementations was due to various reasons like holidays, school assessment or examinations, curricular or co-curricular activities, administrative activities, any functions or celebrations or any competitions.

At the same time, the Achievement tests also were administered at post-test level at the school which was taken up for the control group. All the chapter-wise Achievement tests were conducted immediately after the completion of the respective chapters. These tasks were followed according to the schedule provided by the school of the control group as per the instructions and the intimations about the completion of a chapter given by the Mathematics teachers.

Table – 4.13:
Overview on Schedule for the Implementation of an Instructional Strategy

Sr. No.	Date	Day	Time (Morning to Noon)	Name Of Activity	(Topics Covered at) SOLO Levels
Chapter – wise Schedule					
Chapter – 12 HERON'S FORMULA (Refer Table – 4.2 & 4.3)					
1.	26/08/2014	Tues	08:30 – 09:10	Introduction, Interaction Activity – 1 Counting Blocks	
2.	27/08/2014	Wed	08:55 – 09:35	Activity-2 Types of Triangles	
3.	28/08/2014	Thurs	08:30 – 09:10	(Inspection) Activity-3 Heights/Altitudes of a Triangle Introduced Heron's Formula	
4.	30/08/2014	Sat	08:30 – 09:10	Practice Work	
5.	01/09/2014	Mon	08:30 – 09:10	Activity-4 Pyramids Concept Arrangement	

6.	02/09/2014	Tues	08:30 – 09:10	Achievement Test	-
7.	03/09/2014	Wed	08:55 – 09:35	General Discussion on this chapter, recap & queries Feedback	-
Chapter – 04 L. E. IN TWO VARIABLES (Refer Table – 4.4 & 4.5)					
8.	14/10/2014	Tues	08:30 – 09:10	Class Activity – Vegetable Vendor	
9.	15/10/2014	Wed	08:55 – 09:35	Class Worksheet – 1 Framing Equations Activity – 2 Currency Notes	
10.	16/10/2014	Thurs	08:30 – 09:10	Discussion on Activity – 2 Class Worksheet – 2 Standard Form of L.E.	
11.	17/10/2014	Fri	08:30 – 09:10	Activity – 3 Solving an Equation	
12.	18/10/2014	Sat	08:30 – 09:10	Activity – 4 Plotting Graph Activity – 5 Graphs	
13.	21/10/2014	Tues	08:30 – 09:10	Activity – 5 Graphs (continue..) Activity –6 Equation from graph	
14.	29/10/2014	Wed	08:55 – 09:35	Achievement Test & Feedback	-
Chapter – 08 QUADRILATERALS (Refer Table -4.6 & 4.7)					
15.	25/11/2014	Tue	08:30 – 09:10	Activity – 1 Diagrams with four lines Activity–2 Identifying (Types of) Quadrilaterals Discussion	
16.	02/12/2014	Tue	08:30 – 09:10	Activity – 3 Who am I? Discussion	
17.	03/12/2014	Wed	08:55 – 09:35	Activity – 4 Is it a Parallelogram?	
18.	04/12/2014	Thurs	08:30 – 09:10	Class Worksheet – 1 Venn Diagram1	

				Class Worksheet – 2 Venn Diagram2	
19.	05/12/2014	Fri	08:30 – 09:10	Class Work – Finding Areas and Perimeter Discussion on Formulas and Heron's Formula	
20.	06/12/2014	Sat	08:30 – 09:10	Activity – 5 Comparisons	
21.	09/12/2014	Tue	08:30 – 09:10	Discussions on other types of Quadrilaterals Concept Arrangement	
22.	10/12/2014	Wed	08:55 – 09:35	Activity – 6 Craft Activity	
23.	12/12/2014	Fri	08:30 – 09:10	Achievement Test & Feedback	-
Chapter – 14 STATISTICS (Refer Table-4.8 & 4.9)					
24.	27/01/2015	Tue	08:30 – 09:10	Activity-1 With Play cards Discussion	
25.	28/01/2015	Wed	08:55 – 09:35	Examples and Exercises on Measure of Central Tendency	
26.	29/01/2015	Thurs	08:30 – 09:10	Activity-2 Frequency Distribution Discussion	
27.	30/01/2015	Fri	08:30 – 09:10	Activity-3 A.M. food / Breakfast habits Discussion	
28.	31/01/2015	Sat	08:30 – 09:10	Activity-4 Statistical Graphs Chart paper presentation on Statistical Graphs Discussion	
29.	03/02/2015	Tue	08:30 – 09:10	Class / Practice Worksheet	
30.	04/02/2015	Wed	08:55 – 09:35	Class/Practice Worksheet (cont.)	
31.	05/02/2015	Thurs	08:30 – 09:10	Activity-5 What is my Learning Style? Discussion on Interpretations	

32.	06/02/2015	Fri	08:30 – 09:10	More Exercises from Textbook	-
33.	07/02/2015	Sat	08:30 – 09:10	Achievement Test (of present students)	-
34.	09/02/2015	Mon	08:30 – 09:10	Achievement Test (rest of the students) and Feedback	-
Chapter – 15 PROBABILITY (Refer Table-4.10 & 4.11)					
35.	24/02/2015	Tue	08:30 – 09:10	(Permission and preparation for AV and Computer room)	-
36.	25/02/2015	Wed	08:55 – 09:35	PPT1 presentation on Probability	All
37.	26/02/2015	Thurs	08:30 – 09:10	PPT2 presentation on Probability	All
38.	27/02/2015	Fri	08:30 – 09:10	Activity-1 Probability Line Discussion	
39.	02/03/2015	Mon	08:30 – 09:10	Activity-2 Probability, Activity on Chart Paper - 'Choices & Chances' Discussion	
40.	03/03/2015	Tue	08:30 – 09:10	Activity-3 Doing Experiment Activity-4 Probability Tree Discussion	
41.	04/03/2015	Wed	08:55 – 09:35	Activity-5 Types of Events Activity-6 Probability and Statistics Discussion	
42.	05/03/2015	Thurs	08:30 – 09:10	Achievement Test and Feedback	-
**********					
FINAL TASK					
1	06/03/2015	Fri	08:30 – 09:10	(Final) Reaction Sheet	
2	07/03/2015	Sat	08:00 – 11:10	Final Achievement Test – All SOLO Levels	

All the data were recorded in this Third phase of the implementation were proceeded for the analyses in terms to draw out the interpretations about the efficacy of the developed SOLO based Instructional Strategy and the accomplishment of the said experimental research study in a desired manner. The detailed analyses of the data collected from the study are carried out in the next Chapter-V. And the major findings, discussions and suggestions derived based on the analyses of the collected for the present experimental research study are reported in the Chapter-VI.

●●●●●●●●●