CHAPTER 3

METHODOLOGY

CHAPTER 3

METHODOLOGY OF THE STUDY

3.0 INTRODUCTION

The review of related literature helped the researcher to modify and finalize the methodology for the present study. This chapter describes in detail the plan and procedure adapted to attain the objectives of the study. The chapter presents a detailed description of the sampling techniques, design of the study, the tools employed, the data collection procedure and the various techniques used for data analysis.

3.1 POPULATION

All the class IX students (approximately 1760 students) of the twenty two secondary schools of Baroda city following Central Board of Secondary Education syllabus during the academic year 2012-2013 constituted the population for the study.

The population of the study constituted of the students of class X of the twenty two secondary schools of Baroda city following Central Board of Secondary Education syllabus during the academic year 2011-2012.

3.2 SAMPLE

From the total twenty two English medium schools following Central Board of Secondary Education syllabus in Baroda city, ten schools were randomly selected by the researcher using lottery method. From these ten schools only two schools were ready to allow the researcher to conduct the intervention programme for one academic year throughout. Among the two selected schools one was randomly chosen as control group and another was the experimental group.

There were three sections of standard IX in both the selected schools. By lottery method one section from each school was selected as sample for the present study. All the students of standard IX A of the experimental group and all the students of standard IX C of the control group constituted the sample for the study. The technique used for sampling was the cluster sampling. For requirement of data for objective 1: all the students of the selected school studying in standard X (2011-2012) constituted the sample. The sample as per the objectives is presented below.

Table 3.1
Sample specified as per the objectives

Sr. No	Objective	Sample	Academic Year	Sample Size
1	Objective 1	Students of standard X	2011 -2012	149
2	Objective 2	Students of standard IX	2012 -2013	38
3	Objective 3	Students of standard IX	2012 -2013	38 40
4	Objective 4	Students of standard IX	2012 -2013	38

3.3 DESIGN OF THE STUDY

The present study is Experimental type in nature. The study was carried out in the actual classroom situation for the academic year 2012 -2013. It was confirmed to one group on which the developed intervention programme was experimented and for comparison control group was taken. The entire classroom, not individual students were assigned to treatment. Thus the design involved random assignment of intact groups to treatment, not random assignment of individuals. Hence Quasi Experimental Post test control group experimental group design was used for the present study. An entry level test was conducted on the experimental group as well as on the control group to determine the pre treatment knowledge of the students. The experimental group was then taught through the intervention programme. Post test was administered on both the groups. For the present study, the dependent variable is the achievement in the physics concepts and the independent variable is the intervention programme based on the learner centred activity based approach.

Experimental designs undergo threats to experimental validity i.e. to internal validity and external validity. For the present study the control group took care of the threats to internal validity like maturation, history and testing. The threats to interaction were controlled by taking the two schools which were located at different areas in Baroda. The students of the control group had no interaction with the students of the experimental group. The laboratory setting was controlled as the intervention was implemented in the regular classes as a part of the curriculum; the students were not revealed the purpose of the intervention programme. To control the threat to statistical regression here the two intact groups were selected as a whole irrespective of their entry level scores. The study took care of the experimental mortality as the number of

students remained same throughout the study. Thus attempts were made to control the threats to experimental validity.

3.3.1 Phases of the Study

Phase – 1: Situational Analysis

For the purpose of developing an intervention programme it was essential to locate the gaps between the actual understanding of the concepts and the expected understanding of the concepts. Keeping this in view the researcher carried out the content analysis of previous two years answer sheets (2009-2010, 2010-20011) of students of standard IX Science and Technology subject of the control group and the experimental group. The total numbers of 322 answer sheets were content analysed. Along with the answer sheets the question paper were also reviewed. A semi structured interview and an Information Schedule of Physics was also prepared for students of standard X to locate the actual gaps. The data from the above mentioned tools helped in the development of the intervention programme.

Phase – 2: Development of Intervention programme

The researcher selected the five chapters of Physics from the Science & Technology textbook of standard IX for the development of the Intervention Programme. The programme was developed for the conceptual understanding of the concepts keeping in view the observations from phase 1. Content analyses of the chapters were carried out and an instructional objective for each topic was formulated. The basic focus was on the understanding and applicability of the concepts. The developed programme was based on the student centred activity based approach. It encompassed of group and individual activity, power point presentations, videos, games and sport activity, experiments and demonstrations. Activity based books, reference books and internet sources guided in developing the programme. The developed intervention programme was sent to experts for feedback and suggestions given by experts were incorporated. The developed programme was further modified as per the requirement of the field during the implementation phase.

Phase – 3: Implementation of the programme

The developed intervention programme was implemented for a period of one academic year 2012 -2013. The implementation of the intervention programme

started from 9th April 2012 to 5th February 2013. The period is inclusive of the implementation of tools for data collection. A systematic pattern was followed during the implementation of the programme. The brief implementation plan of the programme is given below.

Table 3.2
Plan of Implementation of the Intervention Programme

Day	Topic	Total Time	Learning Experience
1	Entry level test	135 min	-
2	Motion	45 min	Images projected. Examples and discussion.
3	Distance Displacement	90 min	Small group activity of counting the number of foot steps required to cover the perimeter and the diagonal of the rectangular hall. Discussion with examples to differentiate distance and displacement.
4	Scalar & Vector quantities	45 min	Examples and discussion followed by a list of physical quantities for classification.
5	Uniform motion	90 min	Small group activity on the motion of the pendulum. Construction of graph and infer the characteristics of graph.
6	Non uniform motion	90 min	Individual activity of Digital symbol test. Construction of graph and infer the characteristics of graph.
7	Speed Velocity	135 min	Activity of relay race and calculation of speed.
8	Acceleration Retardation	90 min	Four minute cycle race video. Discussion based on the video shown. Five minute you tube video to sensitize the students towards rash driving. Discussion based on the video shown.
9	Circular motion	90 min	Activity to run on the different shapes of geometrical blocks drawn on the ground and estimate the number of times they need to change their direction in each case.
10	Circular motion	90 min	Demonstration of rotating a small stone tied to a nylon thread. Activity of discus throw by students. Discussion based on the activity and demonstration.

11	Numerical	90 min	Worksheet for students.
12	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on motion.
13	Force	45 min	Listing of activities from day to day life wherein force is applied and mention the effect of force applied.
14	Balanced force Un balanced force	90 min	Activity of Tug of war followed by discussion.
15	Frictional force	90 min	Demonstration of rolling different objects on an inclined plane kept on the smooth surface. Group activity of rolling the marble on a smooth floor and a rough floor. Speed of each object rolled was calculated. Discussion on the activity conducted.
16	Galileo's Observation and conclusion	45 min	Two minute short online video followed by discussion.
17	Inertia	90 min	Demonstration of pulling a set table all of a sudden. Discussion based on demonstration. Activity of sticking a pile of carom coins hard with a striker. Discussion based on activity.
18	Inertia	90 min	Group activity of flicking a five rupee coin kept on a card. Gradually increasing the number of coins and card. Discussion based on the observation of students.
19	Relating Inertia and Mass	45 min	Different objects provided and students were asked to estimate the amount of force required to move each object. Discussion based on students' experience.
20	Types of Inertia	45 min	List of examples and discussion
21	Newton's First Law	45 min	Discussion relating the examples of inertia.
22	Concept of Momentum	90 min	Game of cricket. Discussion on the experiences the students had during the game.
23	Gravitation	45 min	Real life examples and discussion.
24	Acceleration due to gravity	45 min	Short animated online video representing the fall of a feather and coin from a height in a vacuum jar at the same time.

25	Gravity at poles and gravity at equator	45 min	Short animated online video representing the relation between gravity and the radius of earth at different places on earth. Discussion.
26	Mass, Weight	45 min	Activity to calculate the least count of spring balance. Activity to measure the mass and weight of the given objects.
27	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on Gravitation.
28	Newton's second law	90 min	Experiment to establish a relation between force and acceleration keeping mass constant. Experiment to establish a relation between mass and acceleration keeping force constant.
29	Conservation of Momentum	45 min	Demonstration- functioning of Newton's cradle toy. Discussion based on students' observation.
30	Newton's second law in daily life	90 min	List of examples from real life provided. Students discussed in small groups and established the cause and effect relationship.
31	Newton's third law	90 min	Demonstration to prove action and reaction forces are opposite in direction Small group activity to prove action and reaction forces are equal in magnitude. Discussion based on the demonstration and group activity.
32	Newton's third of motion in daily life	90 min	Worksheet to identify the action and the reaction force along with the direction of forces.
33	Numerical	90 min	Worksheet on numerical.
34	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on laws of motion.
35	Concept of Pressure	135 min	Demonstration of an activity to relate the force applied on a surface area to derive pressure. Small group activity to produce depression of the three faces of the cuboid on wet sand. Discussion based on students' observation from the activity and demonstration.

36	Pressure in daily life	90 min	Group discussion on materials and list of examples from daily life.
37	Buoyancy	45 min	Demonstration using a piece of wood and a piece of metal dipped in a beaker half filled with water. Discussion based on students' observation.
38	Floatation	45 min	Demonstration of different objects dropped in a transparent bucket with water. Discussion based on students' observation.
39	Density	45 min	Activity forming different colourful layers of liquid in a test tube. Activity to make a boiled egg float in water. Discussion based on the activities conducted.
40	Density	90 min	Experiment to calculate the density of a given solid by displacement method.
41	Buoyant force and volume	45 min	Demonstration of an activity to prove that with increase in volume of object immersed the buoyant force increases.
42	Archimedes's Principle	90 min	Experiment to establish the relation between loss in weight of a solid when fully immersed in water, with the weight of water displaced by it.
43	Archimedes's Principle in daily life	45 min	Discussion on examples from day to day life
44	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on floatation.
45	Concept of work	45 min	Worksheet with examples to reason out whether scientifically work is done or not.
46,47, 48	Forms of energy	135 min	Small group presentation on different forms of energy in nature.
49	Energy transformation, Law of conservation of energy	45 min	Demonstration to show transformation of energy taking place in a compressed spring dipped in sulphuric acid, in a pendulum and bow and arrow. Discussion based on students' observation.
50	Commercial unit of energy	45 min	Project to calculate the energy consumed by electrical appliance at home each day. Estimate the electric bill for the month.
51	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on energy.

52	Concept of Sound	45 min	Demonstration of sound produced by a vibrating tuning fork. Audio of different musical instruments played. Set of six steel glasses filled with water to different levels used to produce the rhythmic sound effect of '*Jaltarang*'.
53	Production and propagation of sound	90 min	Small group activity to observe the wave propagation in a slinky. Demonstration of vibrating tuning fork producing vibrations in a suspended metal bob. Discussion based on demonstration. Demonstration- A vibrating tuning fork makes the paper rider fall off from the thin wire. Discussion on students' observations.
54	Sound needs a medium	45 min	An online you tube video to show sound cannot travel in vacuum. This was followed by discussion and examples were related.
55	Amplitude, Frequency & Timber of sound	90 min	Sound of different frequency and amplitude played on a keyboard. Students asked to differentiate the sound from each other. Audio sounds and discussion on students' response.
56	Reflection of sound	90 min	Small group activity to prove that angle of incidence of sound waves is nearly equal to angle of reflection of sound waves.
57	Reflection of sound in daily life	45 min	Demonstrating the working of a stethoscope, a clarinet and a bugle. Discussion.
58	Echo & Reverberation	45 min	Three minute online video differentiating the sound of echo and reverberation. Discussion.
59	Ultrasound in daily life	45 min	Power point presentation and discussion.
60	Auditory aspect of human ear	90 min	Online you tube video on ear anatomy/3D human structure. Three dimensional model of inner structure of human ear used to explain the concept. Role play by a group of students to represent the function and working of human ear.
61	Revision	45 min	Flow chart drawn to interconnect concepts. Crossword on sound.

Phase – 4: Effectiveness of the intervention program

To determine the effectiveness of the developed intervention programme the difference in the mean scores of students of experimental group and control group on post test was taken and ANCOVA was computed. Effectiveness was also observed by maintaining a field note during the process of implementation of the programme on the experimental group. The impact of the developed intervention programme was also judged from the ability of the students to interpret and identify the physics concepts from the stories and images of events projected. The effectiveness of the developed and implemented intervention programme was also interpreted on the responses of the experimental group students on the reaction scale.

3.4 TOOLS FOR DATA COLLECTION

3.4.1 Interview Schedule for students

A semi structured interview for students who were recently promoted to standard X of the academic year 2011-2012 was prepared by the researcher to find out the pedagogy taken up by the teachers to teach the different physics concepts in standard IX, the concepts which they felt difficult to understand and comprehend and the way they perceived the teaching and learning of physics. The semi structured interview supplemented the Information schedule of Physics to bring clarity in locating the gap between actual learning outcome and the expected learning outcome.

3.4.2 Information schedule of Physics

The information schedule of physics consisted of list of all the concepts of physics of standard IX in a tabular form. The students who were recently promoted to class X of the academic year 2011-2012 were asked to put a tick to the concept which they felt difficult to comprehend. The information schedule helped the researcher to further probe into the area wherein the intervention was required.

3.4.3 Entry level Test

The entry level test of 50 marks on the physics concepts of standard VIII was prepared to determine the pre treatment knowledge related to the dependent variable. The test was prepared based on the contents and level of objectives in the chapters of physics from standard VIII science and technology textbook. Answer key and blue print of the entry level test was also prepared to maintain objectivity in assessment.

The test had items pertaining to different levels of objectives. It constituted of multiple choice type questions, true and false, puzzle and fill in the blank type questions. The test was validated by experts in terms of level of objectives and clarity of language used. The suggestions of the experts were as mentioned below:

The experts suggested that the instructions mentioned needed modifications and specifications. Experts suggested to add some application based question in the form of puzzle to achieve the higher order objectives apart from the multiple choice type questions. Question no 7 and question no 2 was suggested to be inter related and lack objectivity, hence the items were omitted in the final test.

The suggestions from the experts were considered and the tool was further modified. The blue print of the entry level test is as given below.

Table No: 3.3
Blueprint: Entry-level test

Objectives→ Question No. ↓	Knowledge Level	Understanding Level	Application Level	Skills Level	Total Marks
Q-I	4.5 (09)	05 (10)	0.5(01)	-	10
Q-II	06 (06)	04 (04)	-	-	10
Q-III	03 (06)	3.5 (04)	3.5 (04)	-	10
Q-IV	-	-	11 (11)	-	11
Q-V	02 (02)	02 (02)	02 (02)	-	06
Q-VI	-	-	-	03 (01)	03
Total	15.5	14.5	17	03	50

(The number inside the bracket indicates the total number of questions and the number outside the bracket indicates mark.)

3.4.4 Field Notes

The researcher used field notes to maintain a record of activities conducted and the behaviour of students during the teaching learning process. It helped the researcher to note the participation of the students during the implementation of the intervention programme in the form of questions raised, the way students related the concept with their prior knowledge /experiences and their reflections.

3.4.5 Achievement Test

Achievement test was designed based on the contents from the Physics chapter of Science and Technology subject of standard IX. The test was administrated as a post test on the control group and the experimental group to determine the conceptual understanding of the physics concepts.

The instructional objectives were formulated and the blue print was prepared. The test consisted of activity based questions which were comprehensive in nature establishing the cause and effect relationship. The test items consisted of short answer type direct questions. The test was sent to experts in the field of science for validation. The validation of the test was done with respect to the set of objectives, clarity of instruction, clarity of language and the level of objective to be achieved. The experts suggested that in question no 11, the statement required grammatical correction for clarity of understanding. In question no 13, expert suggested to reframe the question for better clarity. In question no 14 and question no 16, suggestions were to make it more specific by adding *'Towards A or towards B'* and *'Why this difference is observed'* respectively. In question no 32, the expert suggested to reframe the second half of the question as *'Identify the physical quantities which are measured and expressed in the S.I Units given below'*. As per the suggestions and feedback from experts the final draft of achievement test consisting of 36 test items was finalized. A brief outline of the questions in the achievement test with respect to the chapters is given below:

Table No: 3.4

Details of the Questions in achievement test

Name of the chapter	**Question Number from the test**	**Total Number of Questions**	**Total Marks**
Motion	Q.4, Q.12, Q.13, Q.15, Q.32, Q.36	06	09
Force and Laws of Motion	Q.1, Q.5, Q.6, Q.7, Q.10, Q.11, Q.14, Q.24, Q.33, Q.34, Q.35	11	14
Gravitation	Q.2, Q.3, Q.8, Q.16	04	06
Floatation	Q.9, Q.17, Q.18, Q.19, Q.20, Q.31	06	09
Work and Energy	Q.21,Q.22, Q.23, Q.30	04	04
Sound	Q.25, Q.26, Q.27, Q.28, Q.29	05	08
Total	-	36	50

3.4.6 Images of events projected

Scientific concepts follow a sequence of events which are logically arranged to provide an explanation of the phenomenon occurring in nature. Each concept interconnects with the other to lead to a phenomenon. The researcher felt that to achieve higher level of objectives of analysis and synthesis student need to be subjected to certain stimulus which could trigger their logical reasoning. With this objective the researcher identified different images of events that had different concepts of physics cut across the concepts they studied as a part of their curriculum of standard IX. The tool was prepared to study the ability of the student to interconnect the different concepts of physics and synthesize it to form a phenomenon. The tool was validated by experts and the final tool had 12 different images on different concepts of Physics. One by one the images were projected on the screen and the students identified the scientific concepts within the image projected and arranged the occurrence of the concepts in a logical sequence.

3.4.7 Interpretation of Physics concept from the stories

David (2001), Susan (2005) and Shelat (2012) found the impact of stories used as a part of the instructional and assessment strategy. The researcher also felt that in order to measure the real learning outcome of students, the students must be exposed to different situations and made to relate the learnt concept in a real life situation. Stories and incidents of daily life are commonly associated with students and actual learning can be observed in their attempts to connect their classroom learning with the world outside.

With this rationale, the researcher adopted four stories having the basic concepts of Physics keeping in view the level of expected learning outcome of students at standard IX. The stories were developed in relation to the concepts of Motion, Archimedes's principle, Density, and the Laws of Motion. The questions followed had different levels of conceptual understanding. Each story was followed by five questions which the students were to answer. Question 1 and question 2 pertained to the understanding level of objective. Question 3 and question 4 were related to the application level of objective whereas question 5 pertained to all achievable level of objective. The students were to interpret the physics concepts from the stories. The basic objective of the tool was to determine whether the students are able to interpret and relate the concepts learnt in the classroom with the day to day events occurring in

nature. The tool was sent for validation to experts. The experts validated the tool in terms of sentence structure, clarity of language and level of objective. The expert suggested adding title to each story which was not there in the initial draft. The suggestions were incorporated in the final draft.

3.4.8 Reaction Scale

To study the reaction of the students towards the implemented intervention programme, a reaction scale was developed. The tool was sent to experts for validation and incorporating their suggestions the final tool consisted of 20 statements with five options- Always, Most often, Often, Sometimes and Never. The tool was administered on the experimental group students.

3.5 DATA COLLECTION

The researcher took permission from the schools to conduct the study. The schools were assured that the data collected would be kept confidential and will be used only for research purpose. For the situational analysis the data was collected in 2011-2012, and the answer sheets of students of science and technology subject of standard IX of the academic year 2009-2010, 2010-2011 was content analysed. An entry level test was administered on the control group and experimental group by the researcher before the implementation of the developed intervention programme. An intervention programme based on learner centred activity based approach was developed and implemented on the experimental group during the academic year 2012-2013. Post test and the other tools of data collection were personally administered by the researcher on the control group and the experimental group.

3.6 DATA ANALYSIS

Data collected through interviews and previous years answer sheets were analyzed qualitatively through content analysis. The data collected through Information schedule of Physics was analyzed using frequency and percentage. Data collected through achievement test was analyzed employing the statistical technique ANCOVA. Data collected through interpretation of physics concepts from the stories were analyzed using frequency count, percentage and Chi-square technique. The responses of the students were also content analyzed. The analysis of the responses of students on the images of events projected was done through frequency count and percentage.

The logical sequencing patterns of the students were analyzed through content analysis. Data collected through reaction scale was analysed using frequency count and Chi-square. The entire analysis procedure, objective wise have been presented below in tabular form.

Table No: 3.5
Objective- wise analysis of data

Objective No	Theme	Tool	Analysis Technique
Objective **1.**	Situational Analysis	Analysis of 322 answer sheets	Content Analysis
		Interview schedule	Content Analysis
		Information schedule of physics	Frequency count & percentage
Objective **3.**	Effectiveness of the developed Intervention Programme	Achievement test	ANCOVA
		Identification of Physics concepts from stories	Frequency count, Chi-square & content analysis
		Identification and logical sequencing of physics concepts from the images.	Frequency count, Percentage & content analysis
Objective **4.**	Reaction of experimental group students towards the developed intervention programme	Reaction scale	Frequency, percentage count & Chi square

The present chapter described in details the plan and procedure for the study. The development and implementation of the intervention programme is given in brief in this chapter. The following chapter gives a detailed description of the developed and implemented intervention programme.