# CHAPTER 6

# SUMMARY AND DISCUSSION

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The present chapter focuses on the major findings from the study and discussions on the findings in line with the review of related literature. It also provides a summary of the study along with suggestions for further research.

## 6.0 INTRODUCTION

In the present age called 'the age of Science & Technology' knowledge of basic physics is essential to take up certain professional and applied courses. Physics, just as science in general, is not only about nature, it is also about people. It is human pursuit, as old as ingrained in our nature as our search for happiness. As a human activity, it shapes our intellect, mould our view of the world and of ourselves. The modern comfort of human life is indeed a blessing of science in general and physics in particular. The teaching of physics at secondary level aims to provide students with the knowledge, understanding and experimental skills which are necessary for higher level study in the discipline and which are a part of a general scientific education. It aims at the technical and cultural development in our society and strike a balance between scientific epistemology based on phenomenon, facts and theorems. The teaching of physics is endeavour to help students to learn how to talk about physics in a scientific manner, and to use their knowledge of physics in order to deal, quantitatively and qualitatively with the problems arising in working of everyday life.

Researches in science education shows that students enter science classrooms with previously formed explanatory models of the natural world: these naive mental models' have a substantial influence on their learning of the scientific concepts. Physics as a part of Science and Technology in secondary schools contributes a great deal in the development of scientific attitude, reasoning, skills, creativity and helps in satisfying our curiosity about the occurrence of many phenomena around us. If we look around us we will find a large number of electronic and electrical goods which all utilize one or the other principle or laws of physics.

Physics deals with many physical phenomena and experiences. They are not only exciting but also educative. The fall of an apple lead to gravitation. Beating of the

drum causes vibration producing sound. Stars twinkle up in the sky while the planets do not. We come across diverse physical phenomena which are quite exciting and educative. All these phenomena are diverse and complex in nature depending on certain laws and theories of physics. Hence physics as a part of science occupies an important and unparallel place in our secondary school curriculum.

Present day science classroom functions in an artificial and closed environment where its top heavy structure lays a lot of emphasis on the past and fails to provide any positive input to a student to think aloud and construct his own knowledge. Umasree (1999) from her study supports that in 70% of the cases teachers talk predominates about 26 min out of 35 min, taking a major part of the period without students' participation. In only 6% of the cases the teacher talk to student talk was fairly distributed. The contents are not simplified and the language style used by teachers was the same in which the text has been written. Pienyu (2004) found many of the science teachers at secondary school in Nagaland were ignorant about the innovations in science teaching. Text books are referred as the only source of knowledge by the teachers, Bhuyan (2005). Shelat (2012) from the situational analysis phase of standard VII classroom observation found that the no group discussions were carried out in class. None of the classroom observation had activity based teaching or inquiry based teaching. Science classrooms were teacher centred classroom wherein teachers are the authority and students are mere passive listeners. The students are never made a participant in the teaching learning process. They remain as mere recipient in the classroom. Looking at the present scenario of teaching science the basic aim of developing process skills, experimental, observational and investigatory skills in learners is hardly achieved.

Standard IX is the threshold of secondary education; it is at this stage wherein the students are exposed to the basics foundations for the different disciplines of science to be taken up at higher secondary level. They are expected to acquire the basic experiment skills, develop the ability to think logically and use mathematics to solve physical problems and relate the classroom instruction with the world outside. At this stage physics education also aims at proving the basic amount of knowledge in terms of the basic concepts, principles, skills and fundamentals which help them to learn more comprehensive and abstract concepts at higher levels. Suthar (1998) from the survey reported that the teachers felt the syllabus of standard IX science to be difficult

as compared with the syllabus of standard X science. The various commissions and committee recommended a change in the transaction process of science, emphasising the process aspect of science rather than the product. A paradigm shift has been observed from teacher centred approach to student centred approach in teaching of science. The National Curriculum Framework (2005) specifies that the foundation laid at the secondary stage should be able to equip the students with the basic knowledge, skills and attitudes towards making meaningful contributions in the field of their choice. It lays emphasis on the comprehension and not on mere formal definitions. Experimentation as a tool to discover/verify theoretical principles should be an integral part of the curriculum. The students should be exposed to such environment wherein they develop the critical ability to evaluate the epistemological status of facts that they encounter in science.

At secondary stage (IX & X) physics include topics like measurement, motion, force, energy, work, density, pressure, buoyancy, elementary optics, heat, electricity, magnetism, sound, transverse waves etc. Physics of Standard IX initiates the introduction concepts of waves, circular motion, the centrifugal force, particle vibration etc. Physics as a subject is more of a interdisciplinary subject, applying mathematical concepts to obtain formulae and quantitative treatment of various laws and principles. It is in standard IX for the first time the students are introduced to derivation of formulae, use of graphical representations, and numerical computation. Hence the application of mathematics involved in the derivation of formulae and numerical computation is another factor influencing physics learning. Mehna (1986) found abstract reasoning and numerical ability as a significant predictor in achievement in physics. If the basic concept is not understood it becomes difficult to conceptualize the subsequent ones. For example if the student don't understand the difference between displacement and distance it becomes nearly impossible for the student to differentiate between velocity and speed. Singhal (1983) also supports the need for basic concepts for the higher achievement in physics. Once the fundamentals are weak, the students' starts disliking the subject as a whole and develops a phobia for it. Trygstad (2010) found that fears and frustration while studying science topics can lead to science anxiety for some individuals. For those who experience science learning anxiety, the reality is often poor performance, lower self esteem, anger and avoidance of further science courses. Andree (2002) found that female students had

no intentions to choose physics or physics related subjects for their prospective career choices in future. Uplane (2011) through interactions and discussions with teachers found that students had problems in learning physics. Saxena (1985) found that the maximum preference style in physics of the students was for 'Recall' and the least preferred style was 'Questioning'. Jain (1982) studied the basic problems in physics having a direct bearing on various reasoning patterns. The study implied that for effective classroom instruction, curriculum the methods of teaching have to be planned in such a way that the structure of content is in accordance with the level of intellectual development of students. Singhal (1983) from his study concluded that students did not read beyond the syllabus and did not inculcate the habit of understanding the basic concepts of physics. Students were found very weak in numerical work and expressions.

Joshi(1998), Kelkar (1998) from their studies found the need to develop alternative instructional strategies to first master the lower order skills and then proceed for the higher order skills. Research focus on the need to relate the concept learnt in classroom with the outside world. Mohan (1991) emphasized on the development of scientific concepts, through adoption of appropriate instructional technology. He found that blending a number of instructional media might be useful in generating a learning climate that fosters interaction of various components of learning process. It is possible to accelerate thought under certain conditions such as arranging thought provoking problems in their hierarchical order but abstract concepts were difficult to crack Vaidya (1991).

Kamalakantham (1986), Basu (1981), Sivadasan (1981), Sharma (1986), Agnihotri (1987), Pillai (1987), Goel & Agbebi (1990), Joseph (1998), Hanumanthaiah (2000) and Sidhu & Singh (2005) studied the effectiveness of different instructional strategies in the teaching of physics at secondary level with respect to different variables. Jean (2002), Albert (2009) and Han (2010) studied the understanding of abstract concepts in physics and found that it is important to help students build a solid cognitive ground with the help of perceptual anchor. The implications of the studies conducted abroad supports that with the change in the classroom instruction, motivational level, and learning strategies a change could be brought about in the performance and retention of the students. Parvathy (2004), Amin (2011) and Shelat

(2012) advocated the activity based science teaching for significant achievement of all levels of instructional objectives.

From the reviews it was found that students usually perform well till the mechanical reproduction of the physics concept but when it comes to the interpretation and application of the same they badly fail. It's a dire need of time that our classroom activities focus more on the process aspect rather than the product. It's not just enough for the student to score well in exams, but its more essential for them to understand and relate the learnt concepts to the world outside the classroom. In the present study the investigator has attempted to bridge the gap between the classroom teaching and the world outside by developing an intervention programme taking up the concepts of physics from the Standard IX, science and technology Syllabus.

## 6.1 STATEMENT OF THE PROBLEM

Developing and Implementing an Intervention Programme in Science & Technology for Topics of Physics for Standard IX

## 6.2 OBJECTIVES OF THE STUDY

1. To identify the topics of physics from standard IX Science and Technology for Intervention.
2. To develop and implement an Intervention programme in the physics content of standard IX Science and Technology.
3. To study the effectiveness of the developed Intervention Programme in terms of
    - I. Achievement of students on the conceptual understanding of physics concepts.
    - II. Interpretation of Physics concept from the stories.
    - III. Identification of Physics concepts from the images of events projected.
    - IV. Logical sequencing of Physics concepts from the images of events projected.
4. To study the reactions of the students towards the developed Intervention Programme.

## 6.3 HYPOTHESES OF THE STUDY

1. There will be no significant difference between in the adjusted mean score of the control group and experimental group when the scores of Entry level test are considered as a covariate on achievement test.
2. There will be no significant difference between the control group and experimental group on the interpretation of physics concepts from stories.
3. There will be no significant difference in the observed frequency and frequency expected against equal probability on various statements of the reaction scale.

## 6.4 EXPLAINATION OF THE TERMS

### 6.4.1 INTERVENTION PROGRAMME

The programme focused on creating a classroom environment wherein students thinking and involvement, their willingness to express their ideas and critically analyse the new ideas with their prior knowledge and thereby achieve the set instructional objectives. The intervention programme attempted to simplify and enrich the contents with involvement of different learning activities to improve their conceptual understanding of the subject. For the present study the researcher selected topics from the five chapters of physics from the standard IX CBSE science textbook. Content analysis was carried out and looking into the nature of the content various learning experiences were designed. Learning experience encompasses of group and individual activity, power point presentations, games and sports, experiments and demonstrations, animated video, discussions and brainstorming questions. The intervention programme was designed keeping in view the child centred activity based approach.

## 6.5 OPERATIONALISATION OF THE TERMS

### 6.5.1 ACHIEVEMENT

Achievement in the present study was measured by administering a test of total fifty marks. It was constructed by the investigator on the physics content of standard IX Science & technology.

### 6.5.2 EFFECTIVENESS

The effectiveness in the present study is interpreted in terms of the clarity in the learned concepts when measured on an achievement test. It refers to the scores obtained by the students on the final achievement test when compared with the control group. Effectiveness is also perceived as the ability of the students to interpret the physics concepts within a given story. Effectiveness in the present study also refers to the ability of the students to interpret the physics concepts in a logical sequence from the images of events projected to them.

## 6.6 DELIMITATION OF THE STUDY

The study is delimited to the selected topics of physics from the five chapters : Motion, Force and Laws of Motion, Gravitation, Work and Energy and Sound in the standard IX CBSE Science & Technology textbook. The present study is also delimited to the standard IX students of the selected two English Medium Schools following Central Board of Secondary Education (CBSE) syllabus for the academic year 2012 -2013.

## 6.7 METHODOLOGY OF THE STUDY

### 6.7.1 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.

### 6.7.2 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. 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.

## 6.8 DESIGN OF THE STUDY

The present study is Experimental type in nature. The study was carried out in the actual class room 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. 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 the control group to determine the pre treatment knowledge of the students. The experimental group was taught through the intervention programme. Post test was administered on both the groups.

## 6.9 TOOLS FOR DATA COLLECTION

### 6.9.1 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.

### 6.9.2 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.

### 6.9.3 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.

### 6.9.4 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.

### 6.9.5 Achievement Test

Achievement test was designed based on the contents from the Physics chapters of Science and Technology subject of standard IX. The test was administrated as a post test on the control group and the experimental groups 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.

### 6.9.6 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. 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.

### 6.9.7 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. For the present study 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. The students were to interpret the physics concepts from the stories. The tool was sent for validation to experts.

### 6.9.8 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.

## 6.10 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 analyzed. 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.

## 6.11 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 analyzed using frequency count and Chi-square.

## 6.12 MAJOR FINDINGS

The findings from the analysis of the information schedule of physics, interview schedule of physics and analysis of answer sheets of students are presented in chapter 4. The findings and interpretation of the situational analysis was used to develop the intervention programme. The major findings from the study are presented below:

- The adjusted mean score of the experimental group on achievement test was found to be significantly greater than that of the control group when the entry level scores were considered as covariate on the achievement test scores. Hence, the intervention programme resulted into significant achievement scores of the experimental group students.
- The analysis of the data with respect to the interpretation of the physics concepts from the stories reveals that there was significant difference between the control group and experimental group on the interpretation of physics concepts from the stories. The experimental group students were able to identify the physics concepts from the stories significantly better than that of the control group students. Hence, the intervention programme helped the experimental group students to relate the concepts to the daily life events better than that of the control group students.
- The experimental group students could identify and list out more number of concepts/principles from the story. As compared to the control group the experimental group students could better relate the context in the story wherein the principle/concept occurred.

- The analysis of the data with respect to identification of physics concepts from the images of events projected reveals that the experimental group students could identify and list out more number of physics concepts on the projected images as compared to the control group students.
- The analysis of the data with respect to logical sequencing of physics concepts of the images of events projected, it was found that the performance of the experimental group students was significantly better than that of the control group. The experimental group attempted to arrange the identified concepts/principles in a logical sequence with respect to the occurrence of the phenomenon as compared to that of the control group.
- The experimental group students provided several patterns of logical sequence of arranging the identified physics concepts from the particular image. The students also provided a logical reasoning behind the sequential arrangement of the physics concepts. Hence, it could be inferred that the experimental group had comparatively better clarity and understanding of co relating the physics concepts as compared to the control group.
- Overall the intervention programme has been found to be more effective in developing the conceptual understanding of physics concepts of the experimental group when compared with that of the control group.
- After the implementation of the intervention programme students' reaction towards the implemented intervention programme was determined using a reaction scale. It was found that students had a positive and favourable reaction towards the implemented intervention programme.

## 6.13 DISCUSSION

Science is a dynamic, expanding body of knowledge covering ever new domains of experience. Science teaching at secondary school level requires that the learner is engaged in acquiring the methods and process that leads to generation and validation of scientific concepts. Teaching of physics concepts at the secondary level should nurture the natural curiosity of the learner and help the student to concretize the abstract concept and relate it with the day to day life events outside the classroom. The environment so created in the classroom should foster the inquisitiveness, observation skill, thinking skill, comprehension, analytical skill and application of

knowledge in a real life situation. But the present day teaching learning process fails to attain the aims of teaching physics at secondary level.

From the situational analysis it was seen that thirty percent of the students felt physics to be difficult and said that they had to put in more efforts to remember the formulae's and definitions. The findings are supported by the study of Uchat (1982) wherein physics was felt the most difficult and biology was considered the least difficult by the students. Thirty two point five percent (32.5%) of the students felt that the physics concepts in standard IX was difficult as compared to standard X while ten percent (10%)of the students were of the view that in standard X they cannot skip or omit topics and felt compulsion to learn all concepts. Suthar (1998) found that the teachers felt the syllabus of standard IX science to be difficult as compared with the syllabus of standard X. Saxena (1985) found that the cognitive preference styles in physics of the students with maximum preference for 'Recall' and minimum preferences to 'Questioning'. This was also reflected in the finding that forty percent (40%) of the students said that the teacher taught in class and they took notes in class. Questions were asked when the students made noise or talked in the class. Shelat (2012) in her study found that the questions asked in the class were of knowledge level and barely touched the understanding level of students. Even the questions asked in exam were more of knowledge level promoting role memorization by students. Albert (2009) found that a stimulus followed by a question sequence significantly facilitate the conceptual understanding. The present study also finds that forty percent (40%) of the students said that they memorized the definitions as given in the text. They said that they were graded low if at all they attempted to write the definition in their own words. Even Menon (1986) has reported that the questions asked by teachers mostly listed the product aspect and not the product aspect of science. Jean (2002) supported that participants who relied on rote learning did not perform well. The finding related to the activities performed in class is supported by the findings of Shelat (2012) and Umasree (1999). Students though excited and enthusiastic about practical work in lab, fifty five percent (55%) of the students confessed of manipulating the findings and result. Most of them also admitted of memorizing the findings and result to reproduce it in the exam. The findings are in line with the findings of Jacob (2004) wherein he emphasized on providing specific dramatic events with opportunity to connect real life event rather than regular repetition of lab procedures.

The situational analysis found that the theoretical concept of the experiment taken up as a part of the practical lab in first semester is taught in the second semester syllabus. The practical lab activities were not supported with the theoretical base. Goel & Agbebi (1990) found that students who followed the lecture demonstration method achieved at a higher level related cognitive skills than did the group of students which followed the individual laboratory method. The finding of the present study fifty percent (50%) of the students said that they never asked questions during the classroom interactions. Umasree (1999) reports that in majority of the science classes teachers talk predominates, a major part of the period without students' participation. Jain (1982) reported that the teachers need to ask logically arranged questions that lead the students to think in the right direction. In the present study ten percent of the students reported to have referred books and internet sources apart from their class notes while the rest of the students solely depended on the class notes given by teachers'. The finding is supported by Singhal (1983), there was little interest among teachers and students in taking books for reading even when arrangement were made to send the books to their address. The finding from the present study: ten percent (10%) of the students were of the view that the revision classes before exams helped them to presume the expected questions for exam. The findings relate that the evaluation system still remains exam oriented. The teaching learning process aims for product aspect rather than the process aspect.

From the analysis of the answer sheet it was found that students used either wrong formulae or made mistake in mathematical calculations while solving the word problem in physics. Mehna (1986) found abstract reasoning and numerical ability as a significant predictor in achievement in physics. Students also found it difficult to represent the law or definition in symbolic mathematical formulae. Students lacked conceptual clarity on the physical interpretation of the symbolic representation of the formulae. Jain (1982) studied the basic problems in physics having a direct bearing on various reasoning patterns and found that for effective transaction of curriculum the method of teaching have to be planned in such a way that the structure of content is in accordance with the level of intellectual development of students. From the analysis it was also observed that most of the students reproduced the mathematical steps of the derivation without supporting it with theory. It was also found that students used certain terms interchangeably while explaining certain concepts in physics. The findings are in line with the finding of Han (2010). It is important to help students

make a solid cognitive ground with perceptual anchor. Sequential abstraction process strengthens students' understanding and help in gradually reaching the abstract level of understanding.

It was observed from the analysis of the answer sheets that when the questions were directly asked students could respond to it correctly but when the questions were framed on the application level, students found difficult to respond. Grewal (1988) from his study found that the process of prediction and interpretation were hardly found in teaching and that most commonly used processes were inferring and classifying. The students were not exposed to situations wherein they could apply the concept in a real life situation.

Ramakrishnan (1996), Kelkar (1998) and Vijay Kumari (2002) studied the effect of different methods/approaches of teaching science on the achievement of the students with different achievement levels. The strategies proved to be effective in raising the achievement level of the students of the experimental group. It was found in the present study that the adjusted mean score of the experimental group on achievement test was found to be significantly greater than that of the control group when the entry level scores were considered as covariate. Hence, the intervention programme resulted into significant achievement scores of the experimental group students. Shelat (2012), Susan (2005) and David (2001) examined the value of storytelling in a science classroom. The aim of the approach was to present the concepts in a meaningful and memorable context and interlink the concepts in a coherent and connected manner. The concepts to be taught can be seen in an interlinked wholistic manner rather than in isolated fragments. David (2001) found that the students who were taught through stories learned the science concepts, on an average 21% better and retained close to 48% more than the students taught through traditional lessons. In the present study stories were used as a tool to assess the students' conceptual understanding when the concepts of physics were coiled together in the form of a story. It was found that there was significant difference between the control group and experimental group on the interpretation of physics concepts from the stories. The experimental group students were able to identify the physics concepts from the stories significantly better than that of the control group students. Hence, the intervention programme helped the experimental group students to relate the concepts to the daily life events better than that of the control group students. The experimental group students could thus identify the concepts from the stories which were in a coherent and connected

manner. Gail (2006) focused on the research questions: What are the possible meanings of teaching for understanding? How might one teach secondary school science for understanding? Today we need to consciously reflect on what we as teachers are teaching and most important how we are teaching it. Does our teaching reach to our students? Are they able to apply their classroom physics in the world outside or is it that there is a gap between what is being taught to what the students experience? Tsurusaki (2008) explored how making connections between school science and students' everyday life can lead to higher quality science education. The study focused on merging the object of activity and the participation framework to provide opportunity for interaction between students and teachers to make connections between students' fund of knowledge and scientific concepts.

For the present study the students were shown the images of events that occur in our day to day life. The students were to identify the physics concepts from the images and also arrange the concepts in a logical sequence with respect to the occurrence of the phenomenon. It was found that the experimental group students could identify and list out more number of physics concepts on the projected images as compared to the control group students. The analysis of the data with respect to logical sequencing of physics concepts of the images of events projected, it was found that the performance of the experimental group students was significantly better than that of the control group. The experimental group attempted to arrange the identified concepts/principles in a logical sequence with respect to the occurrence of the phenomenon as compared to that of the control group. The experimental group students provided several patterns of logical sequence of arranging the identified physics concepts from the particular image. The students also provided a logical reasoning behind the sequential arrangement of the physics concepts. Hence, it could be inferred that the experimental group had comparatively better clarity and understanding of the physics concepts as compared to the control group who were taught through the traditional approach. Rao (1988) found that the learning process scores and concept scores were low indicating that comprehension was not achieved by giving children bits of information about scientific facts. Rote memory fails to retain the concepts in the memory of students. Vaidya (1991) asserts that it was possible for students to participate in the day to day teaching learning provided, the teacher did not always insist on the right answer. The wrong answer, in fact, revealed the evolving structure of the logical thought.

In the present study it was found that overall the intervention programme has been found to be more effective in developing the conceptual understanding of physics concepts of the experimental group when compared with that of the control group. The finding is supported by Mohan (1991) who found that blending a number of instructional media might be useful in generating a learning climate that fosters interaction of various components of learning process. Amin (2011), Shelat (2012) and Parvathy (2004) support the finding and affirm that activity based science teaching leads to developing clarity on science concepts, enhancing experimental skills and comprehension among students at all levels. Mohapatra (1989) found that students made a great deal of conceptualization on the basis of their observation of day to day happenings in the environment and in home situations. The present study provided a lot of exposure to students to interact with the surrounding and make connection between classroom learning and the real world outside. The intervention programme emphasized on the application of the physics concept in a real life situation. It was found that students had a positive and favourable reaction towards the implemented intervention programme. The students were enthusiastic and participative during the implementation of the intervention programme. They could perceive that learning could be interesting and could take place even when the textbooks are closed. Thus it is important to help students make a solid cognitive ground with perceptual anchor to deepen students' understanding by providing an opportunity to practice their mental simulation by removing sensory modalities used one by one to gradually reach abstract level of understanding.

## 6.14 IMPLICATIONS OF THE PRESENT STUDY

The present study emphasizes on bringing variation in the teaching of the concepts and on students' understanding of the concepts. The cognitive thought process of the students must be given importance rather than promoting rote memorization and reproduction of the concepts. Teachers need to reflect on their teaching and focus on the actual learning of the students. This will indeed make students achieve the higher order instructional objectives of comprehension, application of knowledge, reasoning skills and analytical skills. When students are able to relate the cause and effect of a certain event occurring in nature they develop the scientific attitude. Such a programme wherein students are made a part of the teaching learning process enhances their functional aspects of physics in daily life. Teachers should make effort

to reduce teacher centred learning strategies. Teachers need to integrate physics with day to day life rather than teaching physics in isolation within the four walls of the class. The results of the study will inspire the teachers to use these types of intervention programme in their routine teaching. Such Interventions need to be made an integral part of classroom transaction process, wherein a teacher should strive to design, develop and implement this kind of intervention programme. It will in turn help to improve the quality of physics teaching – learning and students will be empowered and willing for pursuit of studies of physics at higher education level.

## 6.15 SUGGESTIONS FOR FURTHER STUDY

The present study studied the effectiveness of the developed intervention programme in the selected topics of physics from standard IX Science and Technology subject. The following are a few suggestions for further study.

- The present Intervention Programme was developed on topics of Physics from standard IX science and technology subject. A study can be taken up by taking the entire content area in Science and Technology subject of IX standard.
- A comparative study can be taken up to study the conceptual understanding on the physics concepts of standard IX students studying in the Gujarat State Board syllabus with the students in Central Board of Secondary Education (CBSE) and the students in Indian Certificate of Secondary Education (ICSE).
- An intervention programme can be developed and implemented by taking up the topics of chemistry and biology from the syllabus of standard IX Science and Technology subject.
- A longitudinal study can be conducted for a longer duration covering up the topics of physics from standard IX and X. The effectiveness of the study can be qualitatively studied in their understanding and applicability of the concepts in standard XI physics discipline.
- In the present study the stories and Images were used as a tool to study the effectiveness of the developed intervention programme. Similar interventions could be developed by integrating these tools as a part of the intervention programme and its effectiveness could be studied.

- A study could be done on preparation of Modules on the entire content area of standard IX science and technology. The effectiveness of the modules in terms of conceptual clarity and applicability of the students could be studied.
- Similar Intervention programme can be developed and implemented for other school subjects.
- The same study could also be conducted on students with different vernacular medium.
- A comparative study of the retention of the physics concepts in students taught through the intervention programme with that taught through conventional methods can be studied.
- Similar intervention programme in physics can be developed and implemented by taking up the selected concepts at higher secondary level.

## 6.16 CONCLUSION

Science is the study and knowledge of the natural world. The knowledge could be gained through experimentation, observation and deduction. Practical activity based learning serves the basis of the scientific method and thus the heart of science. Experiments and activities in science help the students realize that science is a description of the real world and not something abstract and dry. Activities engage students' interest by making the concepts concrete and students' thus imbibe the basic and essential skills that the future scientist need to develop. Physics is one of the most fundamental of all sciences, which deals with nature and various phenomenon related to day to day life. This makes physics quite interesting and enjoyable subject. Standard IX is an important preparatory platform where students learn concepts and laws of physics which develop their logical reasoning skills and promote their higher order learning skills. If the concepts and definitions are presented to students in a lucid and comprehensible manner students will be able to relate the classroom learning with the everyday life activities. The national curriculum framework (NCF 2005) also recommends that student's life at school must be linked to their life outside the school. Hence classroom teaching in physics at secondary level needs to stimulate the curiosity and inquisitiveness of the students to make them discoverers of knowledge rather than recipient of knowledge. If this transformation happens then in true sense the aims of teaching physics as a part of science at secondary level will be

accomplished. The students in such a stimulated environment will thus be able to visualize and relate the classroom learning with their world outside, they will ask questions and explore their knowledge to rationally arrive at solutions.