Chapter 2

Review of Related Literature

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REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

Review of Related Literature generates an actual image in front of the researcher about the work that has been carried out in past in the area of investigation to be taken up by the researcher. It facilitates the researcher by providing the latest account and discussion of the research findings in a particular area of research which in turn gives an insight to the methodology to be adopted for carrying out the present research. Reviewing what other researchers have done assists to understand one's own research work. Citing studies that show substantial agreement and those that seem to present conflicting conclusions help to sharpen and define understanding of the existing knowledge in the problem area. At times it leads to a more organized planning for the steps of research. The critical analysis based on the review of related literature in a particular area directs to a more demanding study through identification of the research gaps.

The present chapter constitute of review of research studies on science education in India as well as abroad. Inspite of the rather impressive educational research infrastructure existent in India and the considerably large quantum of research output in education as the various educational research surveys indicate, research efforts on science education undertaken in the country are far from adequate. The present chapter is an attempt to give a brief sketch of the researches carried out in the field of science education in India and abroad. The studies have been reviewed from the year 1958 to 2011. The sources used for reviewing related literature were Sixth Survey of Educational Research 1992-2003, Fifth Survey of Educational Research 1988-1992, Fourth Survey of Research in Education 1983-1988, Third Survey of Research in Education 1978-1983, Second Survey of Research in Education 1972-1978, A Survey of Research in Education, Dissertational Abstract International from the year 2002-2011, Indian Educational Abstract, ERIC Data Base.

Ganguli and Vashista (1991) listed a total of 101 studies during the period of first four surveys (1974 to 1988 fourteen years) in educational research. The Table 2.1 gives the quantitative distribution of studies survey wise and theme wise:

Table: 2.1

Quantitative Distribution of the Studies Survey Wise and Theme Wise

Area of Science Education	Survey I	Survey II	Survey III	Survey IV	Others	Total
Science Education	1	-	1	3	2	7
Environmental Education	-	-	5	3	-	8
Science Curriculum & TB Evaluation	1	4	4	18	2	29
Scientific Attitude and Aptitude	-	1	4	6	3	14
Creativity in Science	-	-	5	-	2	7
Construction of tests in Science	-	1	4	3	1	9
Correlates of Achievement in Science	2	-	6	13	5	26
Science Teaching	1	2	20	16	11	50
Total	**5**	**8**	**49**	**62**	**26**	**150***

Source: Fourth Survey of Educational Research

* The figures include researches in science education based on a multiple classification system. If unilateral classification is followed, there will be only 101 studies.

Vaidya (1997) reported a total of sixty one studies during the period covered by fifth survey (1988-1992). The area where the research was concentrated were Environmental Studies (nine), Science Curriculum Syllabus and textbook (seven), learning science and models of teaching (fifteen), teaching strategies (four), outcomes of science education (scientific temper, attitude, skills and interests) (eight), correlates of achievements in science (seven), educational technology (three). Frequency of researches conducted at various levels is presented in the table below:

Table: 2.2

Level Wise Distribution of the Studies

Levels of Research	Number of studies
M. Phil thesis	05
Doctor of Philosophy	34
Research papers	06
Independent projects/studies reports	16
Total	**61**

Source: Fifth Survey of Educational Research

In the sixth survey (1993-2000) total of 120 researches in the field of science education could be recorded. The numbers of studies in different area of science education are presented in the Table 2.3 on the succeeding page:

Table: 2.3
Area Wise Distributions of the Studies Covered in VI Survey

Area of Science Education	Number of Studies
Students' Attitude towards Science	13
Cognitive studies in science	39
Teaching material	18
Science teaching	23
Environmental factors	07
Achievement of students in science subjects	06
Creativity	03
Gender issues in science teaching	06
Miscellaneous	05
Total	**120**

Source: Sixth Survey of Educational Research

The resources covered by VI survey were Indian Educational Abstracts, International Journal of Science Education, Resonance Journal of Research in Science teaching and journal of education and social change.

The Table 2.4 shows different academic levels at which the studies were conducted.

Table: 2.4
Level Wise Distribution of the Studies

Levels of Research	Number of studies
M. Phil thesis	-
Doctor of Philosophy	14
Research papers	92
Independent projects/studies reports	4
NCERT/SCERT Publications	10
Total	**120**

Source: Sixth Survey of Educational Research

2.1 STUDIES CONDUCTED IN INDIA

A total of fifty six studies were reviewed conducted in India which are directly or indirectly related to the present study. The research studies under review were then classified into four broad categories namely studies related to status of science education (13), Studies on effectiveness of module/programme/strategy/method in comparison with the traditional method of teaching (24), studies on relative effectiveness of more than one method of instruction (6), studies on process skills, understanding of science concepts and acquisition of science concepts (13).

2.1.1 Studies related to status of science education

Veerappa (1958) conducted a study to examine the position of science education in India and assessed the developed trends on the basis of observation in the USA, UK

and the feasibility of introducing these trends in Indian institutions was also investigated. The researcher examined the trends in science education from primary through the degree course level. Researcher found that due to lack of proper laboratories, well equipped science teachers and effective teaching methods science education in India was not on a proper footing. Researcher found that teaching science through herbartian plans, the lecture demonstration method, and essay type questions in examinations were the common trends. Researcher has suggested that teaching science through the integrated or concept approach has scope in Indian situation.

Patole (1967) explored the existing weakness of teaching science in rural primary schools and attempted to devise methods for improvement in the existing situation. The researcher studied the teaching of science in rural primary schools through an extensive survey of 100 schools, 550 teachers, 550 elementary teacher trainees, 2000 pupils and 200 rural family heads and found that primary science teaching was in a miserable condition. Science was taught as a part of social science; the teachers were not qualified; in standard one, the teacher handled as many as seventy three students; only ten per cent of the schools possessed complete science equipment and none of the schools had a separate science room. The researcher found that activity based method of teaching the subject was superior to traditional one.

Muddu (1978) conducted a study entitled 'A study of prevalent status of instructional procedures in biology in high schools'. The objectives of the study were to evaluate the facilities provided to teachers, such as laboratories, audio visual aids, to find out the type of instruction adopted in teaching biology in accordance with the concepts envisaged in the syllabi, and to find out the extent to which the instructional procedures met the demands of biology syllabi in the process of reorganizing the scheme of secondary education. The study was designed as a quantitative empirical study. The sample consisted of teachers of 120 high schools teaching biology in class VIII, IX and X of the twin cities of Hyderabad and Secunderabad. The variables involved in the investigation were the present status of instructional procedures followed by teachers in biology teaching, the adequacy of classroom instruction to effect behavioural changes in students and the adequacy of the laboratories, reading materials, extracurricular activities in secondary schools. A questionnaire was prepared and administered to the selected teachers' and percentages were computed to process the data. Analysis of the data revealed fifty nine percent of the teachers stated they did not have adequate classrooms to teach biology, for eighty five percent of the

teachers instructional procedures followed by them were not according to the aims and objectives of biology teaching. This was due to non availability of adequate teaching aids, most teachers preferred only the lecture demonstration method, facilities of reference books on biology were not adequately available in school libraries, sixty six percent teachers were found to give priority to knowledge objectives in dealing with the topics in biology while application and interest aspects were accorded least preferences, in seventy percent schools there were no separate laboratories for biological sciences and in thirty percent schools there were improvised laboratory facilities for biological instruments. Only thirty five per cent students maintained good practical notebooks, teachers expressed their difficulty in conducting demonstrations and practical in biology because of the absence of adequately equipped laboratories, lack of leisure periods and overcrowded classrooms. Tools such as demonstration tables, bulletin board were in poor condition and were rarely used in biology instruction, availability of aids like filmstrips, projectors, and microscopes were very inadequate.

Rajput et al (1978) carried out a survey of science laboratories in the western region. The objective of the survey was to study the role of laboratories in the basic education of science as perceived by science teachers. It intended to analyse the main objectives of laboratory work in the opinion of science teachers, the extent to which the objectives were realized, the area of the laboratory , the number of experimental tables in the laboratory, the total time allotted for laboratory work in each subject, the problem faced in conducting the laboratory classes, the procedure adopted for making purchases for the laboratory, the total grant available for the laboratory, the additional grant needed for the laboratory and the assistance in the conduct of laboratory work by trained laboratory attendants and helpers. The study was conducted on ninety four science teachers of whom, thirty five were from Madhya Pradesh (M.P.), twenty seven from Gujarat, twenty two from Maharashtra and ten from Goa, who attended the correspondence cum contact programme at the Regional College of Education, Bhopal. A questionnaire was developed to collect data. The main findings of the survey were the objectives of the laboratory work outlined by the teachers were to verify facts taught in theory classes, to develop habit of doing independent work among the students, to create interest in science, to prepare students for higher studies, to develop skills of handling the apparatus/equipments, to observe and critically think about the results, to develop the habit of reasoning, to avoid memorizing the subject,

to create interest for research, to have clear understanding of the concepts of the respective subjects and to find limitations and drawbacks in the theory portion and to develop habit of doing systematic work. The major unwritten goal of laboratory work was however to prepare students for practical examination held externally. In M.P. sixty eight percent schools did not have any water supply in the laboratories, ninety one percent schools had no gas supply, twenty eight percent did not have electric fittings, seventy seven percent did not have any botanical garden and eighty nine percent schools did not have any workshop for undertaking minor repairs. In Maharashtra the percentage of schools having water supply was forty five, gas thirty two, electricity eighty two, botanical gardens twenty three and workshops forty five while corresponding percentages in Gujarat were forty four, eighteen, almost nil and twenty two respectively. As many as half the schools included in the sample won prizes and certificates for distinctive work in science. In M. P. fifteen percent schools did not have any experimental tables and in Gujarat and Maharashtra the corresponding percentages were eight and five respectively. Practical work not attempted in class IX in about fifty five percent schools in M. P. and for Maharashtra and Gujarat the corresponding figure was twenty per cent. The main problems faced by the teachers were lack of free time for them to arrange for practical work, laboratory assistant being busy elsewhere, the poor quality of equipment and chemicals supplied by firms offering lowest quotations and disciplinary problems of students.

Swaranamma (1978) conducted a study entitled 'An enquiry into the teaching of biology in the upper primary schools of Kerala'. The major objectives of the study were to identify topics to be deleted from the biology syllabus of standards VI and VII from the point of view of pupils, to identify activities which are found rather difficult by pupils of standards VI and VII, to identify the techniques of teaching adopted by the teachers teaching biology at the upper primary classes in the Trivandrum district, to identify the objectives aimed at by the teachers of biology of the upper primary stage and to find out the level of attainment of pupils of standard VII in biology. Twelve schools were selected on a stratified random basis for the study. Three classes each from standards VI and VII of the schools were observed by the investigator for collecting information about the method of teaching biology in those classes. An achievement test was administered to 500 pupils studying in standard VII of the selected schools towards the end of the academic year. A group of fifty experts in the

field of biology education was interviewed to collect their opinion about the teaching of biology in the primary classes. The major findings of the study were the topics identified as very difficult by the pupils of standard VI were the structure of cell, protozoa and classification of plants and animals. The lack of facilities in schools, lack of mastery of subject matter on the part of the teachers, lack of experimentation in the classroom, overdependence of teachers on the textbooks, overcrowding in classrooms, were listed by the pupils as some of the reasons for finding biology a difficult subject, the ability to analyse materials by simple techniques had not been developed among the pupils to a desired extent. Most teachers resorted to lecture demonstration method in teaching of biology in upper primary classes, the objectives aimed at by the teacher in teaching biology at upper primary level were oral and written expression in science, functional knowledge of facts and concepts, interest in scientific hobbies and interest in surroundings, the pupils found it difficult to draw diagram and to mark parts thereof, the achievement level of pupils was not quite satisfactory. Even in the case of simple skills, adequate mastery was not gained by the pupils, the teachers in general failed to develop scientific attitude among pupils of upper primary classes, there are high positive correlation between expected realizability and actual realization in regard to recognition and appreciation type objectives.

Sharma (1982) carried out a study entitled growth and development of science education in Bihar. The objectives of the study was to analyse the aims, curriculum, textbooks and techniques, materials and equipment, teacher training programmes, supervision and inspection and agencies of the improvement of science education in Bihar. Data were collected from ten primary schools, ten middle schools, ten secondary schools and the State Council for Educational Research and Training. Five science teacher educators of secondary education colleges and ten science teacher educators of primary teacher education colleges were interviewed with the help of a specially prepared interview schedule. At the time of the study the state government was making attempt to reorganize the educational structure on the 10+2+3 pattern. As a result curriculum, textbook, methods, teacher education programme and process of evaluation were revised. It was emphasized that while science education had largely expanded during the last decade the administrative bodies and methods had remained more or less unchanged. Thus there was need for modernizing and strengthening administration in the field of science education. There was also an urgent need for

exploring the possibilities of using modern approaches and devices which were being adopted in advanced countries for teaching science so as to maximize the performance of teachers and students.

Barman (1983) conducted study entitled the origin and development of modern science in pre-independence India. The main aim of the research was to study the origin and development of modern science in pre- independence period. The historical survey method was adopted. Some of the major conclusion were modern science grew in India as part of British occupation in the country. It was primarily an extension of British science and purported to serve the needs of colonial power. Modern science was introduced by the British in the nineteenth and twentieth century. But the growth of modern science in India, unlike that in Europe was more or less stunted. Let alone the British period even now the benefits of modern science have failed to reach the illiterate masses. Science still appeared as something alien and imposed from a foreign world. There were ideological and social constraints on the development of science in India.

Aziz (1984) conducted a study of science education programmes in the secondary schools of Bangladesh. The major objectives of the inquiry were to study the science education programmes mainly in terms of physical facilities, budget allocation, science teachers, procedure of teaching, evaluation, to study science education practices in some selected schools with better than usual results and varied physical facilities. The study was conducted in two phases. In the first phase survey was conducted on 500 secondary schools of Bangladesh and was followed by analysis of textbook. In the second phase ten schools were selected five with high and five with low facilities with better than usual results in science. The tools used were questionnaire, opinionnaire, an analysis sheet, interview schedules, an observation schedule and an attitude scale. The statistical techniques used were frequency, percentages, mean, median and product moment coefficient of correlation. The major findings of the study were all types of schools showed shortage of science teacher except government rural girls school, the average class size for science was much higher than the optimum (forty) in all types of schools except non government rural girls schools, the supervision system was weak, due to their non science background the majority of the heads of the schools were not very enterprising in respect of science education and majority of schools did not have reports of the existing curriculum and syllabus committees.

Dighal (1985) conducted study entitled improved method of teaching biological sciences in schools of Tripura and West Bengal. The objectives of the study were to explore how to make life science teaching lively, realistic and interesting to the students, to attempt scientifically the improvement of the present methods, to remove drudgery in the teaching of biological science, and to prepare a better method, which was an extraction from the existing methods, and more scientific and refined. The sample consisted of 500 students of class IX from five schools, four in Tripura and one in West Bengal. The tools used were two questionnaires. The design of the study was a survey and it was comparative in nature. The statistics used were graphical representations and product-moment correlation. The major findings of the study were there was a significant difference in the effectiveness of self activity method, life science club method, and audio-visual method, two or three methods when combined, formed an improved one on the basis of their similar nature. Combination of methods could be made according to the needs of a teacher, preparation of charts and models, collection of specimens through local excursions, organization of science exhibitions by the students, arrangement of film shows by the school, and orientation programmes for life science teachers brought better results.

Bajracharya (1986) conducted a study of science education in the secondary schools of Nepal with a view to evolving a functional model for improving the science education. The objectives of the study were to study the existing conditions of secondary science education in Nepal, to identify the problems of the existing secondary science education in Nepal, and to evolve a functional model for improving secondary science education in Nepal. The study was designed in three phases. The first phase was conducted with a view to knowing the conditions of the existing secondary science education programme. The second phase was concerned with formulation of a model. The third phase covered evaluation of developed models and formulation of a functional model. The findings of the study were the existing curricular objectives general as well as specific of the secondary science curriculum were unsystematic and insufficient. These objectives were not achieved as there was no practical work in the curriculum for the pupils, the existing curricular content of grades IX and X was theory-oriented and far from the pupils' daily lives, the techniques of teaching science which were practised in most of the schools were traditional. The only teaching aid used in the classroom was the blackboard and chalk. Some methods such as discovery and free choice activity were not known to many

teachers, the prescribed textbook contained inappropriate topics and diagrams. It reflected only reading skill and did not provide for practical skill and concept development, teaching time per day for one class was forty to forty five minutes. All science teachers had expressed that this was not enough for demonstration and other activities in the class. There was a need for more time per day, from the class teaching it was seen that teaching in most of the schools was very dry. There was no interaction between students and teachers which could help pupils to develop their interest in and attitude towards science learning.

Desai (1986) conducted a study entitled "A Critical Study of Science Teaching Programme at Middle School level in Karnataka state." The study intended to investigate into aspects of science teaching touching the sufficiency of teachers' qualifications, understanding of the course content, effect of teachers workload, practical work competence, methods and aids of teaching science, evaluation procedures, co-curricular activities, teacher reaction to the syllabus and its efficiency, sufficiency of laboratory and library facilities in-service training, effect of hand book, problems of syllabus implementation and suggestion for improving science teaching. Researcher has collected the opinions of the teachers, head masters and supervisors of the schools. Majority of them, more then (seventy six percent) opined that, schools did not have science clubs and laboratory, experiments performed by teachers were helpful in learning, there was no help from higher authorities to improve the facilities regarding science teaching, teachers were not trained to teach using laboratories effectively, scientific knowledge given in the textbooks was suitable in day-to-day life.

Shaikh (1992) conducted a study of teaching competency of secondary school science teachers of Dhaka city. Major objectives of the study were, to identify the competencies of science teachers in teaching of science, to identify the competent science teachers with the help of the rating scale constructed by the researcher, to study the competent science teachers in relation to the different attributes such as inherent capacity environmental facilities home and school and academic background. In the initial stage researcher has listed the teaching competencies in different categories and based on that constructed a rating scale to identify teachers in four categories. Major findings of the study were teachers' interest in their profession has the significant relationship with teaching competency, the teaching competency of science teachers substantially depends on the academic achievement of teachers, and

there is positive and significant relationship between professional training and teachers' competency.

Umashree (1999) conducted a study entitled science curriculum and its transaction: an exploratory study in secondary schools of Vadodara. The objectives of study were: to study the intentions of science curriculum at the secondary level under operation in schools at Vadodara, to study the curriculum transaction in science in the classroom situations in schools at Vadodara, to gather the teachers' opinion about the different aspects of science curriculum through classroom observation, questionnaire and interviews, to evaluate the congruency between the intended and transacted curriculum. The sample for actual classroom observation consisted of sixteen secondary schools in Vadodara city covering fifty teachers and 240 classroom sessions in science for eighth, ninth and tenth standards. The tools consisted of classroom observations, and semi-structured interviews schedule. The data analysis was done through content analysis. The findings of study were majority of teachers (eighty three) indicated that the objectives of teaching science were precise. Statements like cultivating social, moral, ethical, and aesthetic values are also not clear to them. Teacher created space for student's participation. The student response was more in terms of the number ready to answer the teacher's questions about the activity. Lecture method was the most convenient to use as large chunks of information could be conveyed in less amount of time. In large classroom it was not convenient to have discussions, lecture method was used in seventy percent of cases, lecture cum discussion method in ten percent and lecture cum activity teaching strategy in six percent of the cases non conventional approaches were observed in the remaining fourteen percent of the classes i.e. reading aloud, a brief explanation and silent reading, the instructional activities operating in the secondary schools at Vadodara in the classroom transaction are centered around the textbook. In none of the classes under observation, problem solving or inquiry based teaching had been noticed. Learners were not assigned any project work.

2.1.2 Studies on effectiveness of module/programme/strategy/method in comparison with the traditional method of teaching

Kamalakanthan (1968) conducted an experimental study of teaching physics by traditional and problem solving method. The study attempted to find out which of the two specific methods, traditional (conventional) or problem solving, provided for students' gain in and retention of knowledge and abilities. The sample consisted of

thirty two students of class X. A test on the unit on heat was prepared. After consultation with the subject teachers and experts in the field, items comprising the pretest, numbering sixty were finalized and were administered to all thirty two students at the same time, under exactly similar conditions. On the basis of the scores obtained the students were divided into two groups, comprising sixteen students in each group. One group was designated the control group while the other was designated experimental group. The control group was taught by the traditional method. The experimental group was taught by the problem solving method. The two groups were taught for a period of eight days, the unit on electricity and magnetism by the traditional and problem solving methods, respectively, at the rate of an hour for each group. The gain in or retention of knowledge and abilities was measured by noting the score points in the three group tests- base test, post test and delayed retest of identical nature given at the start, at the close and after the lapse of some time. Mean, standard deviation and t test were employed to analyse the data. The findings of the study were: the differences in respect of both growth and retention were not at all statistically significant, the difference in the percentage of growth between the control and the experimental groups together was not statistically significant (t=0.78), neither of the methods was significantly superior to the other, the difference in the percentage of retention was not statistically significant for both the groups, however from the point of view of objectives and the end products of science teaching, the problem solving method had positive favourable points as compared to the traditional method of teaching.

Muddu (1978) carried out study of the effectiveness of the use of motion pictures as aids in the teaching of biological sciences as compared to the usual methods. The objective of the study was films provide the elements for vicarious visual experiences, the use of effective and appropriate films results in more learning in less time and better retention of what is learned, films help in increasing factual knowledge, teaching skills, building attitudes, changing motivation, retention of knowledge, films are the most powerful, prolific, popular, pointed and polished of all the media that penetrate into the conceptualistic skeleton of the human mind. This was an experimental study comprising pretest post-test, experimental group and control group design. The sample of the study consisted of sixty students of class VIII of the age group twelve to fourteen years. The sample students (thirty students to each group) were assigned to the experimental and control group randomly. The mean

achievement gain of both groups was compared. The findings of the study were there was a significant improvement in the post-test performance of students in both the groups over the pretest, there was significant improvement in post- test performance over pretest performance in higher ranges of scores particularly in the case of the experimental group, There was a definite improvement in the pass percentage in case of the experimental group, the sound pictures helped to a great extent the above average students to comprehend the subject matter in biology, the use of films in teaching of biological sciences helped in more learning in lesser time and better retention of what was learnt, instructional films stimulated the scientific interest of the students, instructional films had immense potentialities in teaching and provided the elements for vicarious visual experiences which in turn made the lessons more vital and further made the language used in lessons more meaningful.

Adinarayan (1979) conducted study entitled 'a teaching strategy for developing appropriate skills required in students for conducting scientific investigations'. The objectives of the study were to construct learning packages suitable for average children in an ordinary classroom situation, to determine the advantages and effectiveness of learning through the packages by individual and group. The sample consisted of 100 students of standard VII divided into two equivalent groups. The major findings were at the demonstration phase the performance of the experimental group taught through learning packages was significantly better than control group taught through conventional method. The effectiveness of learning through the package did not differ from unit to unit when examined in terms of knowledge acquisition but differed significantly when examined in terms of knowledge and development of skills. At the laboratory stage it was found that in conducting scientific investigation the experimental group was higher as compared to control group.

Exemmal (1980) carried out a study on construction of certain models for teaching school botany using environmental and ethnic resources and testing the efficacy of such models. The major objectives of the study were to construct models for teaching botany using environmental and ethnic resources, to test the efficacy of the teaching models by comparing the achievement in botany of the treatment groups, to examine the effect of environmental approach on the attitude of pupils towards teaching and learning and to compare the effectiveness of environmental approach and formal approach in realizing certain select educational outcomes. The tools employed for the

study were teaching models in botany, a rating scale on teaching models, an achievement test in botany, a scale for measuring the attitude of pupils towards science teaching and learning, a judgment schedule for teachers and pupils and verbal and group test of intelligence, a science interest inventory and a general data sheet. Six topics from the botany syllabus of standard IX were selected for the construction of teaching models and tested experimentally using parallel group design by comparing the immediate post teaching and the extent of forgetting scores of the total sample and the subsample of the environmental approach group and the formal approach group. The effect of the environmental teaching and learning was studied by comparing the pre and post attitude scores of both the groups. The experimental study was limited to eight schools. The rating scale was administered to 300 teachers and 100 experts. The major findings of the study were the environmental approach was significantly superior to the formal approach in terms of immediate post teaching and delayed memory scores, significant difference existed between rural and urban students in their immediate post teaching achievement when the groups were exposed to the environmental teaching, pupils belonging to low SES groups were significantly superior to those belonging to high SES groups in their achievement when taught through environmental approach, pupils belonging to rural areas were significantly superior to urban students in their achievement when taught through environmental approach.

Sahajahan (1980) conducted an experimental study of teaching science in standard VI and VII through modules. The objectives were to design and develop modules for teaching science in standard VI and VII, to study the effectiveness of the modules as an instructional method with respect to the conventional method, to study the relationship between the students achievement through the modules and attitude of the students towards the module as well as academic motivation of the students and to compare the achievements through modules of high achievers and low achievers, boys and girls. Two classes from Dacca city in Bangladesh were selected for the study. Matched group design was used. The tools used for data collection were achievement test, module evaluation check list and attitude scales for studying students' attitude towards the module. The data were analysed using t test, chi square. The major findings of the investigation were the modular way of learning was more effective than the conventional method in the case of some modules while in the case of other modules it was found as effective as the conventional method. An overwhelming

majority of the students possessed a favorable attitude towards modular instruction and their attitude was stable throughout the period. The attitude towards instructional modules, academic motivation of the students and their reading comprehension were not related to one another. The achievement of the students through instructional modules seemed to have a low positive correlation with their attitude towards modular way of learning.

Basu (1981) studied effectiveness of multimedia programmed materials in the teaching of physics. The main purpose of the study was to make an appraisal of relative effectiveness of multimedia programmed instruction on criteria of immediate achievement and retention. Sample consisted of 400 learners of standard IX. There was a significant difference among the different strategy means on criterion on overall achievement.

Sivadasan (1981) undertook a project on developing science kits and self instructional software for audio tutorial system. The main objectives were to prepare materials for individualized instruction and to test them for efficiency as learning strategy. The topic light in physics prescribed for standard IX in schools of Kerala was selected for preparing audio lessons. By administering diagnostic tests on reflection, refraction and mirrors & lenses the concepts that were not understood were located. In all, scripts for audio lessons for fifteen concepts were prepared following guided discovery approach as a strategy. The major outcomes of the project were the audio tutorial system was an effective strategy for learning, in audio tutorial system the guided discovery approach was possible and effective, students could learn at their own pace, the teacher's role was minimized in audio tutorial.

Ravindranath (1982) developed a multimedia instructional strategy for teaching science (biology) at class VIII. The main objectives of the study were to develop a duly validated multimedia instructional strategy for teaching the course in biology at standard VIII, to study the relationship between students achievement and intelligence, to study the feasibility of the strategy in terms of cost and time and to develop alternative instructional components for teaching few concept and their relative effectiveness. The major findings were the instructional strategy was effective to the extent that seventy percent of the experimental group students obtained sixty percent and above in all the unit tests and comprehensive test, the experimental group students performed better than the control group on the comprehensive test and also on the annual examination conducted by the school authorities. Development of

scientific attitude was significantly higher for the experimental group, about seventy percent students expressed favourable reaction to all the components except towards team teaching, there was a positive and significant correlation between intelligence and achievement through the strategy, the strategy was quite feasible in terms of time as it required only ten additional periods spread over the whole year for completion of the course.

Sastry (1982) carried out a study of effectiveness of using educative toys in teaching science for primary standards. Two sections of standard V of a school in Karnataka were selected as sample. One section was taught through toys for an academic year. The data were gathered with the help of questionnaire, observation and school test marks. The findings were the experimental group did considerably better on the post test than the control group. However the number of pass outs in the two groups was same, probably because indirectly they had become aware of the treatment. Initially the use of toys in the experimental group consumed more time than the traditional method but in later stages teaching was quicker and easier.

Shinde (1982) conducted a study of non-formal science activities in secondary schools of Maharashtra state with special reference to their impact on scientific attitude and achievements in science. Major objective was to study the involvement of secondary science students in non-formal scientific activities. Sample comprised of 1600 secondary students of Maharashtra selected on a random basis from all the regions of the state. The tools used were a scale to measure involvement in scientific activities, scientific attitude scale, and a checklist. Descriptive statistics were used for data analysis. Major finding of the study were, involvement of the students in non-formal scientific activities differ from region to region. Students' academic achievement was not related to their participation in non-formal activities, it was found that field observation activity participation, and activity involvements of students were interrelated.

Vardhini (1983) developed a multimedia instructional strategy for teaching science (physics and chemistry) at secondary level and studied relationship between achievement using the strategy and intelligence and scientific attitude. Objective of the study was to develop a validated multimedia instructional strategy for teaching science in standard VIII and study the relationship between achievement using the strategy and intelligence and scientific attitude. It also intended to develop alternative instructional inputs and study their effectiveness. The inputs of the strategy were

introduction, lecture, discussion, guided discovery, audio-visual and biographical accounts, summaries, glossary, diagrams, exercises and assignments, criterion tests. The instruments used in the study were criterion test and comprehensive tests prepared by the investigator, scientific attitude scale prepared by the investigator, Madhooker Patel's Intelligence Test, a reaction scale prepared by the investigator and the examinations conducted by the school. Descriptive statistical techniques and the t-test were used for analysis and hypothesis testing. The strategy was found valid against the criterion of scientific attitude and almost all the units indicated average/high level of performance on total test, the strategy was found valid amongst criterion of scientific attitude in that significantly higher performance was noted for the group in the post test over the pre-test, Visual projections with teacher explanation and those with taped commentary were equally effective in terms of achievement, the strategy was found feasible when seen in terms of its reproducibility and the cost management by individual schools.

Adinarayan (1984) conducted study entitled science teaching in primary schools-a training programme. The major objectives of the study were to identify areas of competence in the teaching of elementary science, to evaluate the course in elementary science based on competency required in the teacher, to develop competence criteria for observational, investigatory and inquiry skills in pupils, to develop packages of instructional aids for teachers, and to determine the advantages and effectiveness of packages in terms of development of skills in pupils. Two units of the science syllabus of class IV and V, prescribed by the Tamil Nadu Government, were selected for teaching. Instructional packages were prepared for teaching through the experimental method as well as the customary method. A comparison of the effectiveness of the methods was made on the basis of criterion tests for knowledge, comprehension and observation, inquiry and investigatory skills. Some semi-urban and rural schools were selected from Athoor Panchayat Union of Madurai district using stratified random sampling. Forty-eight teachers were selected of whom twenty four comprised the experimental group and were oriented to the objectives of the programme, analysis of content, methods, and evaluation techniques, organization of classes, administration of tests, and the role of teachers during teaching, discussion, group work and demonstrations. The sample of 760 pupils was divided into equated groups in each school on the basis of age, mental ability and science background test. A criterion test was developed for assessing knowledge and comprehension,

observation, inquiry and investigatory skills. Reaction towards science activities was measured through a reaction scale prepared by the investigator. The major findings were there was a significant difference in the development of skills among students in the experimental group, Class IV students in nine schools and class V students in seven schools of the experimental group indicated an increase in knowledge and comprehension in comparison to the control group of students, as regards observational skills, class IV students in nine schools and class V students in eleven schools of the experimental group showed significant improvement, investigatory skills developed significantly in eleven schools in each of the classes of the experimental group, performance of the experimental group in inquiry skills of ten schools in class IV and seven schools in class V increased significantly, the experimental group greatly favored science activities.

Deopuria (1984) conducted a comparative study of teaching science through Environmental and Traditional Approach in schools of Madhya Pradesh. Researcher selected the students of V, VIII, IX and X grades and compared their achievement in science in these two different approaches regarding certain variables. Major findings of the study were, the environmental attitude inventory showed significant positive gains in attitude towards the environment for the entire experimental group of students, the environmental approach showed greater cognitive gain in knowledge, understanding and application of science concepts related to environmental education but it was not effective in the teaching factual recall type concepts at middle and secondary school levels. Researcher has suggested that, the teachers can use the environmental approach for improving the teaching learning processes by involving students in activities which create awareness in them.

Desai (1985) conducted an investigation into efficacy of different instructional media in the teaching of science to pupils of class VIII in relation to certain variable. The objectives of the study were to compare the achievement of pupils in science learning through different instructional media and the traditional way of teaching. The density, specific density of solid and the cell and its structure were selected for the preparation of the material for instructional media. The programmed learning material, slides and laboratory experiments were designed. The experiment was carried out in two schools of Anand city. Four equivalent groups were formed and each group had twenty five students. One group was taught through programmed learning, second through slides with discussion approach the third through experimental approach and fourth through

the traditional approach. The analysis of covariance was used to test the various hypotheses. The major findings of the study were the programmed learning approach was more effective than traditional way of teaching, the slide with discussion approach was more effective than the traditional, experimental approach was more effective than the traditional way of teaching science. The experimental approach was the most effective of all the approaches.

Brave (1986) conducted study on preparation field and testing of filmstrips for the teaching of Science a Course in Standard IX, and a study of their comparative effectiveness in the teaching-learning process as compared to the traditional practice. The objectives of the study were to prepare filmstrips on selected topics from the science course of standard IX, to teach the selected units of the science course of standard IX by using these filmstrips, to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of the achievement of the learner, to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of achievement of the learner considering sex and level of achievement as parameters, and to compare the effectiveness of teaching with the help of filmstrips in terms of achievement of the learner considering age, liking and availability of gadgets at home as parameters. The researcher developed ten filmstrips based on units of science from the syllabus. In order to study the effectiveness of the filmstrips, the researcher used untreated control group design with pretest post- test. The students for the experiment were chosen by the incidental sampling method. Pre-achievement and post-tests were administered to both the groups. The test scores were analysed by using analysis of variance. The major findings of the study were filmstrip was more effective than the traditional method for teaching the facts, principles and concepts in science, filmstrip and the traditional methods were equally effective for teaching abstract concepts in science, filmstrip was an effective teaching aid for all levels of learners, i.e. low, medium and high achievers, filmstrip was more effective for the learners between thirteen and sixteen years of age than for learners between seventeen and twenty one years of age, filmstrip was a more effective method of teaching science for both sexes, i.e. males and females.

Khalwania (1986) conducted a study on effectiveness of concept based science curriculum in developing cognitive structures and acquisition of process skills among high school students. Major objectives of the study were to develop the concept based

science curriculum in developing cognitive structures and acquisition of process skills among high school students, to study its efficiency as compared to a conventional curriculum to teach a few important science concepts, to study the effect of socio-economic status of the learner on the development of cognitive structure. Researcher has taken 160 samples for his study and divided them in two groups of eighty each. This was the randomized group pre-test/post-test design study and found that the concept based curriculum was more effective than the conventional curriculum in terms of acquisition of process skills. Students having high socio-economic status do not differ significantly with that of students with low socio economic status. Both the group did equal in process skills. Curriculum types do not interact significantly with levels of intelligence, levels of self-concepts and levels of socio-economic status.

Joshi (1987) conducted a study on "Evolvement of an instructional strategy for teaching elements of science to class IX students of M.P. state." The major objectives of the study were to develop an Instructional Strategy (IS) and study its effectiveness in terms of students' performance on criterion related tests and students reactions towards various components of the instructional strategy as a whole. The sample for the field study comprised 109 students studying in class IX. The design of the study was post-test only control group design. Intelligence was controlled statistically. Data were analysed through ANOVA followed by t-test, chi-square technique and percentiles. It was an experimental study. The major findings were, the developed strategy was found to be effective than the traditional teaching in terms of achievement of the students towards different components of the IS and the IS as a whole, the developed IS was found significantly superior to the traditional method in terms of the development of higher mental ability in science, adjusted with respect to their IQ.

Kalacherry (1987) conducted study entitled preparation and experimental tryout of Programmed Instructional Material in the syllabus of chemistry prescribed for class VIII in Maharashtra state. The major objectives of the study were to prepare programmed lessons on the prescribed topics of the chemistry syllabus, to try out the programmed instructional material, to find out the error rate and time factor, to finalize the programmed material for actual use and to determine effectiveness of the programmed instructional material. The sample was 200 students of class VIII of four schools in natural settings. The major findings of the study were about eighty three percent of the students were able to respond correctly to eighty three percent of the

frames, though ninety on ninety standards could not be reached the attainment was considered satisfactory. It was found that a few students who scored usually below fifty percent in the traditional system scored above eighty five percent through the use of Programmed material.

Rao (1988) carried out study entitled "Exploration in optimizing learning science in schools" where in an attempt was made to explore certain intervention material which enable in optimizing learning science in schools. The major objective of the study was to find out the extent to which children entering class VI have assimilated science content up to class V and to build up tangible hypotheses for an intervention programme to optimize science learning. The sample comprised of fifty elementary schools of Karnataka, Delhi and Bihar of the students studying in class VI. The major findings of the study were that the learning process scores and concept scores were low indicating to the science educator that comprehension was not achieved by giving children bits of information about scientific facts. Science achievement test indicated that very little was retained by children by rote memory.

Vaidya (1991) conducted a study on "Developing teaching learning strategies for enhancing students' achievement in science." Random sampling method was adopted to draw thirty three students who were studying in grade VI of the Mother school and the Mirambica School. Relevant data were collected using a questionnaire and the Modules .Study reveals that, it was possible to accelerate thought provoking problems in their hierarchical order but abstract piagetian schemes of thought were difficult to crack.

Kelkar (1998) conducted a Study of Effectiveness of Methodology "Exploring the Mind" for Teaching Science to the Students of Standard VIII. The objectives of the study were to find out different methodologies used for teaching science in different schools, to analyze the effectiveness of these methodologies in the learning of science subject, to find out concepts which are not clearly understood by the students by application of traditional methodologies, to analyze the reasons which inhibit understanding of the concepts, to evaluate the effectiveness of the methodology "Exploring the mind". The study was experimental. Pretest-posttest control group design was used. Sample consisted of 588 students studying in standard VIII selected randomly from seven schools out of twenty five private co-educational English medium schools from Pune Municipal Corporation. After pretest, the selected three topics: metals and non-metals, pressure and microbes were taught to experimental

group through "Exploring the Mind" methodology and to control group through traditional method by their teacher. Treatment was continued for two weeks with thirty five minutes school period. The investigator constructed questionnaire and achievement test. t-test was used for data analysis. The findings of the study were there is significant difference between the mean of experimental group and control group of all schools. The mean of experimental group is greater than mean of control group, when methodology "Exploring the Mind" is applied to boys & girls in developed or developing schools, the level of achievement is the same for all irrespective of sex factor or infrastructure of the school.

Remadevi (1998) conducted study entitled "Application of Information Processing Models in Teaching Chemistry at the Secondary and Higher Secondary Levels". The objectives of this study were to find out whether Information Processing Models (IPM) in the teaching of chemistry in comparison with the Conventional Method (CM) of teaching are effective or not in the Secondary and Higher Secondary Schools of Kerala. To prepare learning materials based on IPM in chemistry for the Secondary and Higher Secondary classes as revealed through the achievement of pupils, to compare IPM and CM in teaching chemistry for the secondary and higher secondary classes as revealed through the achievement of pupils. To compare the effectiveness of IPM and CM in teaching chemistry for the secondary and higher secondary classes as revealed through the achievement of pupils with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement, High Intelligence categories, low Intelligence Categories, categories of high achievers on scientific attitude scale and categories of low achievers from Secondary and Higher Secondary on scientific attitude scale, to compare the effectiveness of IPM and CM in developing scientific attitudinal change in pupils, to test whether there is any significant difference in the scientific attitude scores when IPM is used and when CM is used. The sample consisted of two divisions each of classes VIII, IX, X, XI and XII from N.S.S. G.H.S Changanacherry, Sacred Heart High School Changanacherry, Government Higher Secondary School Karappuzha and Government Higher Secondary School Kalavoor of Kottayam District. The one division was considered to be experimental group to be taught through IPM, while the second was through CM. The Lesson transcripts based on IPM and CM for each of the unit; Scientific Attitude Scale and Verbal Group test of Intelligence by N.P.Pillai et al. were used for collecting the data. The statistical techniques used for the analysis of the data were

ANCOVA followed by t-test. The major findings of the study were the pupils taught through the IPM were found to have significantly higher achievement than those taught through CM in the test as a whole. The pupils taught through IPM were found to have significantly higher achievement than those taught through CM with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement and application level of cognitive achievement at 0.01 level of significance. The pupils belong to high intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to low intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to the categories of high achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to the categories of low achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils taught through IPM were found to have significantly higher scores on scientific attitude scale than those taught through CM. There was significant difference in the scores on scientific attitude scale when CM was used.

Thaker (2001) Effectiveness of Mastery Learning Programme with reference to Science Teaching. The major objectives were to construct a 'Mastery Learning Programme' for the Science subject and to test the influence of Mastery Learning Programme with reference to 'General class teaching' on students' Science Learning Interest at the level of standard VIII and standard VI. For the study Experimental method was used as a research method and 'Quasi' (Pretest - Posttest) Experimental Design was implemented. The major findings were: Science Learning Interest was found higher among the students taught by the 'Mastery Learning Programme' than the students taught by the 'General class teaching' at the level of standard VIII and standard VI with reference to Science Teaching and Test Anxiety was found lower among the students taught by the 'Mastery Learning Programme' than the students taught by the 'General class teaching' at the level of standard VIII and standard VI with reference to Science Teaching.

Upadhyaya (2001) carried out a study on Inquiry Training Model (ITM): An investigation into the Effectiveness of ITM in teaching of science in secondary schools of Gujarat. The main objectives of the study were to study the effectiveness of

ITM in terms of students' higher mental ability in science, general creativity, scientific creativity, inductive reasoning ability, theory building capacity, achievement in science and reaction towards (ITM), to compare ITM with Traditional Method (TM) in terms of students', to study the influence of Treatment, Sex and their various interactions on students'. The sample comprised of 226 students (132 boys and ninety four girls) of class IX of different schools. The study was an Experimental in nature and it employed Pretest –Posttest Non equivalent Control Group Design. The tools used were Intelligence test, SES scale, Higher Mental Ability in Science test (HMA in Science), General Creativity test (GC), Science Creativity test (SC), Inductive Reasoning Ability test (IRA), Theory Building Capacity test (TBC), Achievement in Scientific Aptitude scale (SA), Science Attitude scale and Reaction Towards ITM scale. The major findings of the study were ITM was found to be more effective than TM in terms of GC, SC, IRA, TBC, achievement in Science and reaction towards ITM, but in case of HMA in Science ITM and TM were found to be equally effective ITM was found to be significantly superior to TM in terms of GC, SC, IRA, TBC, Achievement in Science, but ITM was found to be insignificant in terms of HMA in Science when the groups were matched statistically with respect to Intelligence, SES, scientific Aptitude and precious Achievement in Science.

2.1.3 Studies on relative effectiveness of more than one methods of instruction

Sharma (1978) conducted an experimental study of teaching natural sciences at primary level in central schools. The study was undertaken to ascertain the existing position of teaching natural sciences at the primary level in the central schools and to compare the effectiveness of different methods of teaching science at the primary school level. To ascertain the existing position of teaching natural sciences a survey was first undertaken. A questionnaire consisting of 106 items was prepared and sent to forty five teachers teaching natural sciences at the primary stage in the eleven central schools in the state of Punjab. Forty three persons returned the completed questionnaires. The second part of the study examined experimentally the relative effectiveness of self activity and guided activity. The experimental study was based on a sample of ninety students of class III. The students were divided into three matched groups of equal size. Three units were selected from the curriculum for teaching all the three groups. Before starting the experiment the students were tested. After the experiment lasting for six months, three post tests each of half hour duration specially prepared for the purpose were administered on the three groups. The pretest

and the post test data were subjected to analysis of covariance. The results were most of the teachers used traditional methods for teaching natural sciences, some tended to make natural sciences teaching at this level activity oriented, the teachers were not well equipped for teaching science, it was admitted by most of the teachers that activity should be the basis of teaching natural sciences at primary level. Guided activity was more effective than self activity in respect of concept formation, development of scientific attitude, acquisition of scientific knowledge, training in scientific skill and development of scientific attitude.

Jha (1979) conducted an experimental comparison of different methods of teaching high school biology. The study was designed to test experimentally the relative effectiveness of various methods of teaching biology. The experimental study was conducted on a sample of sixty students in class X in bankipur government girls high school, Patna. These students were regular students and they were selected out of a total number of 100 students in the class. Again the sixty students were divided into three groups randomly. The first group was control group, second demonstration group and third activity group. The investigator taught all the groups after administering pretest. Only one group was taught in a day. To avoid fatigue every group was taught in the first period. Post test was administered at the end of the experiment. Analysis of covariance was employed to analyse the results. The difference was further examined by paired t test. The main finding of the study was that there was strong evidence in favour of activity based approach in teaching school science in respect of acquisition of knowledge, application of the scientific knowledge and development of scientific skill.

Kumar (1981) carried out an experimental study of the relative effectiveness of three methods of instruction exposition method, programmed learning method and multimedia method in science education. The main objectives of the study were to find out the relative effectiveness of the three methods of instruction, to study the relative retention in learning through the three methods. A 3x2 factorial design was employed. The biology students of classes IX and X of two inter colleges formed the sample of the study. In all 180 students were divided into three groups of sixty each. The findings of the investigation were the multimedia was more effective than the programmed learning method or expository method, the programmed learning method was more effective than the expository method, retention in learning by the multimedia method was higher than the other two, retention in learning by the

programmed learning group and the expository group was equal, there was no interaction between three methods of instruction and the levels of intelligence.

Shah (1981) conducted a study entitled "An experimental investigation of the effects of selected teaching strategies on the development of creative thinking and achievement in science." Researcher has used four different strategies to identify the relative effectiveness. The used strategies were 1.Lecture 2.Lecture + discussion 3.Lecture + discussion + practical and 4. Lecture + discussion + practical + A.V.Aids. Samples have been selected purposively from one school of Petlad (Kheda district) keeping in mind certain criteria. From the selected school, researcher has made four equivalent groups of twenty four students from grade VIII. Four teachers from one purposively selected B.Ed. College and four units from standard VIII science textbook following Gujarat Secondary Education Board syllabus were selected for the study. The study reveals that the difference existed between the selected strategies for their effectiveness in developing creative thinking and achievement in science of eight class pupils significantly, the strategy four was more effective in developing creative thinking and its components as compared to all other strategies, the results highlighted the importance of having the maximum use of audio visual aids in the classroom teaching for enhancement of creative thinking, it was found that the Strategy four produced significantly high mean scores for achievement of·pupils then all other strategies. Strategies three and two produced significantly higher mean scores than one and no significant difference between strategy three and strategy two.

Hopper (1982) conducted an experimental study in the use of modular approach for teaching biology in standard XI. The main objectives were to design and develop instructional modules on selected unit in morphology, physiology and ecology, to find out relative effectiveness of three modular approaches involving self learning, peer group learning and peer group learning with teacher intervention. The sample consisted of students of standard XI of three higher secondary schools of Madras. The sample consisted of fifty three, fifty and fifty three students. The major findings of the study were all the three structured modular approached of teaching were effective in terms of mean gain in cognitive achievement. However, the self learning approach was more effective than the other two approaches. There was no relationship between intelligence and mean gain in achievement through modular instruction.

Vijay Kumari (2002) studied the effect of different methods of teaching Science on the achievement, basic science process skills and scientific attitude of pupils with

different achievement levels. The objectives of study were to study the effect of methods, levels of pre-acts and their interaction on achievement of knowledge, understanding and application objectives separately by taking intelligence as covariate, to compare variation in interaction patterns due to change in prior achievement levels of pupils with respect to Teacher Demonstration Method (TDM), Guided Discovery (GD) and Cooperative Learning Method (GDLM & CLM) of teaching science, to explain the relationship between significant differences in achievement, improvement of scientific attitude and Basic Science Process Skills (BSPS) in terms of differences in teaching process. The study was experimental in nature. 3X2 factorial design was used. The findings of study were: The TDM was significantly more effective than CLM with respect to the criterion of achievement scores on knowledge objective but CLM was as effective as GD and TD methods. TDM and CLM were equally effective with respect to knowledge objective, The TDM was significantly more effective than guided DM and CLM while TDM were equally effective on the understanding and application objective respectively, on total achievement in science the TDM was significantly more effective than both GDM and CLM, GDM was significantly more effective with respect to improvement of scores on science attitude of low achievers than high achievers.

2.1.4 Studies on process skills, understanding of science concepts and acquisition of science concepts

Mukhopadhyay (1983) conducted study entitled the relationship between comprehensibility of language used in the science textbook and science achievement in terms of learning objectives at primary level in the state of Rajasthan. The objectives of the study were to make a linguistic analysis of the textbook prescribed for the subject of science for grade III, to compare the linguistic content of the textbook with the spoken and written language of children of the particular grade, to measure the comprehensibility of language used in the science textbook, to measure the achievement of science in terms of knowledge and comprehension categories, to study the relationship between comprehensibility of language used in the textbook of science and the science achievement, The purposive sampling technique was used for selecting the sample. The final tests were administered on 400 children in sixteen primary schools in the district of Jaipur. The Comprehensibility of Language Test was developed and the Science Achievement Test was developed. Conclusions were drawn on the basis of results of chi-square test, product-moment correlation multiple

correlation and analysis of variance. The findings of the study were the science text book maintained some sort of consistency in using the number and types of parts of speech in relation to the spoken and written language of urban children, Urban children had a significantly better capacity in using parts of speech in their spoken and written language than rural children. Significant inconsistency existed regarding the use of sentences in their number and types between the written language of the children and the science textbook, urban children used significantly more sentences than rural children in their spoken and written language under the given situation and within the same context. There was no significant difference in comprehensibility of language between rural and urban children. There was a significant difference in science achievement in terms of learning objectives between rural and urban children. Urban children were superior to rural children with respect to science achievement.

Mehna (1986) conducted a study entitled "An investigation into some factors affecting academic achievement in science of standard IX students of greater Bombay" with a view to find out the predictors of achievements in science as a whole with relation to certain variables. Major research findings of the study were, six variables, viz. verbal intelligence, motivation for learning, general science, scientific knowledge and aptitude, numerical ability, liking for teachers of science and interest in medicine were significant predictors of achievement of class IX students in general science (R=0.5773). The research findings imply that pupils performance in science subject can be improved if teachers succeed in generating a feeling of liking for them among pupils, if teachers develop aptitude for science among children by providing scientific information, if teachers can motivate children to learn science subject. This needs adequate information and training for teachers of science in making science teaching interesting and in training them in the techniques of arousing pupils' motivation for learning science.

Menon (1986) conducted the Study of a System of Science Education in the Perspective of the Process of Science Inquiry. The major objectives of the study were to arrive at the norms of development of the process skill of scientific inquiry among students of secondary and higher secondary classes of the English medium schools which followed the curriculum system framed by the Gujarat Secondary and Higher Secondary Education Board, to study the overall impact of the curriculum system on the development of the process skills of scientific inquiry, to examine the science textbooks for standards VIII to XII for their suitability to develop skills of scientific

inquiry, and to examine the instruction and evaluation practices in relation to scientific inquiry. In order to develop the norms of development of the process skills of scientific inquiry, a multi-cross-sectional survey was conducted among a sample of 1448 students of standards VIII to XII belonging to the English medium schools in the city of Baroda. Data were collected with the help of the Test of the Process of Scientific Inquiry (TOPSI) which was constructed and validated by the investigator. The information generated through this survey was contrasted with that generated in the first survey. The obtained data were subjected to content analysis. A sample of forty four lessons given by science teachers of the English medium schools following the curricula under study were observed using the System of Observation of Cognitive Processes in Science Instruction (SOCOPSI). In addition to this a sample of practical lessons in the laboratory were also observed and 220 questions asked in the classroom tests were content analysed. The major findings of the study were the overall proficiency in the process skills steadily increased as students went up from standard to standard, there was a sudden transition in the overall development of process skills between standards X and XI (around the age of sixteen years), the skill of identifying variables had been developed by the time students reached standard VIII, the skill of interpreting observational data was developed around fifteen years of age, the skill of controlling the variables did not develop among the students in the system at seventeen years of age. Children of the schools affiliated to the CBSE were found better in the development of the process skills. Textbooks were the only curricular material through which the curriculum guidelines percolated up to practising schools and questions mostly tested the product aspects and not the process aspects.

Grewal (1988) developed, validated and tested the efficacy of self learning process based material for the development of some integrated processes in science. The integrated processes of science such as classifying, inferring, interpreting, predicting, hypothesis making and testing were taken up in the study. The sample of the study initially comprised 390 higher secondary students from four higher secondary schools of Bihar city which was reduced finally to seventy seven. It was found that the processes like prediction and interpretation were hardly found in teaching. More commonly used processes were inferring and classifying.

Mohapatra (1989) conducted a study on "Four dimensions of the teaching-learning of science: Characteristics and implications." Major objective of the study was to identify the role of the teacher and the learner in the teaching learning process in

developing and modifying scientific concepts. Whole study was based on the review of related literature regarding the origin of scientific concept formation in the minds of children and related it to the teaching-learning situations. The major finding of the study was the science teacher had an important role in helping the child to develop proper concepts about objects and events by utilizing children's personal experiences with the rational thinking process.

Phalachandra (1989) tried to critically examine the correlates in the acquisition of science concepts in school children. The major objectives were to construct and develop concept achievement tests to measure acquisition of science concepts, to explore the influence of the school environment and influence of SES in the acquisition of science concepts. The sample comprised 453 students selected from twelve elementary schools of Bangalore city. It was found that boys achieved better than girls in all four concept achievement test viz. physical and chemical change, composition of substances, plants growth and its process, animal parts and their functions. Out of ten independent variables considered, parental qualification alone accounted six to sixteen percent variation of performance in different concept achievement test.

Kar (1990) conducted a study on "Relationship between attitude and achievement in general science of class IX students of Cuttack city." Samples were drawn using stratified random sampling method. Sample of the study comprised 700 students studying in class IX from ten high schools of Cuttack city and also included seventy four teachers and some science experts, professors, educationists and head masters of the schools. The tools used to collect the data were questionnaire, interview scheduled, attitude scale and achievement test in science. Study reveals that there existed a positive relationship between attitude and achievement in science and the distribution of the scientific score was negatively skewed.

Kansakar (1996) did an Investigation into the understanding of Science and Scientific Temper: A Cross Cultural Study. The objectives of study were to develop and validate instrument on understanding of science, to develop and validate instrument on scientific temper, to study the effect of type of school, class, level, geographical location, sex on level of understanding of science among students. The sample comprised of 1315 Students of classes X & XI from India and Nepal. The sample was selected through Random Sampling Technique. The major finding of

study was students from Nepal were found to possess significantly higher understanding of science and higher level of scientific temper than students of India.

Rathore (1999) studied scholastic achievement of children studying at primary level in Environmental Study (Science) with special reference to MLLs and development of remedial teaching strategies. Total sample of 1000 (500 FPS and 500 NFS) children were drawn from the city of Khandwa and the adjoining areas of Khandwa district covering rural and urban areas for the purpose of comparison of scholastic achievement of children. Data were analyzed with the help of percentage and t-test. The major findings of study were majority of instructors agreed that adequate training for instructors in content and pedagogy was quite helpful in improving the level of learning of the children. It was also supported by the substantial increase in the achievement of NFE children from pretest to posttest which was as a result of teaching by specially trained instructors and supervisors through remedial teaching strategies.

Kwatra (2000) studied Understanding of Science Process in Relation to Scientific Creativity, Intelligence and Problem Solving Ability of Middle School Students of Bhopal Division. The objectives of study were to construct and standardize a test of science processes for the students of eighth grade, to evaluate the influence of scientific creativity on the understanding of science process among students of high, middle and low groups for each science process separately, to evaluate an influence of intelligence on the understanding of science process among students of high, middle and low groups for each science process separately, to evaluate the influence of problem solving ability on the understanding of science process among students of high, middle and low groups for each science process separately. The sample comprised of 631 students selected through Stratified Random Sampling Method. The major finding of study was the higher group is superior to the lower and middle groups in understanding of science processes.

Sharma (2000) studied interrelationship between quantitative achievement and conceptual understanding of the students learning science. The methodology adopted was descriptive method of comparative quantitative correlation type. The sample containing 1967 pupils from IX standard were selected using stratified random sampling technique. A significant relationship was found between the quantitative achievement and conceptual understanding of secondary school subjects.

Ramkumar (2003) developed an instructional programme in environmental studies for acquisition of process skills by IV standard pupils. It was found that instructional programme facilitated the teacher in evolving teaching strategies for enhancing teacher-pupils interaction during the acquisition of process skills, pupils proposed hypothesis based on certain concepts to explain the occurrence of events during the context of scientific investigation, pupils showed willingness to change idea in the light of evidence. It was also found that during the context of scientific investigation pupils expressed autonomy in learning through interactions with teacher and fellow peers.

Amin (2011) developed and implemented an activity based science teaching programme for pre service student teachers. The researcher studied effectiveness of the developed programmes in terms of content knowledge of science and technology, experimental ability, understanding about nature of science, teaching qualities enhanced as science teachers, understanding about science teaching. The sample consisted of 40 student teachers. The design used was single group pretest post test. The researcher found that the developed activity based science teaching programme was effective in terms of developing clarity on science concepts, enhancing experimental skills, enhancing the understanding about the nature of science, improving qualities as a teacher in general and science teacher in particular. It was also found that there was enhancement in understanding of the benefits of scientific activities among the pre service student teachers.

2.2 SUMMARY OF STUDIES CONDUCTED IN INDIA

A total of fifty six studies were reviewed related to science education and science teaching carried out in different parts of India. Of these fifty six studies reviewed thirteen studies were on the status of science education. Veerappa (1958), for the first time, conducted a study to examine the position of science education in India and assessed the developing trends on the basis of observations in the USA, UK. The feasibility of introducing these trends in Indian institutions was also investigated. It was found that teaching science through Herbartian plans, the lecture demonstration method, and essay type questions in the examinations were the then trends. Researcher suggested that teaching science through integrated or concept approach has scope in Indian situation. Chanana (1967) attempted to historically analyse the development of high school curriculum in Punjab during twentieth century. Patole (1967) explored existing weakness of teaching science in rural primary school and

attempted to devise improvement in the existing situation. Researcher found activity based method of teaching science superior to the traditional one. Pillai (1968) investigated into the changes in content and scope of primary and secondary school curriculum in Kerala from 1934 to 1964 with a view to ascertaining how far these have been helpful in intensifying of standards. The study resorted to mostly document analysis and opinion survey. Shukla (1975) studied the curriculum development at elementary school stage in Gujarat as it has evolved from 1940 to 1970. The researcher also analysed the primary school curriculum introduced in Gujarat in 1968 and developed a scheme of curriculum construction. Muddu (1978) studied status of instructional procedures in biology in high schools in twin city of Hyderabad and secundrabad using questionnaire. Swaranamma (1978) observed classroom of standard VI and VII in Kerala, Trivandrum district and found that most of the teachers resorted to lecture demonstration method in teaching biology in upper primary classes. Sharma (1982) studied growth and development of science education in Bihar and opined urgent need of using modern approaches to maximize performance of students as well as teachers. Dighal (1985) using questionnaire found that two or more methods combined together for teaching improved the results. Desai (1986) studied science teaching at middle school in Karnataka while Umashree (1999) carried out observation of 240 classroom observations of sixteen schools in Vadodara and found that seventy percent teachers used lecture method for teaching. Ganguly (1986) gave a detailed account of integrated science development in India. Hijam (1986), through a district-based survey, showed how carelessly science curriculum was implemented. Barman (1983) studied the origin and development of modern science in pre-independent India while Sharma (1984) studied school science from 1947 to 1977. The researchers reported that the journey has been from teaching science through the integrated or concept approach, shifting from general science to separate subjects and inclusion of environmental study programmes. These studies have highlighted the various shifts in the development of modern science curricula. Aziz (1984) and Bajracharya (1986) studied science education in secondary schools in Bangladesh and Nepal respectively. Exemmal (1980) carried out study to test the efficacy of the environmental approach. In this study, six topics from the botany syllabus of standard IX were selected for construction of teaching models and tested for their efficacy through a parallel group design. The results were very encouraging. The environmental approach was found to be superior to the formal approach besides this

a unique finding was that students of rural and low SES groups were significantly better in profiting from such instruction than their counterparts in urban areas and coming from high SES. Deopuria (1984) also compared the traditional and environmental approach and had very similar results. He found that primary students did better through the environmental approach than did middle and secondary level students. Also, both male and female teachers showed a positive attitude towards the environmental approach to learning. Bhargava (1979) discussed in detail the special character of science in the first ten years of school, i.e. in general education. Efforts were made to partially reflect such thinking in the NCERT-produced Upper Primary Science Curriculum which was developed between 1975 and 1978. But, in general, the science curriculum remained loaded with facts, figures and data and was oriented only towards the examination. The development and transaction of curriculum at national and state levels continued to remain divorced from the objectives spelt out for science education. In the years 1981-83, the Department of Education in Science and Mathematics undertook in-depth studies and the actual state of science education were identified. On the basis of these findings, in the year 1985, the Department of Education in Science and Mathematics of the NCERT presented an approach paper in a National Seminar which was organized to discuss the New National Policy on Education. The new policy was finalized, in 1986. Immediately after the coming of the New Education Policy, the NCERT set up a Working Group. This working group discussed the findings of the Department of Education in Science and Mathematics of the NCERT. In its report, the working group spelt out the dimensions of scientific literacy, which need to be attained through the study of science in general education. On the basis of the report of this working group, a national-level meeting of voluntary agencies was held in 1986 to spell out the steps to be taken for improving science education. In the light of recommendations of this meeting, the Department of Education, Ministry of Human Resource Development, introduced two projects: (1) a Scheme for Improvement of Science Education in Schools, and (2) a Scheme of Environmental Orientation to School Education. Bhargava, between 1981 and 1987 gave thought-provoking views on the existing state of science teaching, the requirements for higher studies in science, objectives of science in general education and the constraints on effective implementation. Except for Adinarayan (1984) who judged the status of science teaching in primary schools of Tamil Nadu through a parallel group design of experimental method, the rest of the studies in this sub-area

relied on questionnaires and interview schedule or, in one case an achievement test (Swarnamma, 1978) besides the opinionnaire. Patole (1967) studied the teaching of science in rural primary schools through an extensive survey of 100 schools, 550 teachers, 550 elementary teacher trainees, 2000 pupils and 200 rural family heads and found that primary science teaching was in a miserable condition. Science was taught as a part of social science; the teachers were not qualified; in standard 1, the teacher handled as many as seventy three students; only ten per cent of the schools possessed complete science equipment and none of the schools had a separate science room. Swarnamma (1978) and Sachdeva (1986) found almost similar conditions for the teaching of biology and physics respectively. Muddu (1978) conducted a survey of 120 high schools and then Desai (1986) surveyed 460 higher primary (middle) schools of Karnataka and found that, though the textbooks were attractive and suitable, and experiments were conducted by teachers, the climate for motivation for teaching and learning of science was not there. Rajput et al. (1978), Muddu (1978) and Singhal (1983) found similar findings. The findings were highly disappointing. Teaching science without practical or laboratories, teachers teaching subjects other than the one they are qualified and appointed for, weak expression and strictly confining themselves to the syllabus were some of the problems exposed through these studies.

There are number of studies conducted on effectiveness of instructional material or module. Many of the studies found the effectiveness of the material/module/strategy with traditional method of teaching while few found the relative effectiveness of the methods of teaching. Researcher reviewed in all twenty four studies conducted on effectiveness of instructional material or module or programme to that of traditional method of teaching. Kamalakanthan (1968), though, found that the problem-solving method was in no way more effective than the traditional method, he, could not desist from commenting in the end that the problem-solving method still had a favourable position and the spirit of the scientific method could not prevail. In other studies, Sharma (1978) found guided activity, Muddu (1978) found motion pictures, Exemmal (1980) found an environmental approach, Sahajahan (1980) found modular way, Basu (1981) found multimedia programmed material, Sivadasan (1981) found science kits and the tutorial system- audio tutorial system, Hopper (1982) found the modular approach, Sastry (1982) found educative toys, Anjaria (1984) found a systems approach, Deopuria (1984) found an environmental approach, Adinarayan (1984)

found instructional packages, Ganguli (1985) found an open-ended approach of doing practicals, Dwivedi (1983), Desai (1986) and Kalacherry (1987) found programmed learning, Brave (1986) and Soner (1975) found filmstrips, Sushma (1987) found the concept attainment model in biology and Pillai (1987) found Gagne's conditions, Remadevi (1998) found information processing models of learning more effective than the traditional methods of teaching science. Basu (1981), Ravindranath (1982), Vardhini (1983), Desai (1985), Joshi (1987) and Lambhate (1987) developed instructional strategies for science teaching and found them effective. Adinarayan (1979) found the learning package effective in terms of development of skills while Khalwania (1986) found concept based curriculum more effective than conventional curriculum in terms of acquisition of skills. Kelkar (1998) found exploring the minds methodology effective while Thaker (2001) found mastery learning programme effective. Upadhyaya (2001) found the effectiveness of Inquiry Training Model effective in secondary schools of Gujarat.

Researcher also reviewed six studies in which the relative effectiveness of different methods of teaching was found. Kumar (1981) and Sharma (1982), however, compared three methods not with traditional methods but among themselves and found the multi-media method the most effective; programmed learning as the second most effective; and the expository method as the least effective of the three; and also that a branching programme was more effective than a linear programme. Hopper (1982) found the relative effectiveness of three modular approaches to teach biology to standard XI students of Madras and found self learning approach more effective. Dighal (1985) found the effectiveness of self activity method, life science club method, and audio-visual method and discovered that two or three methods when combined gave better results than any one in isolation. Sharma (1978) found relative effectiveness of self activity and guided activity on class III students and found guided activity more effective than self discovery. Jha (1979) was in strong favour of activity based approach in teaching school science. Vijaykumari (2002) found relative effectiveness of Teacher Demonstration Method (TDM), Guided Discovery Method (GDM) and Cooperative Learning Method (CLM) and found that on total achievement in science the TDM was significantly more effective than both GDM and CLM. Mukhopadhyay (1983) measured the achievement of science in terms of knowledge and comprehension categories at class III of Rajasthan and found Urban children superior to rural children with respect to science achievement. Menon (1986)

found that textbooks were the only curricular material through which the curriculum guidelines percolated up to practising schools in Vadodara city. Kansakar (1996) did an investigation into the understanding of Science and Scientific Temper: A Cross Cultural Study between India and Nepal and found that the students of Nepal had better understanding on science concepts as compared to the Indian students. Sharma (2000) found significant interrelationship between quantitative achievement and conceptual understanding of the students learning science at secondary level. Ramkumar (2003) found that instructional programme facilitated the teacher in evolving teaching strategies for enhancing teacher-pupils interaction during the acquisition of process skills and Amin (2011) found the activity based science teaching programme effective in enhancing content knowledge of science and technology, experimental ability, understanding about nature of science, teaching qualities, understanding about science teaching among preservice science teachers.

2.3 STUDIES CONDUCTED ABROAD

Jones (2002) conducted a study on "The effects of video-based and activity-based instruction on high school students' knowledge, attitudes, and behavioral intentions related to seat belt use. The purpose of the study was to determine the effect of video-based science instruction and accompanying activity-based instruction on the knowledge, attitudes and behavioral intentions of high school students' use of seat belt. Another purpose was to determine order effects and interaction between the two treatments used in the study: video-based instruction and hands on activity-based instruction. The study used a pretest-posttest-posttest treatment design. Data were conducted on 194 students in high school introductory biology and chemistry classes in Gainesville, Florida. The treatment group students participated in at least 500 minutes of instructional time divided among five seasons over ten instructional days. Treatment 'A' was defined as participation in video-based instruction. Treatment 'B' was defined as the participation in four hands on science activities regarding crash related physics concepts. The results of the analysis revealed that, combining both the treatment produced significantly higher mean score than either treatment used individually. Participating in video-based instruction initially produced significant changes in students' attitudes but these changes were not maintained after students completed the activity-based instruction.

Kenyon (2003) found the effect of explicit, inquiry instruction on freshman college science majors' understanding of the nature of science. The participants included

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seventy four freshman college science majors, forty students in the experimental group and twenty four students in the control group. The research design of this study used a pretest post test instrument, the views of nature of science questionnaire form c and an essay paper at the end of the course. The results were analysed using ANCOVA. The results indicated that the understanding of the nature of science of freshman college science majors who have participated in explicit inquiry instruction is statistically greater than the understanding of the nature of science of freshman college science majors who have participated in traditional instruction.

University of Louisiana at Monroe (2004) conducted a study entitled "the effect of an integrated, activity-based science curriculum on students' achievement, science process skills and attitude towards science" the study was intended to investigate the effect of the IASC (Integrated Activity-based Science Curriculum). It compared the performance of seventh grade students using an IASC to that of seventh grade students using a traditional science curriculum. The ANCOVA results for the ITBS science scores showed that the seventh graders involved in the IS activity-based science program had a significantly higher adjusted posttest mean compare to students in a traditional science programme. Similarly positive results have found with ninth grade students involved in an activity based science programme.

Rosso (2004) conducted a study on "Observation as an experience: using the aesthetics John Dewey as a model for inquiry." This research developed an activity designed to promote vital experience. For the purpose of this study, combination of visual skills and reflective thinking is described as an aesthetic experience, which represents a heterogeneous approach to science, and an effective learning experience. Dewey' concept of experience was used to define the connection between experience and education. If education is experience based then the integrity of a student's experience is vital. The goal of the research was to determine the extent to which participating in The Questioning Project (TQP), a science activity developed by the researcher, promoted an aesthetic experience for the participants. The data analysis in aggregate measured a strong perceptual experience, a moderate intellectual experience, a minimal emotional experience, and an insufficient communication experience. Individual analysis showed that ten of the thirteen participants had an aesthetics experience through their participation in the questioning project. The Questioning Project, to a modest extent, improved observational skills, promoted intellectual growth, and provided a unique creative experience.

Brookins (2005) conducted study of assessing the effects of teacher generated and student generated motivational and learning strategies on the retention of a science curriculum with at risk male high school students exposed to a scientific curriculum. The sample of eighty five male students showed remarkable improvement from pretest retention tests on multiple choice assessments. Of special importance was the performance of low achieving students who showed an ability to match the performance of higher achieving students on all aspects of the test. The most improvement resulted from the combination of student generated motivational and learning strategies.

Jerald (2005) carried out a study to examine the relationship between teachers' perception and implementation of inquiry instruction as well as their student' perception and performance on inquiry activities. A group of six science teacher and their students form grades seven to twelve were the subjects for this study. A mixed methodology was utilized. Teachers exhibit a continuum of inquiry ranging from teachers who incorporate a little inquiry into their instruction to those who have integrated it as a part of their normal instruction. Teachers beliefs about student learning and inquiry instructions are related to their pedagogical practices. Another finding is that students have little say into what occurs instructionally in the classroom. Lastly there exists an incongruity between the data from the surveys and the interview data which further illustrates the usefulness of a mixed methodological approach.

Ray (2005) conducted study entitled investigating the effectiveness of implementing the science writing heuristic on student performance in general chemistry class. The Science Writing Heuristic (SWH) consists of two components, writing to learn strategies and conducting the laboratory session in a student centered, guided inquiry fashion. The writing component replaced the standard laboratory report with a series of questions that guided the students' critical thinking along the line of scientific investigation. The writing process helped students to construct knowledge. The student's scores improved when the teacher properly implemented to SWH, when students responded positively to the implementation of SWH and when there was a proper classroom dynamic created between the teacher and the student.

Sidawi (2005) conducted study on teaching science to eighth graders by engaging them in a design and technology activity. The study was conducted at an urban school in Philadelphia where a sample of thirty six eighth grade students were taught a

science unit, Energy, Machines and Motion and engaged in a technology design task that was chosen based on the scientific content of the unit. Two approaches of relating teaching science to technological design were given technology lessons in addition to their science lessons. The study showed that the students' learning of science was impacted by their weak prerequisite knowledge in science, their poor verbal and written communication skills and their style as dependent learners. Also the study showed the great impact of the school and classroom culture on the participation of the students in a design and technology activity.

Diane (2006) studied students' development of astronomy concepts across time. The goals of the study were to describe childrens' knowledge of apparent celestial motion across elementary and middle school, explore early elementary students' ability to learn these topics through planetarium instruction. First, third and eighth grade students (N=60) were interviewed. Analysis suggests that students are not making the type of observation of the sky necessary to learn apparent celestial motion.

Gail (2006) conducted study entitled 'Understanding understanding in secondary school science: An interpretive study. This study investigated the teaching of secondary school science with an emphasis on promoting student understanding. Semi-structured interviews were conducted with thirteen secondary school science teachers, grounded theory methodology was used to interpret the data. Fourteen components of teaching for understanding were found.

Jerine (2006) conducted study on developing explanations: student reasoning about science concepts during Claims-Evidence Inquiry lessons. The study examined the nature of student reasoning about science concepts during Claims-Evidence Inquiry lessons. It was found that Claims-Evidence Inquiry model provides a framework for encouraging student reasoning about science concepts by providing supports for the development of explanations.

Jung (2006) studied student perception and conceptual development as represented by student mental models of atomic structure. The study explored student perception of atomic structure and how students learn about this concept by analyzing student mental models of atomic structure. The study reveals that conceptual development can be achieved either by elevating mental models toward higher levels of understanding or developing a single mental model.

Colburn (2008) studied curricular impact on elementary students images of science: informational science text read and scientific inquiry. Understanding what influences

images elementary students create about science has been researched for thirty years. This research sought to understand how the way science is presented in school influences images elementary students hold about science. The study's question included: what images of science do second and fourth grade students portray through dialogue as they experience read aloud of informational science texts?, what images of science do second and fourth grade students portray through dialogue as they experience science through inquiry with manipulative objects? And what life world resources influence students' images of science? Drawing upon symbolic interaction within a socio cultural framework this qualitative study began during summer 2005 and continued till fall 2007. Primary data included transcript of students' dialogue during sessions, interviews, observations, field notes, demographic data and assessment data. The researcher conducted three sessions with each of the four groups of three students, spending thirty minutes observing, listening and taping students in each session. All twelve students were interviewed after each of the three sessions. Emergent themes suggests that despite students using process skills in both sessions, the informational book reading sessions were ritualized such that the students viewed the experience as a reading exercise only and not being a scientist. In contrast, students in the manipulative sessions saw themselves as acting like or being scientists. Last, students in both sessions, drew upon funds of knowledge accrued from socio cultural influences and home experiences to construct personal and joint meaning of the objects in the sessions. Students within the manipulative sessions however drew upon funds of knowledge that guided and shaped the construction of curriculum, while students in the book session drew upon their funds of knowledge to explain and make sense of the curriculum prescribed for them.

Hick (2008) carried out a study entitled "who can do it? New science teachers with reform based teaching strategies". Despite consistent calls for pedagogical changes in the teaching of science since the 1989 publication of science for all Americans (Rutherford and Ahlgren), most science teachers still teach in traditional ways. This is most surprisingly true even for new science teacher whose teacher education programs have emphasized reform based instruction. In order to understand how reform based teaching can be done by new teachers, researcher examined the experiences and beliefs of three reform based new secondary science teachers. Research in teacher socialization has shown that three separate phases "life history" teacher education, and in service shape a teachers beliefs and practices, findings from

this collective case study suggest that the ability to teach in reform based ways in the "rough and tumble of practice" crawfold, 2007 may be linked to a teacher having a "belief in" reform rather than a "knowledge of" reform. Findings from this study also provides evidence of teachers relying on their own learning style as a guide for teaching drawing on authentic inquiry experiences in their instruction and their conceptions of the nature of science and benefiting from having digital forms of lessons available, regardless of level of reform, to use as a springboard to crafting reform based lessons. A possible link is explored between a disposition towards stewardship of the environment and disposition towards stewardship of children as learners. Recommendations are made for research, teacher education and teacher in service with regards to selection, preparation and in service support of new science teachers who can teach in reform based ways.

Kesner (2008) assessed the affects of hands-on, inquiry-based instruction on student science achievement in a high-stakes testing environment. A quasi experimental design employing quantitative and qualitative methods was used. Results indicated a general improvement of students meeting mastery of fifth grade science state assessment when kits were implemented.

Pillsbury (2008) carried out study entitled "Diagramming the Never Ending Story: student generated diagrammatic stories integrate and retain science concepts improving science literacy". This research examined an instructional strategy called diagramming the never ending story. A method called diagramming was taught to sixth grade students via an outdoor science inquiry ecology nit. Students generated diagrams of the new ecology concepts they encountered creating explanatory captions for their newly drawn diagrams while connecting them in a memorable story. The diagramming process culminates in twenty to thirty meter long murals called never ending story. Months of science instructions are constructed as pictorial scrolls, making sense of all new science concepts they encounter. This method was taught at a north Carolina public charter school, childrens community school to measure efficacy in helping students comprehend scientific concepts and retain them thereby increasing scientific literacy. There were four demographically similar classes of twenty students each. Two treatment classes randomly chosen from the four classes generated their never ending stories after being taught the diagramming method. A Solomon four group designs was employed two classes one control and one treatment were administered pre and post test two classes received post tests only. The tests were

comprised of multiple choice, fill in and extended response (open ended) sections. Multiple choice and fill in test data were not statistically significant whereas extended response test data confirm that treatment classes made statistically significant gains.

Newton (2008) carried a study entitled 'the status of inquiry based science instruction in a midsized school district for grade three to eight as mandated state wide testing begins: a survey of teacher practices'. The purpose of this study was to investigate the extent to which science educators (151) in grades three to eight in a midsized school district in North Carolina report practicing inquiry based instruction in their classroom and to identify factors related to the use of inquiry. Data were gathered using a researcher designed on line survey. Analyses indicate that teachers in this district use inquiry moderately, implementing the lower process skills more than the higher process skills. It was found that class size, the number of professional development sessions the teacher attended that covered inquiry and the percentage of economically disadvantaged students in the school were statistically significant in their impact on the level of inquiry use reported by the teacher.

Lodge (2008) studied chemistry to music: discovering how music based teaching affects academic achievement and student motivation in an eighth grade science class. Teachers should have access to new and innovative tools in order to engage and motivate their students in the classroom. This is especially important as many students view school as an antiquated and dull environment which they must seemingly suffer through the advance. School need not be a dreaded environment. The use of music as a tool for learning can be employed by any teacher to create an engaging and exciting atmosphere where students actively participate and learn to value their classroom experience. Through this study a product and process was developed that is now available for any eighth grade science teacher interested in using music to enhance their content. In this study eighth grade students (N=forty one) in a public school classroom actively interacted with modern songs created to enhance the teaching of chemistry. Data were collected and analyzed in order to determine the effects that the music treatment had on students achievement and motivation, compared to a control group (n=thirty five). Current literature provides a foundation for the benefits for music as a tool for teaching content was noticeably absent. This study identified a new area of research called music based teaching which results in increase in motivation for eighth grade students learning chemistry. The unintended results of the

study are additionally significant as the teacher conducting the treatment experienced new found enthusiasm passion and excitement for her profession.

Rae (2008) studied the effects of constructivist classroom contextual factors in a life science laboratory and a traditional science classroom on elementary students motivation and learning strategies. The purpose of the study was to determine if there is a differential effect of two different learning environments determined by constructivist classroom contextual factors on elementary science students motivation and learning strategies. Teaching and learning practices in the regular classroom versus teaching and learning practices in a life laboratory were investigated for this study. The constructivist teaching inventory was used to examine classroom contextual factors. The Motivated Strategies for Learning Questionnaire (MSLQ) was used to examine student motivation and learning strategies. A wilcozon nonparametric test determined that constructivist teaching practices were found to occur more often in the life laboratory than in the regular classroom. Although constructivist teaching practices increased at each observation time in both the regular classroom and in the life laboratory, a Friedman test determined that they were not statistically significant increases. Also, some individual teachers had lower constructivist teaching practices in the life laboratory than in regular classroom, indicating that classroom contextual factors can be teacher controlled and thus not simply location dependent. Paired sample t tests determined that student motivation and learning strategies were higher in the life laboratory than in the regular classroom overall as well as at each survey time except for learning strategies at post one which although the life laboratory score was higher did not show a statistically significant difference. A 2x4 between three within repeated measure ANOVA determined that student MSLQ motivation and learning strategy scores in the life laboratory varied statistically significantly by teacher. To triangulate data individual interviews of teachers, selected convenience sample of students were conducted at the end of the semester and focused on patterns of instruction and student learning. Theme analysis revealed students regard the life laboratory as an asset to their science study enabling advanced knowledge acquisition, however students do appreciate and value working in the learning environment that the regular classroom provides, especially when it comes to learning new science concepts.

Berg (2010) carried a study entitled teaching for conceptual change: an intervention to promote deeper understanding of diffusion and osmosis. This study was a quasi

experimental study using non equivalent groups design to compare the treatment and control groups. Sixty six community college students comprised the sample. The treatment group received the intervention in the form of an instructional module about the difference between scientific processes that are emergent versus processes that are non emergent. Data were analysed using t tests and analysis of variance. No statistically significant differences were found between the two groups based on the learning measures. The short length of this intervention may not provide adequate time for students to successfully acquire the schema to understand conceptually difficult science concepts such as diffusion and osmosis.

Barrows (2010) found the effects of teaching a science topic in the regents living environment course in a mini lesson instructional environment. The findings of the study reveal that the students had considerable difficulty with several areas relating to basic biology about the cell structure and functions and did not have an integrated conceptual understanding of the topic. The study revealed that mini lesson instruction appeared to impact student learning and understanding as to how to communicate and share ideas.

Han (2010) carried out an embodied instructional process including haptic augmented educational simulation as an instructional tool to provide perceptual experiences as well as further instruction to activate those previous experiences with perceptual simulation. 220 fifth grade students participated in the study from three elementary schools in Bronx, New York. The result indicated that haptic augmented simulation was needed to construct a fully loaded multimodal representation that could be activated when the instruction with less sensory modalities was being given.

Lee (2010) carried out a study entitled young childrens conception of science and scientists. A cross sectional design was used to study how students idea differ over the first three years of elementary school. A modified version of draw a scientist test and a semi structured interview were administered to beginning kindergarten, first and second grade students. Quantitative and qualitative analyses of data revealed that young children come to school with vast amount of knowledge about the natural world. However a significant shift in childrens conceptions of science and scientists occurs over the first ten years of school. The data suggest that young childrens image of science and scientists are broad and still malleable at the beginning of elementary school, but they slowly begin to narrow and become stereotypic by the end of the first grade.

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Mancuso (2010) conducted study entitled using discrepant events in science demonstrations to promote student engagement in scientific investigations. The study explored how science demonstrations can be designed to promote students engagement in scientific investigations. The researcher used discrepant events as a part of demonstrations and used predict observe and explain. The data sources included audiotapes of each lesson, students written work, teachers written reflections, observes field notes and semi structured interview with students. The findings of the study show that discrepant event demonstrations can generate student interest and inform worthwhile student led science investigation without requiring great time commitment.

Powell (2010) found the effect of instructional methodology on high school students natural sciences standardized tests scores. The quasi experimental quantitative study comprised of two stages. First stage used a survey to identify teaching methods of a convenience sample of fifty seven teacher participants and determined level of inquiry used in instruction to place participants into instructional groups. Stage two used ANCOVA. Results demonstrated a statistically significant gain in test scores when taught using inquiry based instruction.

2.4 SUMMARY OF STUDIES CONDUCTED ABROAD

Jones (2002) found that participating in video-based instruction initially produced significant changes in students' attitudes but these changes were not maintained after students completed the activity-based instruction and opined that combining both the treatment produced significantly higher mean score than either treatment used individually. Kenyon (2003) indicated that the understanding of the nature of science of freshman college science majors who have participated in explicit inquiry instruction is statically greater than the understanding of the nature of science of freshman college science majors who have participated in traditional instruction. Department of Education, university of Louisiana at Monroe (2004) found activity based teaching effective than the traditional teaching for seventh class. Brookins (2005) found combination of student generated motivational and learning strategies most effective. Jerald (2005) found that students have little say into what occurs instructionally in the classroom. Ray (2005) found Science Writing Heuristic effective in improving students score. Diane (2006) found that students are not making the type of observation of the sky necessary to learn apparent celestial motion. Gail (2006) conducted study entitled 'Understanding understanding in secondary school science

using grounded theory. Jerine (2006) found that Claims-Evidence Inquiry model provides a framework for encouraging student reasoning about science concepts by providing supports for the development of explanations. A study by Jung (2006) reveals that conceptual development can be achieved either by elevating mental models toward higher levels of understanding or developing a single mental model. Colburn (2008) studied curricular impact on elementary students images of science and opined the way science is presented in school influences images elementary students hold about science. The study of Kesner (2008) indicated a general improvement of students meeting mastery of fifth grade science state assessment when kits were implemented. Hick (2008) found that most science teachers still teach in traditional ways and found it true even for new science teacher whose teacher education programs have emphasized reform based instruction. Pillsbury (2008) examined an instructional strategy called diagramming the never ending story to measure efficacy in helping students comprehend scientific concepts and retain them thereby increasing scientific literacy. Newton (2008) indicate that teachers use inquiry moderately, implementing the lower process skills more than the higher process skills. Lodge (2008) identified a new area of research called music based teaching which results in increase in motivation for eighth grade students learning chemistry. Rae (2008) studied the effects of constructivist classroom contextual factors in a life science laboratory and a traditional science classroom on elementary students motivation and learning strategies. The findings reveal that although constructivist teaching practices increased at each observation time in both the regular classroom and in the life laboratory, a Friedman test determined that they were not statistically significant increases. Berg (2010) did not find instructional module effective. Barrows (2010) found mini lesson instruction to impact student learning and understanding as to how to communicate and share ideas. Lee (2010) found that young childrens image of science and scientists are broad and still malleable at the beginning of elementary school, but they slowly begin to narrow and become stereotypic by the end of the first grade. Mancuso (2010) found that discrepant event demonstrations can generate student interest. Powell (2010) found the instructional methodology on high school students' natural sciences effective as compared to the traditional method of teaching.

2.5 IMPLICATION FOR THE PRESENT STUDY

The brief summary of the review of the related literature makes it clear that various researches have been carried out in the area of science teaching, correlates of science achievement and other variables. Review of related literature reveals that majority of the researches focused basically on two types of studies. Status studies pertaining to state of teaching science subject at different levels, while the other type is related to experimental verification of the effectiveness of different methods of teaching or developed strategies of teaching. Though the numbers of studies focusing on instructional strategies were many in number the focus of these studies was to find the effectiveness of developed strategy with the traditional method of teaching in general achievement not specifically on comprehension.

Study conducted by Grewal (1988) was on four higher secondary school of Bihar city and found that processes like prediction and interpretation were hardly found in teaching. Rao (1988) collected data from the students studying in class of fifty elementary schools of Karnataka, Delhi and Bihar. The major findings of the study were that the learning process scores and concept scores were low indicating to the science educator that comprehension was not achieved by giving children bits of information about scientific facts. Science achievement test indicated that very little was retained by children by rote memory. Vaidya (1991) developed teaching learning strategies for enhancing students' achievement in science. Researcher used random sampling method to draw thirty three students who were studying in grade VI of the Mother school and the Mirambica School. Relevant data were collected using a questionnaire and the Modules and found that it was possible to accelerate thought provoking problems in their hierarchical order but abstract piagetian schemes of thought were difficult to crack. Kansakar (1996) found that students of Nepal (X & XI) possessed significantly higher understanding of science and higher level of scientific temper than students of India. Sharma (2000) found significant relationship between quantitative achievement and conceptual understanding of secondary school students. Most of the studies which the researcher could come across have focused on secondary level and higher secondary level that too confined to see the relationship between different variables, rather than probing into the understanding and development of skills in the student. It is observed from the findings of the studies reviewed that use of inquiry-based, practical based teaching can enhance the learning in students. Review reveals that the understanding of science was less in the students

and the students were lacking in the process skills. Investigator could come across very few studies focusing the understanding of students. Out of those which are focusing on understanding either the study was focusing secondary level or higher secondary level. Though the study conducted by Sahajahan (1980) is found to be similar to the present study being experimental study at class VI and VII taking chapters on physics but the study was carried out in Dacca city of Bangladesh and was carried out in the year 1980. According to Ganguli and Vashista (1991) "There is a great need for research into the dimensions of the instructional and nurturing effects of various types of instructional practices in science education today. Competence in teaching stems from the capacity to reach out to differing children and to create a rich and multi-dimensional environment for them. This demands that we widen our experience with different models of instruction in various classroom settings". Ganguli and Vashista (1991) further adds that there is a dire need to examine a varied range of substitute patterns of instruction upon which teachers may model their behaviour. Each design of instruction prepared, with learning theory underlying its procedures, should be validated to see that each child becomes a productive and effective learner. Science education researchers also should be interested to know exactly what changes in knowledge occur as a result of instruction. Science education research, thus, should direct its attention to improving the existing procedures of science instruction and to establishing new and verified procedures for teaching science. Therefore the researcher felt a dire need to take up a study at upper primary level and to develop an instructional strategy and determine its effectiveness for comprehension in science and even taking up only one school that is taking up small sample so that the understanding of students can be determined taking up varied sources and various tools.

The following chapter provides detailed description of the plan and procedure employed in the present study.