CHAPTER 2

REVIEW OF LITERATURE

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2.0 INTRODUCTION

Research is a co-operative effort carried out by individuals to enrich the existing fund of knowledge. Review of research work carried out by others in the form of articles, abstracts, books, research reports, dissertations and electronic media helps the researcher to view their own study in the mirror of reality. Reviews provide the framework of the studies already conducted in the area of the study, which in turn helps the investigator to visualize the research work in all possible dimensions. It provides the understanding and insights necessary to develop a logical framework for the present study. The design, methodology and procedure adapted in the research work of other researchers endow with a feel of what the actual field could be. Reviews help to bring clarity in an individuals' research work. Critical review of the related literature facilitates a researcher to avoid duplication and indicate ones' contribution to the fund of existing knowledge. It facilitates to discover the research trend in the area of study. An analytic study of the research trend facilitates to locate the research gaps.

The review of related literature forms an important aspect of any research work. It helps in avoiding the ambiguity and brings clarity in stating the objectives and structuring the methodology. The tools and analysis techniques used in the reviewed research work assist the researcher to choose the appropriate statistical computation for the present study. Hence, review of related literature provides inputs to strengthen the present study and endow with a strong rationale for the present study.

2.1 Review of studies conducted in India

A total of seventy two studies conducted in India were reviewed for the present study. The reviewed studies were further categorized under the four categories – six studies on status of science education, thirty-six studies on effectiveness of different transactional modes in science teaching, eleven studies on learning experience, scientific inquiry and conceptual understanding of science concepts while nineteen studies were on teaching and learning of physics.

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2.1.1 Studies on Status of Science Education

Aziz (1984) studied the science education programme in the secondary schools of Bangladesh. The major objectives of the inquiry were to study the science curriculum programme mainly in terms of physical facilities, budget allocation, science teachers, procedures of teaching, evaluation etc, to study science education practices in some selected schools with better than usual results and varied physical facilities. The investigation was conducted in two phases. In the first phase, a survey was conducted in 500 secondary schools of Bangladesh and it was followed by an analysis of existing science textbooks. In the second phase, ten schools were selected five with high and five with low facilities with better than usual results in science. The data were collected with the help of a questionnaire, an analysis sheet, interview schedule, observation schedule and an attitude scale. Data from 500 schools were collected by mailing the questionnaire whereas data from ten schools in the second phase were collected through visits by the investigator. The main statistical techniques used for analysing the obtained data were frequency occurrence, percentages, mean, medium and product moment co efficient of correlation. The major findings of the study were that all types of schools showed, in general, shortage of science teachers except non government rural girl's schools. The average class size for science was much higher than the optimum in all types of schools, except the non government rural girls' school. The supervision system of schools was very weak and the schools were not being supervised regularly by the inspectors. Due to their non science background, the majority of the heads of the schools were not very enterprising in respect to science education, and the majority of the schools did not have report of the existing curriculum and syllabus.

Desai (1986) conducted a critical study on the science teaching programme at middle school level in Karnataka state. The objective of the study was to investigate into the aspects of science teaching, teachers' qualifications, understanding of the course content, the effect of workload on teachers, practical work competence, teaching aids and methods of teaching science, evaluation procedure, co curricular activities, teacher reaction to the syllabus and its efficiency, laboratory and library facilities, in service training facilities, effect of hand book, problems of syllabus implementation and suggestion for improving science teaching. The survey was carried out on 460 higher primary schools of Karnataka. The findings from the opinion of the teachers,

head master and supervisors reveal that 63% of schools did not have science clubs and laboratory in school. The experiments performed by teachers were helpful to the students in learning science. Teachers were not trained to teach using laboratories effectively.

Suthar (1998) made a comparative study of science education of Uttar Buniyadi Schools and Secondary Schools of Gujarat. The objectives of the study were: To compare the objectives, curriculum, textbooks and teaching methods of science education of Uttar Buniyadi schools and secondary schools. The survey method was employed for the study. The sample was selected by employing Stratified Random Sampling Technique. The sample comprised of 125 Uttar Buniyadi schools (letter basic school) and 125 secondary schools of Gujarat state. 500 pupils (250 from each types of the school) of standards VII, IX and X were selected. Five Uttar Buniyadi schools were selected for personal visit. The tools used were interview and questionnaires for principals, science teachers and pupils. The data were analyzed by Chi-Square test. The major findings were: The objectives, curriculum and textbooks of science in both the types of schools were same. So far as the teaching methods were concerned, lecture method was used by majority of science teachers of secondary schools. About half the teachers of the Uttar Buniyadi schools used lecture method. A few teachers in both the types of schools used programmed or heuristic method. Many teachers used question-answer method and pictures and examples. The teachers felt the syllabus of Standard IX Science was difficult where as the syllabus of Standard X was comparatively easy. The laboratories were not well equipped in both types of schools.

Umasree (1999) conducted a study on the Science Curriculum and its Transaction in the Secondary Schools of Baroda. The objectives of the study were to study the intentions of science curriculum at the secondary level in schools of Vadodara city, to study the curriculum transaction in science in the classroom situation in schools of Vadodara city, to gather the teacher's opinion about the different aspects of science curriculum through classroom observations, questionnaire and interviews, to evaluate the congruency between the intended and transacted curriculum. The research questions of the study were: What are the values, images and practices associated with the teaching and learning of the present science curriculum as can be constructed from the intended objective of teaching science? Do the teachers possess a shared

understanding of the intended objective of teaching science? Do the objectives as framed, serve their functional purpose of guiding the section of curricular material and transacting the same? Do the teachers find the objectives significant with reference to the disciplinary nature of science and learners' requirement of science as a part of general education at the secondary level? Do the teachers posses understanding of the thrust on scientific literacy? The tools for data collection consisted of classroom observation, semi structured interview, questionnaire and Question papers. The sample of the study for actual classroom observation were 16 secondary schools in Vadodara city, covering 50 teachers and 240 classroom sessions in science for VIII, IX and X standards were selected. The teachers were interviewed. Question papers were collected from various schools. The technique used for data analysis was frequency and percentage. The findings of the study reveal that 83% of teachers indicated that the objectives of teaching science were precise. During the follow up interview on the questionnaire, the teachers (17%) said that one of the objectives is to develop scientific temper but how it was to be developed had not been stated in the textbook. The teachers conveyed that the objectives of science curriculum which they consider significant are that the students should acquire scientific knowledge and giving the learner an adequate exposure to practical work. Findings related to the classroom observation state that lecture method was used in 70% of cases, lecture cum discussion method in 10% and lecture cum activity teaching strategy in 6% of the cases. Non conventional approaches were observed in the remaining 14 % of the classes (read aloud, reading aloud and translating into vernacular language, reading aloud with brief explanation thereafter). Majority of the cases, "teachers talk" predominates, a major part of the period without students' participation. In 6 % of the cases, the teacher talk to student talk was fairly evenly distributed, and the students actively participated in the development of the lesson. Teaching aids through available, were not generally utilized in the classroom. In general the students were attentive to the proceedings in the classroom but remain as passive listeners throughout. Few questions asked by the teachers if any was to serve the purpose of introducing or ending a lesson. None of the classes under observation, used problem solving or inquiry based teaching strategy. The language style used by the teacher was the same in which the textbook has been written. It is not simplified and conveyed to the students.

Pienyu (2004) studied the status and development of science education at high and higher secondary school level in Nagaland. The objectives of the study were: To trace the historical development of science education at school level in Nagaland, to find the relevancy of curriculum in science education at school level, to know the methodology of teaching and innovations in science education, to study the examination system and evaluation system of science teaching, to study the problems related to the promotion of science education in the State. The study was descriptive and survey type. A sample 120 schools out of 364 schools in Nagaland and 215 science teachers constituted the samples for the study. The data were collected with the help of questionnaire- cum- interview schedule and by referring office records from the governmental agencies. The study concluded the following findings: More than half the total number of the Science Teachers (57%) were of the opinion that objectives of Science Education were not clear to them and accordingly less achievement of objectives of science education. 54.5% of the science teachers were found satisfied with the present science curriculum and reported that it was relevant to the present society. Whereas the remaining 45.5% found it bookish, theoretical in nature, and therefore felt the need to update by framing a dynamic, practical based science curriculum at par with the national curriculum. There was no science laboratory and infrastructure facility for science practical available in 71% of the schools in the State. Many of the Science Teachers were found ignorant about innovations in science and lack in professional training and orientation courses meant for them.

Bhuyan (2005) conducted a study on general science curriculum and its teaching in the secondary schools of Assam. The objectives were to study the appraisal of the general science curriculum in terms of objectives and content, to make an analysis of the general science textbook of class IX and X prescribed by the state, to appraise the instructional strategies adopted by the teachers in teaching general science, to appraise students' achievement in general science in terms of knowledge, understanding and application, to provide ways and means for improvement of teaching general science on the basis of the study. Sample of 40 schools were selected through simple random sampling technique. A total of 224 students of class IX, 215 students of class X and 300 science teachers formed the sample for the study. A questionnaire and an observation schedule were used as tools for the study. The K.K. Deka's standardized

academic achievement test for students of class IX was used. The data were analysed using the properties of normal probability curve, chi square test, product moment co-efficient of correlation, significance of difference in percentage, significance of difference in means and efforts were made for qualitative analysis. It was found that in stating objectives of general science curriculum less stress is given in development of experimental skills, affective domain and values. 40% of the teachers felt that there are some anomalies in organisation of the curriculum. For overall improvement of the curriculum suggestions were: inclusion of compulsory project and fieldwork, topics related to removal of superstitions, special activities for slow learners. 56.67% of the teachers felt that the textbook of class IX fail to meet the objectives like development of scientific attitude and inculcation of qualities like curiosity, open mindedness etc. 42% of the teachers found that in the textbook of class IX some concepts have been presented without using inductive approach. There was no significant difference between achievement in knowledge and application aspects on achievement test of class IX. There was a significant difference between achievement in knowledge and understanding aspects on the achievement test of class IX.

2.1.2 Studies on effectiveness of different transactional modes in science teaching

Adinarayan (1979) conducted a study entitled "A Teaching Strategy for Developing Appropriate Skills Required in Students for conducting Scientific Investigations". The objectives of the study were: To develop competence criteria for the skills in operational terms, to construct learning packages suitable for average children in ordinary classroom situation, to extend the study of the classroom situation and evaluate the outcomes, to obtain evidence concerning the ability of standard VII children to conduct simple scientific investigations in a laboratory situation. The sample consisted of students of standard VII in the age group 11 +. One hundred students selected for this purpose were divided into two equivalent groups. The subject chosen for the study was science. The study was conducted in six phases (i) pilot study (ii) preparation of learning packages (iii) demonstration phase (v) extension phase and (vii) laboratory phase. Data were collected with the help of the individual record sheets, revision data sheet and error sheets prepared to modify the learning packages, criterion tests for four units prepared to measure the development of skills, performance test and checklist prepared to measure student's competence in conducting investigations and reaction and attitude scales. The data obtained was

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analysed using t-test. The findings state that, at the demonstration phase the performance of the experimental group taught through the learning packages was significantly better than that of the control group taught by the conventional method. The effectiveness of the developed 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. The development of laboratory skills was not uniform. The performance of the students who were exposed to the learning packages and given good training was significantly higher than that of the students who were not exposed to the learning packages but given conventional treatment. The teachers and students had favourable attitudes towards the learning packages.

Sahajahan (1980) conducted a study "An experimental study of Teaching Science in Standard VI and VII through Modules". The objectives of the study were (i) to design and develop modules for science in standard VI and VII. (ii) to study the effectiveness of the modules as instructional method with respect to the conventional method. (iii) to study the relationship between the students achievement through the modules and attitude of the students towards the modules as well as academic motivation of the students and to compare the achievements through modules of high achievers and low achievers. The sample consisted of two classes from Decca city in Bangladesh. Matched group design was used. The tools used were achievement test, module evaluation check list and attitude scales for studying students' attitude towards the modules. Data was analysed through t test and chi square. The major finding of the study was that 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 to as effective as the conventional method. An overwhelming majority of students had a favourable attitude towards the modular instruction and their attitude was stable throughout the period of experimentation. 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 attitudes towards modular way of learning.

Hopper (1982) conducted an experimental study in the use of modular approach for teaching biology in standard XI. The main objectives of the study were to design and

develop instructional modules on selected units for higher secondary classes, to find out the relative effectiveness of three modular approaches involving self learning, peer group learning with teacher intervention with reference to the cognitive objectives, to compare the cumulative achievements of students through three different sequences of content presentation, to study the effect of different modular courses of study on the academic motivation of students. The sample consisted of one hundred fifty six students in three different higher secondary schools of Madras. No deliberate attempt was made to match the three experimental groups; however pre test measures revealed that the three groups were equivalent in terms of means and standard deviations. Experiment was conducted adopting the rotation group design. Duration of experiment was twelve weeks involving learner engaged time of sixty six periods. Tools used in the study included Cognitive Entry Behaviour Test and Module Reaction scale developed by the investigator. Data were analysed using statistical technique of product moment correlation, t test, analysis of variance and chi – square. The findings state that all the three structured modular approaches of teaching were effective in terms of mean gain in cognitive achievement. However the self learning approach was more effective than the other two modular approaches. All the three modular approaches were effective for the attainment of mean gain in higher mental abilities with respect to morphology and ecology. Interaction between method and context was significant influencing total achievement as well as achievement with respect to knowledge and comprehension objectives, but the interaction effect was not statistically significant with respect to attainment of higher mental abilities. The modular approach of teaching biology led to a significant increase in the academic motivation and retention in students. In the total sample, 84 % pupils favoured the modular approach involving peer group learning with the teacher available at the time of need.

Deopuria (1984) compared teaching of science through environmental approach with that of the traditional approach in schools of Madhya Pradesh. The objective of the study was to compare the cognitive achievement of the students in science of class V, VIII, IX and X grades when taught through environmental approach vs. traditional approach. The findings of the study revealed that 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 on the teaching of 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.

Ramesh (1984) developed an objective based science curriculum and studied its efficacy in the acquisition of process skills among high school science students. The objectives of the study were to find out whether the objective based curriculum was superior to the conventional curriculum of science at high school level in terms of achievement, whether intelligence contributed to achievement, whether the objective based curriculum was superior to the conventional curriculum of science at high school level in terms of acquisition of process skills among high school science students, whether personality traits contributed to the acquisition of process skills among high school science students, whether there was a significant effect of the interaction between types of curriculum and intelligence on achievement and acquisition of process skills, whether the effect of the interaction between intelligence and personality traits was significant, whether there was significant interaction between the learner's characteristics and the design of the curriculum. A sample of 150 students was selected randomly from class IX students from government and privately run schools of Ropar district. A 2x3x2 factorial design was followed in the study. Independent variables in the study were curriculum design, intelligence and personality. The criterion variables were achievement in science (knowledge, comprehension and application) and acquisition of process skills. The students were exposed to an objective based curriculum developed in three topics of chemistry, keeping in view educational objectives expressed in behavioural terms. The tools used in the study were achievement test, test to measure the process skills of observing, measuring objects and phenomena, seeing a problem and seeking ways to solve it, formulating hypothesis, solving the problem by giving reasons, interpreting the data and drawing conclusions. The test retest reliability of this test was 0.70 and it had content validity, the Jalota group test and General Mental ability, the Nymann – Kohlstedt Diagnostic test for personality. The findings of the study were that the objective based curriculum and conventional curriculum in chemistry were equally effective so far as achievement in science was concerned. However, students taught

through the objective based curriculum scored significantly higher on comprehension than those taught through the conventional curriculum. The high ability group performed better than the average and low ability groups. For average and below average ability students, the conventional curriculum was equally suitable. The mean scores of the groups taught through the objective based curriculum was more effective with respect to acquisition of process skills than the traditional curriculum group. The personality of the students did not affect the acquisition of process skills.

Dighal (1985) conducted a study on "Improved Method of Teaching Biological Sciences in Schools of Tipura 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 sciences and to prepare a better, scientific and refined method. The sample consisted of 500 students of class IX. The tools used were two questionnaires. The data analysed through product moment correlation states that there was a significant difference in the effectiveness of self activity method, life science club method and audio visual method.

Barve (1986) conducted a 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 film strips. To compare the effectiveness of teaching science with the help of filmstrips and the traditional practice in terms of the achievement of the learner. The researcher developed ten filmstrips based on units from the syllabus. In order to study the effectiveness untreated control group design with pre test /post test. The students for the experiment were chosen by the incidental sampling method. 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. Filmstrips were an effective teaching aid for all levels of learners. Filmstrips were more affective for the learners between 13 and 16 years of age than for learners between 17 and 21 years of age.

Joshi (1987) evolved an instructional strategy to teach elements of science to class IX students. The objectives of the study were to develop an instructional strategy and study its effectiveness in terms of students' reaction towards the various components of the instructional strategy as a whole, to compare the mean achievement scores of students taught through the developed instructional strategy with those taught through the traditional method by taking intelligence as a covariate, to study the effect of treatment, intelligence and their interaction on overall achievement of students. The study was experimental in nature and conducted in two stages – try out stage and field study. The sample at the try out stage comprised of 30 students of class IX. The sample for the field study comprised 109 students in class IX. The design of the study was post test only control group design. The experiment continued for seventy working days. Data were analysed using ANOVA followed by t-test, chi square technique and percentiles. The major findings of the study were that the developed instructional strategy was found to be effective in terms of achievement of students on criterion tests and reaction of students towards different components of Instructional strategy. The developed strategy was found to be significantly superior to the traditional method when the students' mean achievement scores were not adjusted with respect to intelligence. Majority of the students belonging to different levels of intelligence, personality and total adjustment expressed their favourable reactions towards the majority of component of the Instructional strategy.

Sushma (1987) conducted a study on effectiveness of concept attainment and biological science Inquiry Model for teaching biological sciences to class VIII students. The objectives of inquiry were to study the effect of concept attainment model based teaching on pupils' achievement, to compare the effectiveness of concept attainment mode based teaching, biological science inquiry model based teaching and the traditional teaching approach in pupil's achievement , to study the effects of biological science inquiry model based teaching on pupils' attitude towards biological science; to study the difference in change in attitude towards biological science when taught through different models of teaching. Purposive sampling was done and the sample consisted of 78 students of class VIII. The study was conducted on two experiment groups. One group was taught through concept attainment model and the other group through biological science inquiry model. The control group was taught through the traditional approach. The tools used in the study were Samanya Mansik

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Yogyata Parikshan by M.C.Joshi, socio economic scale by R.P. Verma and P.C.Saxena. Data were analysed by applying ANOVA and t-test. The major findings of the study were that the concept attainment model and biological science inquiry model were found effective at 0.01 levels when the means of pre test and post test scores were compared applying t test. The concept attainment model was found more effective than the biological science inquiry model. The biological science inquiry model was found more effective than the conventional teaching. When the means of pre test and post test attitude scores were compared, both the models had significant effects. The concept attainment model changed the attitude more favourably than the biological science inquiry model. No significant difference was found between the gain scores of attitude with the biological science inquiry model based teaching and conventional teaching.

Saxena (1988) examined the effect of teaching based on structural concepts, considering being the core concepts in learning of chemistry. Sequential attainment of the concepts in chemistry through the periodic table has been in focus of study. The objective of the study was to study the effect of concept based instructions, using a control and experimental group design. A total sample comprised of 80 girls. An achievement test prepared by the investigator served as a tool. The data were analysed statistically using mean, SD and t-test. The major finding of the study was that it was observed that the experimental group taught by discussion method and supplemented by reading material regarding the related concepts gave better results in terms of their performance.

Aziz (1990) conducted a comparative study on the effectiveness of the information processing models of teaching in developing certain concepts in chemistry at the secondary stage. It is said that day in and day out teaching of science should be approached conceptually rather than factually. The objectives of the study were to develop teaching programme in specified content areas in chemistry to teach inductively through concept attainment and inductive thinking models and to compare the teaching programme based on information processing models with the traditional teaching programme in chemistry with regard to the concept attainment model. The sample comprised of 280 students of class IX selected randomly from the schools of Delhi. Experimental group control group design was used for the study. The collected data were analysed by analysis of covariance technique. The major findings of the

study were that the pupils exposed to the teaching programme based on information processing model of teaching performed significantly better than the pupils taught through the traditional approach of teaching. Concept attainment model and inductive thinking model both were effective for teaching science concepts. Thinking could be taught if appropriate teaching strategies were used. Bruner's concept attainment model was effective for attainment of concepts.

Joshi (1995) compared the effectiveness of Audio- Visual stimuli in the context of science teaching. The objectives of the study were: to construct and establish the medium of audio - visual in relation to achievement, to study the effect of numeric difference in words through audio media on students' achievement, to study the differential effect between audio, audio-visual and audio & still picture on students' achievement. 60 students from three sections of class 8th constituted the sample for the study. After pre-test the experimental group was exposed to different types of audio – visual medium. The section A was exposed to audio media, Section B to audio-visual media and Section C to audio & Still pictures. Lastly, post-test was administered. The achievement test developed by the investigator was used as a tool. The findings of the study were: Audio, Audio-Visual, Audio & Still picture as media can be developed for science teaching. The numeric difference of words used through audio media affected the students' achievement. Effective instruction in relation to students' achievement can be equally done through audio, audio-visual and audio & still picture. The comparative effect between audio, audio-visual and audio & still picture was not visible. All three media differentially affected the knowledge, understanding and applicability of concepts as seen on achievement of students. Students' interest increases when instructed through audio-visual media.

Ramakrishnan (1996) studied the effectiveness of various instructional strategies on achievement in science and interaction of school students. The objectives of the study were: To find out the relative effectiveness of the selected four instructional strategies in relation to the achievement of pupils in Science - Traditional or conventional learning method; Programmed learning method; Cooperative learning method; Multi-media approach, to investigate the impact of standard on the achievement and attitude in relation to teaching strategies, to study the attitude changes of the students and teachers towards the teaching-learning process as a result of the specific instructional strategies adopted by the teacher, to study the nature of

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interaction of students in relation to specific teaching strategies in the classroom. 44 teachers were selected randomly from seven schools which were equivalent in terms of educational standards, the assigning of instructional strategies were again made with the help of simple random sampling procedures. The students under each teacher were taught through a particular instructional strategy during the period of the treatment. A total of 1395 students took part in the study. Teaching strategy has four levels namely: conventional method; programmed learning; cooperative learning; multimedia approach. Standard has two levels, namely, VIII and IX. The investigator used four major tools for pupil perception towards teaching learning process, the tools developed by National Council of Educational Training and Research (NCERT) were adopted. The investigator used pre-test treatment post-test design by treating the conventional group as the control group and the other three groups as the experimental groups. Therefore the teachers did not have a choice of their own in selecting a particular method of instruction. The data were analyzed with the help of ANOVA followed by t-test. Findings of the study were: Comparisons of the means of different instructional strategies reveal that multimedia strategy results in higher achievement than other strategies. There is no significant difference between the achievement patterns of students on the basis of standards. Cooperative learning and multimedia strategy are more effective in case of urban students than that of the rural students.

Bala (1997) studied the effect the Mastery Learning Strategy and Concept Attainment Model on student's achievement in science, their self concept and classroom behaviour. The objectives of the study were: To compare the mean scores on the Criterion Achievement test in Science of the three groups of Pupils taught Science with the use of Mastery Learning Strategy (MLS), Concept Attainment Model (CAM) and Conventional Method (CM) of Teaching before and after the experimental treatment. To compare the mean scores on the test of self - concept of the three groups of Pupils taught Science with the use of MLS, CAM and CM of Teaching before and after the experimental treatment. To compare the mean scores on the test of Classroom Trust Behaviour of the three groups of Pupils taught Science with the use of MLS, CAM and CM of Teaching before and after the experimental treatment. The sample constituted of 90 Pupils studying in three sections of class IX of a Government School in Delhi. Each section contains 30 students, one section formed the

Experimental Group I, second section formed the Experimental Group II and the third section constituted the Control Group. The findings of the study were: The results of the study showed that the post-test Achievement mean scores of the group of students taught Science through Mastery Learning Strategy and the students taught Science through Conventional Method differ significantly. The group of Pupils taught Science through Mastery Learning Strategy showed significantly higher gain in Achievement than the group of Pupils taught Science through Conventional Method. At the completion of the experiment, group of Pupils taught Science through Mastery Learning Strategy and through Concept Achievement Model achieved significantly higher mean scores on the test of self -concept than the group of Pupils taught Science through the Conventional Method. The group of Pupils taught Science through Concept Attainment Model showed significantly higher mean gain scores in Achievement than the group of Pupils taught Science through Mastery Learning Strategy. No significant difference was found in the mean gain scores of the group of students taught Science through Mastery Learning Strategy and the group of students taught Science through Concept Attainment Model on the test of Classroom Trust Behaviour.

Joshi (1998) experimented on the Concept Attainment Model as a Technique of Remedial Teaching in Science for students of standard VIII. The objectives of the study were: To develop a test in Science for identifying the concept in Science found difficult by students of standard VIII, to tryout Concept Attainment Model (CAM) of Bruner as a remedial tool for teaching Science to students who found the concepts difficult to learn, to assess the opinion of students on the use of CAM as a remedial tool for teaching difficult concepts in Science. Single group experimental design was used. Sample consisted of 149 students of standard VIII. The researcher developed an achievement test to find the difficult concepts of Science students of standard VIII. The teaching through CAM was repeated till the group selected for remedial teaching had scored 70% marks. Percentage, t-test and graphical analysis were used as statistical techniques. The findings of the study were: The remedial group taught "Magnetism; Metals and Minerals; Plants and Animals; Electricity; and Manmade Materials" through CAM was found to have improved during respective sessions. The remedial group was found to have improved significantly during teaching through CAM for all selected concepts. Regarding the effectiveness of teaching through

CAM, majority of students (above 70%) strongly agreed that the CAM provided enough scope to think independently, they got motivated during session, it developed the ability to state the definition of the concept, they could recognize new example, they got a chance of learning from one another, and they felt this new method was better than usual teaching method in learning the concept.

Kelkar (1998) studied the 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 different methodologies in learning science subject. To find out the concepts which are not clearly understood by the students by application of traditional methods. To analyze the reasons which inhibit understanding of the concepts. To evaluate the effectiveness of the methodology "Exploring the mind". The study was experimental Pre-test Post-test control group design was used. Sample consisted of 588 students studying in standard VIII selected randomly from seven schools out of 25 private co-educational English medium schools from Pune Municipal Corporation. After pre-test, 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 35 minutes school period. The data was analysed employing t-test. The findings of the study were: There was significant difference between the mean of experimental group and control group of all schools. The mean of experimental group was greater than mean of control group. When methodology "Exploring the Mind" was applied to boys & girls in developed or developing schools, the level of achievement was the same for all irrespective of sex factor or infrastructure of the school.

Remadevi (1998) studied the application of Information Processing Models in Teaching Chemistry. 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 the effectiveness of IPM and CM in teaching chemistry for the secondary and higher secondary classes as revealed through the

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achievement of pupils with respect to (a) Knowledge level of cognitive achievement; (b) Comprehension level of cognitive achievement. The sample consisted of two divisions each of classes VIII, IX, X, XI and XII selected from different government schools of Kottayam District. The one division was considered to be experimental group to be taught through IPM, while the second division was taught 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, as well as with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement and application level of cognitive achievement at .01 level. The pupils taught through IPM were found to have significantly higher achievement scores irrespective of their level of intelligence. The pupils taught through IPM were found to have significantly higher scores on scientific attitude scale than those taught through CM.

Tomar (1998) prepared an intervention program to improve the quality of instruction in Environmental science for primary level school children. The objectives of study were: To prepare the intervention program for seven units in the subject of Environmental Science for standard IV, to implement the intervention program to study its effectiveness on standard IV students in terms of their academic achievement, to study teachers' and students opinion about the intervention program. Sample was selected randomly. The design selected for the study was a single group pre-test post-test design wherein the achievement was studied prior to the implementation of the intervention program and after the implementation of the intervention program. Tools prepared by the researcher were the achievement tests, semi-structured interview schedule for the teachers and semi-structured interview schedule for pupils. In phase I, observation was done in five different schools in Baroda city. The observation took five weeks. The implementation phase had pilot study and actual implementation of the intervention program. Finally, interviews were conducted with the students and the teacher. Data were analyzed through t-test and qualitative analysis. The findings of study were: It was found that the difference between pre-test and post-test scores for all the units and all types of tests was

significant. This clearly indicates the overall effectiveness of intervention program. If there is a change in the infrastructural facilities, school ecology is good and if the facilities provided at the school level are good and utilized properly, the achievement of students was found to improve. It was found that if environment was taught with environmental aspects, the achievement of students has improved.

Thatte (1998) studied the relative effectiveness of Programmed Learning and Learning through Audio Visual (AV) Aids with reference to certain selected topics from the syllabus of science. The objective of the study was : To compare the mean achievement scores of the students of Std. V, VI, and VII studying through Audio Visual Aids method, Programmed Learning Method and Traditional method. The sample for the study constituted of a total of 1381 students of eight schools of Greater Mumbai. The collected data was analysed through Central tendencies, percentile and percentile ranks, SD, ANCOVA and t test. The finding of the study state that Audio Visual Aids method was found to be significantly more effective than the Programmed Learning Method and the Traditional method in terms of achievement at Std. V, VI, and VII. Programmed Instruction Method was found to be significantly more effective than the Traditional Method in terms of achievement at Std. V, VI, and VII. Programmed Learning Method and Audio Visual Method are more successful when the classes are small, at the same time they are more effective for average students. No significant effect of interaction between treatment and sex was found on the achievement of students.

Rathore (1999) conducted a study on the scholastic achievement of children studying at primary level in environmental science with special reference to MLLS and development of remedial teaching strategies. The objectives of the study were to compare the achievement level of boys and girls at Non Formal Education centres and formal primary schools in rural areas in EVS-II (science), to compare the overall achievement of boys and girls of rural areas, to identify the level of learning in EVS-II of the children of formal primary schools and Non Formal Education centres and to develop the remedial teaching strategies for achievement the mastery levels of learning, to identify pupils weaknesses in EVS-II, to study the availability of teaching-learning materials available at the Non Formal Education centres and formal primary schools. The samples of the study were 1333 formal primary schools and 500 children studying in class III of Khandwa districts. From the Non-formal Education

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(NFE) the sample constituted a group of 426 primary level centres, 100 NFE centres were selected for the study. Data were analyzed with the help of percentage and t-test. The findings of study were: A 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. The findings also supported substantial increase in the achievement of NFE children from pre-test to post-test which was as a result of teaching by specially trained instructors and supervisors through remedial teaching strategies. The study also indicated a significant difference in the overall scholastic achievement of children of FPS and NFE centre's at the time of pre-test.

Pandit (2000) experimented in teaching general science to standard VI students without the prescribed textbook. The objectives of study were: To find out the relative effectiveness of teaching science between control group (taught with text) and experimental group (taught without text but with reference material) on certain criterion variables, to find out which of the following types of students have benefited most in terms of science achievement low scholastic aptitude or high scholastic aptitude, to find out whether there is any significant difference in the opinion of Teachers with less experience (less than 10 years) and Teacher with more experience (10 years and above) regarding the effectiveness of teaching science without the textbook, to find out the view of teachers on the quality of standard VI science textbook in particular and science textbooks in use in general, to find the views of teachers on different aspects of teaching science and the problems involved in it. The study was carried out in two phases. In the first phase, the experimental method was followed. The design was two parallel groups post-test. The sample comprised of 180 students. The tools used were Scholastic Aptitude Test (SAT), Nafde's Non-Verbal Test of Intelligence (NVTI), Otis Self Administered Test of Mental Ability (OTIS), and Achievement Test in Science (Unit-1, Unit-2 and Unit-1+2) developed by researcher. ANCOVA was used for data analysis. In the second phase, the survey method was used. The sample comprised of 211 teachers from 50 different schools. A scale to measure the opinion of teachers regarding the effectiveness of teaching science without textbook and questionnaires to study the opinion of teachers were used. The findings of study were: In regard to the total achievement in science of the total experimental group and total control group, the experimental group performed significantly higher as compared to control group. In regard to total group, the

scholastic aptitude has a significant effect on the performance of the students in achievement in science. The interaction between treatment and scholastic aptitude was not significant. There was no significant difference in the opinion of the teachers with less experience (less than 10 years) and teacher with more experience (10 years and above) regarding teaching science without the textbook, they were of the view that teaching without the textbook gives you better opportunities to teach students to discover the facts of science. The opinion of postgraduate teachers was significantly higher than that of graduate teachers on the criterion variable- "It will be more interesting to teach science with pictures and actual specimens than through the textbook". None of the teachers (from the population) were satisfied with the quality of standard VI science textbook in particular and science textbook in general, which led to teachers having problems in teaching science.

Thaker (2001) studied the 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 students' Science Learning Interest at the level of standard VIII and standard VI. To test the influence of Mastery Learning Programme with reference to students' Retention in the science subject at the level of standard VIII and standard VI. For the study Experimental method was used as a research method and 'Quasi' (Pre-test/ Post-test) Experimental Design was implemented. Two classes from one school of standard VIII and two classes of standard VI from another school were selected for the experiment. One class was taken as Experimental Group and another was taken as Control Group. 'Mastery Learning Programme' was developed and implemented as experiment-effect. ANOVA and t-test were used as statistical method. 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. In Retention no significant difference was found between the students taught by the 'Mastery Learning Programme' and the students taught by the 'General class teaching' at the level of standard VIII and standard VI with reference to Science Teaching.

Upadhyaya (2001) investigated the effectiveness of Inquiry Training Model (ITM) in teaching of science in secondary schools of Gujarat state. The objectives of the study were: to study the effectiveness of Inquiry Training Model (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 in terms of students' Higher Mental Ability in Science, General Creativity, Scientific Creativity, Inductive Reasoning Ability, Theory Building Capacity and Achievement in Science, separately by taking Intelligence, SES Scientific Aptitude and previous Achievement in Science as covariate, to study the contribution of Previous Achievement in Science, General Creativity, Scientific Creativity and Scientific Aptitude in the prediction of Higher Mental Ability in Science, Inductive Reasoning Ability, Theory Building Capacity and Achievement in Science, separately of the students taught through ITM, to study the change in Attitude towards Science of the students treated through ITM as well as those treated through Traditional Method and to study the change in students' reaction towards ITM. Pre-test Post-test Non - equivalent Control Group Design was used. An Incidental Purposive Sample of 226 students of standard IX was taken. The collected data were analyzed through correlated t-test, percentile, coefficient of variance, ANCOVA, 2 X 2 X 2 Factorial Design, ANOVA of unequal cell size, multiple regression and chi-square. The major findings of the study were: ITM and traditional method were found to be equally effective in terms of higher mental ability in Science but ITM was found to be more effective than traditional method in terms of General Creativity, Scientific Creativity, Inductive Reasoning, Theory Building Capacity, Achievement in Science and Reaction towards ITM. Inquiry Training Model was found to be insignificant in term of higher mental ability in Science when the groups were matched statistically with respect to Intelligence, Scientific Aptitude and previous Achievement in Science. ITM was superior to Traditional Method in bringing about significant favourable change in the students' Attitude towards Science.

Vijay Kumari (2002) studied the effect of different methods of teaching science on the achievement, basic 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

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and application objectives separately by taking: intelligence and science process skills as covariates. To compare the lacking processes in terms of interaction patterns associated with the teacher demonstration, guided discovery and co-operative learning methods of teaching science. 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 (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. 22 lessons each on the two units selected from textbook on science in standard six, through four selected methods. Total of ninety six lessons of the duration of forty minutes each were taught by the investigator. Sample comprised of 96 students of standard six of randomly selected government higher primary schools of rural areas. Data analysis was done by using ANCOVA, ANOVA and t-test. 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 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. The GDM was significantly more effective than the CLM and TDM in the retention of low achievers with respect to achievement on the application objective. The CLM was significantly more effective than GDM and TDM in retention of high achievers with respect to achievement on the application objective. Prolonged teacher initiated talk with respect to explanation of content, demonstrations and giving directions and student initiated talk followed by teacher acceptance were significantly higher in high achievers.

Leuva (2002) studied the effectiveness of competency based inductive thinking model in science to develop reasoning ability students. The objectives of the study were: To study the effectiveness of competency based Inductive Thinking Model in Science to develop the Reasoning Ability of Primary School Students. The

equivalence of the experimental group and control group was established on the basis of achievement in Science for Standard VI, IQ, SES and Reasoning Ability. The tools used for the study were IQ test, SES test and Reasoning Ability tests constructed by the investigator. t-test was used for data analysis. The findings of the study were that the mean achievement of the experimental group has been found significantly higher than the mean achievement of the control group. It establishes the effectiveness of Inductive Thinking Model in developing reasoning ability. The Inductive Thinking Model has been found to develop the Reasoning Ability of the pupils of all the levels. The retention through the Inductive Thinking Model has been found greater than through the traditional method. The pupils have been found to like learning through the Inductive Thinking Model.

Ramkumar (2003) conducted a study on acquisition of process skills by IV standard pupils through an Instructional Programme in Environmental studies. The objectives of the study were to prepare and implement an instructional programme in environmental studies for IV standard pupils, to identify the process skills employed by pupils during the instructional programme, to study the acquisition of process skills employed by pupils during the instructional programme. The instructional programme was prepared with respect to three topics soil, sound and water evaporation from IV standard textbook Environmental science textbook. The instructional programme consisted of the following components: instructional materials for teachers, lesson plans, and instructional sheets for pupils, teaching strategies and assessment procedures. The data collection approaches were qualitative and were governed by 'case study methodology'. The sample of the study was purposively selected and the researcher took the role of a teacher to collect data from IV standard pupil. The data collected through participant observation, in depth interviews and document analysis for a period of six months. These were used to prepare field notes. The data analysis was done through data triangulation. The emergent patterns from the field notes were listed and then triangulated to construct meaning on the preparation of instructional programme. The findings state that Instructional Programme facilitated the teacher in evolving teaching strategies for enhancing teacher pupil interaction during the acquisition of process skills. During the context of scientific investigation pupils expressed autonomy in learning through interactions with teachers and fellow peers. Pupils proposed hypothesis based on

certain concepts to explain the occurrence of events during the context of scientific investigation. Pupils showed willingness to change ideas in the light of evidence.

Sanjana (2003) made a comparative study of the effectiveness of Computer Assisted Instruction (CAI) and Computer Managed Instruction (CMI) on Pupil's achievement in Science, their self concept and study involvement. The objectives of the study were: To design and develop instructional plan for Teaching selected unit in Science amongst the prescribed course of study at class VII stage based on Computer Aided Instructions (CAI) & Computer Managed Instructions (CMI). To construct and standardize Achievement test in selected units of Science for class VII. To study individual Effectiveness of CAI and CMI on Self -concept; study involvement; and Academic Achievement. To compare the effectiveness of CAI and CMI instructions on: Academic Achievement, Self –concept and study involvement of students. The study was conducted on a sample of 90 Pupils studying in three sections of the Class VII of Evergreen Public School, New Delhi. From each section 30 students were selected purposively. Two sections formed the two Experimental Groups (E1 and E2) and one section formed the Control Group (C). The data were analyzed with the help of t-test. The findings of the study were: At the end of the experiment, it was found that the group of Pupils taught Science through Computer Assisted Instructions was effective in raising the Self -concept of the Pupils. The post-test mean scores of the Pupils taught Science through Computer Assisted Instructions increased significantly which indicates that Computer Assisted Instructions enhanced study involvement of the Pupils. The group of Pupils taught Science through Computer Assisted Instructions showed significantly higher post-test mean score on Achievement in Science in comparison to pre-test mean Achievement score. At the completion of experiment, it was found that the group of Pupils taught Science through Computer Managed Instructions was effective in raising the study involvement of the Pupils. The mean gain score of the group of Pupils taught Science through Computer Managed Instructions was found to be significantly higher on Achievement than the group of Pupils taught Science through Computer Assisted Instructions. The group of Pupils taught Science through Computer Assisted Instructions and those groups of Pupils taught Science through Computer Managed Instructions showed significantly higher mean gain score on Achievement than the group of Pupils taught Science through traditional method.

Parvathy (2004) studied the effectiveness of activity oriented method in teaching biology in small groups and large groups of secondary school students. The objectives of the study were to find out the achievement total of the pupils taught by activity oriented method I and activity oriented method II. To study the comparative retention of the learnt concept on achievement scores of the pupils when taught through activity oriented method I and activity oriented method II. To compare the achievement total of the pupils taught by activity oriented methods with that of conventional textbook approach. The sample consisted of students of VIII standard selected from two secondary schools of Trivandrum. From the total sample, 69 students in experimental group I taught through activity oriented method I, 70 students in experimental group II taught through activity oriented method II, and 68 students in control group taught through conventional textbook approach. The components of activity oriented method I were small group activities, activity sheets and instruction cards. The components of activity oriented method II were large group activities and lesson transcripts. The data collected was analysed using t-test and analysis of covariance. The findings of the study signifies the achievement of students of experiment group taught by activity oriented method I were better than the achievement of students in control group at knowledge and understanding level. The activity oriented method II was more effective than the conventional textbook approach in increasing the understanding level retention of students of standard VIII in biology. The findings indicate that the activity oriented method in teaching was effective for large group as well as small group varying with respect to achievement of level of instructional objectives.

Sanjiwani (2005) studied the effectiveness of concept attainment model and inductive thinking model of teaching on students' achievement in science, scientific creativity and attitude towards science. The objectives of the study were: To study the effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method of Teaching on improving Achievement in Science of IX class students. To study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method on improving Achievement in Science of IX class students. To compare the effectiveness of Concept Attainment Model and Inductive Thinking Model on Achievement in Science of IX class students, Reasoning Ability, Scientific Creativity and Attitude towards Science. Study was experimental in nature and pre-test treatment post-test

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design was followed. A purposive sample was used for the study drawn from the population of IX class students chosen from three Marathi medium schools in Nagpur. The sample consisted of 377 students. Data was analyzed by using t-test and ANOVA. The findings were: Concept Attainment Model and Inductive Thinking Model of teaching were found to be equally effective in terms of Achievement in Science of IX class students, Reasoning Ability, Scientific Creativity and Attitude towards Science. Traditional Method of teaching was found to be effective in developing Reasoning Ability, Scientific Creativity and favorable Attitude towards Science among the students of IX standard. Concept Attainment Model was more effective than the Traditional Method of teaching in terms of achievement of students in science. Inductive Thinking Model was more effective than the Traditional Method of teaching in terms of achievement of students in science.

Agarwal (2007) studied the effectiveness of computer based learning material on the selected chapters of standard X science. The objectives of the study were to study the effect of treatment, Intelligence and their interactions on the achievement of standard X students on the selected variables of the study. Pre-test post-test experimental control group design was employed on a sample of 167 students of standard X drawn through systematic random sampling. The teaching on the selected chapters for both the groups was spread over 18 weeks, each class of 40 minutes per day. Data analysis techniques used for the study were t test, two way ANCOVA and percentage analysis. The findings of the study found a significant gain in the achievement of the students taught through computer based learning material. The scientific reasoning of the experimental group students was found to be significantly higher than that of the controlled group. The scientific reasoning of the students was found to be independent of the interaction between: intelligence, treatment and computer awareness.

Chako (2009) studied the effect of concept mapping on the cognitive process and scholastic performance in general science for standard VII students within Pune city. The objectives of the study were to study the impact of teaching through concept mapping on the achievement of standard VII students in chemistry and biology. The study was conducted on 84 students studying in class VII of secondary school in Pune city. Purposive sampling procedure was employed to select the sample. The research used Intelligence test and achievement test for data collection. The finding from the study state that the students belonging to experimental group differed from control

group in their academic achievement. There was significant difference between experimental and control group in test scores of chemistry and biology when taught through concept mapping strategy.

Rawat (2009) studied the efficacy of concept mapping as a learning device for developing understanding and critical thinking. The objectives of the study were to develop learning material on concept mapping on the selected topics of science for the secondary school students, to study the effectiveness and limitations of concept mapping as a learning device for the secondary schools students in science subject. The study employed Experimental Group Pre-test Post-test design. Sample constituted of 33 students of standard IX drawn randomly. Concept map was the independent variable while IQ and Gender were the moderator variables. The treatment of the experimental group was distributed across 17 days, one period per day. The control group was taught by traditional approach for the same period. The data collected were analysed using t test and Mann Whitney test. The findings of the study were that the understanding of the experimental group taught through concept mapping has been found to be significantly greater than that of the control group. Students taught through concept mapping showed significant improvement in their critical thinking skills.

Amin (2011) conducted a study entitled on development and implementation of an Activity Based Teaching Programme for pre service student teachers. The main objectives of the study were: To develop and implement activity Based Science teaching programme on student teachers. To study the effectiveness of the developed programme in terms of differences in student teachers with respect to content knowledge, experimental ability, understanding about the nature of science and understanding about the science teaching. To study the effectiveness of the developed programme in terms of student teacher opinion about each of the activities after their implementation. Design of the study was single group pre test treatment post test design. Sample for the study was selected purposively and comprised of 40 student teachers. The programme was implemented throughout the academic year. Tools used for the study were achievement test, activity evaluation sheet, nature of science scale, observation, rating scale and field notes. The collected data was quantitatively analysed using t- test, frequency, percentage and qualitative data was analysed through content analysis. The finding reveals that the achievement of student teachers

were found to be more in post test as compare to that on pre test. There was a significant difference in the score of experimental skills of the student teachers with respect to the given treatment. There was a significant difference in the nature of science scale of the student teachers with respect to the given treatment. Overall 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 student teachers.

Bathari (2012) conducted a comparative study of teaching science at standard VIII in the government schools through improvised demonstration and traditional demonstration methods. The objectives of the study were to compare the mean achievement scores of Improvised Demonstration Group and Traditional Demonstration Group of students in science considering covariates: Intelligence, Scientific Attitude and Scientific tendency. To study the effect of remediation, on the achievement of students in science. To study the reactions of the students' on the treatment. Post-test control group design was employed. A sample of 186 students of standard VIII was selected randomly from four schools of Khandwa city. Improvised material was developed in science on twenty five topics of physics for class VIII. The data was analysed through ANCOVA, ANOVA and percentage analysis. The findings of the study state that the mean achievement in science through improvised demonstration was found to be significantly greater than that through traditional demonstration when scientific attitude and intelligence was taken as a covariate. The improvised demonstration was found to affect higher intelligence and lower intelligence students equally. Students (85%) were found to have favourable reactions towards the Improvised Demonstration.

Parekh (2012) developed and implemented a wholistic science education program at secondary school level. The objectives of the study were to develop a wholistic science education program and to study its effectiveness with respect to certain selected variables of the study. The sample for the study constituted of students of standard IX of the selected schools. The sampling technique used was cluster sampling. Tools for the study were content test, Value Inventory, activity based

demonstration scale, environment sensitivity test, life skill inventory and spirituality test. The techniques used for data analysis were t-test, ANCOVA and Chi Square for quantitative data and content analysis for qualitative data. The major finding of the study was that the adjusted mean score of the experimental group on content test was found to be significantly greater than that of the control group. It implies that the developed program resulted into significant cognitive development.

Shelat (2012) conducted a study on developing an instructional strategy and studying its effectiveness for comprehension in science among class VII students. The objectives of the study were to study the teaching procedure followed by the teachers in teaching science and technology with respect to various methods, approaches used for teaching science, use of audio visual aids, use of demonstrations in the classrooms, various methods, approaches used for teaching science, involvement of students in performing experiments. To determine the comprehension in science of class VII students. To develop and implement a strategy to enhance comprehension in science of class VII students. To study the effectiveness of the developed strategy in terms of comprehension in science and reaction of students. The study was experimental in nature employing pre test/post test design. The sample was selected through cluster sampling technique, consisted of 15 school teachers and 94 students studying in class VII of the selected schools. The strategy developed included activities/experiments by students, demonstrations, making toys from trash or low cost material, showing of animated films, power point presentation, making students predict, observe and explain by providing deficient situation. The tools used for the study were observation, field notes, interview schedule, science comprehension test in the form of story and achievement test based on comprehension in science. Data was analysed using t-test and content analysis. From the classroom observation it was found that in sixty percent classroom science was taught by reading the content from the textbook. In rest 30 % of the classroom it was found that lecture method was used and in only 10%of the cases demonstration or media was used. 20 % of the teachers used to explain the read paragraph in vernacular language. The questions raised by the teacher focussed on recall and recognize type and none of the teachers asked questions catering to understanding or application level. Majority of the teacher did not give time to students to think. Experiments given in the journal were filled in by dictation given by the teachers. Students were also made to write the findings and conclusions

of the experiments. Students remained passive listeners in the class while teachers were explaining the concept of science. No group work or group discussions were carried out in the classroom. In none of the classroom observation the activity based teaching, inquiry based teaching or problem solving method was used. The questions asked in the examinations were more of knowledge level barely touching upon understanding level questions. The teachers did not give any challenging, innovative or creative homework to the students which would develop scientific attitude among the students. The instructional strategy developed by the researcher was effective in terms of mean gain score on comprehension of experimental group significantly greater than that of the control group. The instructional strategy had a significant effect on the comprehension in science of the experimental group students. Analysis and interpretation of the responses to science comprehension on the stories implies that the mean gain scores on comprehension of experimental group are significantly greater than the mean gain scored on comprehension of the control group.

2.1.3 Studies on learning experience, scientific inquiry and conceptual understanding of science concepts

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. The objectives of the study were to develop a concept based science curriculum to teach a few important science concepts, to study its efficiency as compared to a conventional curriculum in terms of development of cognitive structures and acquisition of process skills, to study the interaction of the curriculum with the level of intelligence, to study the relationship of self concept of the learner with his cognitive structure. This was an experimental study where pre test/post test randomized group was employed. The study involved four independent factors. There were two criterion variables, namely, process skills and cognitive structures. The sample of the study consisted of 160 students divided into two groups. The data was analysed with the help of factorial design of analysis of variance. The findings state that the concept based curriculum was more effective than the conventional curriculum in terms of acquisition of process skills as well as in developing better cognitive structures. Level of intelligence did not affect mean scores on the process skill test. Intelligence acted as a redundant variable as far as development of cognitive structure was concerned. Low ability students having low socio economic status when

taught the concept based curriculum performed better on the cognitive structure test than high ability and high socio economic group students.

Mehna (1986) investigated into some factors affecting academic achievement in science of standard IX students of greater Bombay. The main objectives of the study were to find out the predictors of achievement in science as a whole, physics, chemistry and biology, to study sex difference in case of predictors of achievement in science as a whole, physics, chemistry and biology. The independent variables selected for the study were non-verbal intelligence, verbal intelligence, abstract reasoning, mechanical comprehension, numerical ability, scientific aptitude etc. The criterion variables were achievement in science, physics, chemistry and biology. The sample comprised of 308 girls and 376 boys of class IX of English medium schools of greater Bombay selected through the cluster sampling method. Stepwise multiple regression analysis was applied for data analysis. The major findings of the study were that six variables – 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 significant predictor variables for boys were scientific knowledge and aptitude, motivation for general science, verbal intelligence, interest in commerce, numerical ability and liking for science teachers (R= 0.5463). The significant predictors' variables for achievement in physics for students of class IX were the same as those found in case of general science with the addition of the variable, abstract reasoning. The significant predictors of achievement in physics in case of boys were scientific knowledge and aptitude, motivation for learning physics, verbal intelligence, interest in commerce, motivation for learning general science and numerical ability (R = 0.5798). In the case of girls, the predictors' for physics achievement were scientific knowledge and aptitude, motivation for learning general science other than physics, verbal intelligence, numerical ability and liking for physics teachers (R =0.6184). Abstract reasoning was found to be significant predictor only for physics achievement. Numerical ability was a significant predictor of achievement in physics and chemistry but not biology. The research findings imply that the pupil's 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 and if

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teachers can motivate children to learn science subjects. This needs adequate training for teachers in making science teaching interesting and in training them in the techniques of arousing pupils' motivation for learning science.

Menon (1986) studied the 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 skills 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 of the process skills of scientific inquiry and to examine the instruction and evaluation practices in relation to 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 was collected with the help of the test of the process of scientific inquiry which was constructed and validated by the investigator. To study the overall impact of the curricular system on the development of the process skills of scientific inquiry, a similar multi cross sectional survey was conducted with a sample of 238 students of standards VIII to XII studying in English medium schools of Baroda affiliated to the Central Board of Secondary Education. The information generated through this survey was contrasted with that of the first survey. A benchmark survey was undertaken to identify the extent to which the various forms of curricular material were utilised in instruction. The respondent for this purpose were students and teachers. The obtained data were subjected to content analysis. The major findings of the study were that 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 standard X and XI standard. The skills of identifying variables had been developed by the time students reached standard VIII. The skill of interpreting observational data was developed around 15 years of age. The skills of controlling the variables did not develop among the students in the system at the 17 years of age. Textbook 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.

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Grewal (1988) focussed on the need to organize learning experiences in such a manner where learners are exposed to the basic and integrated skills required in dealing with the scientific knowledge. The objectives of the study were to develop and test the efficacy of auto learning process based materials for the development of integrated processes of science such as classifying, inferring, interpretation, predicting, hypothesis making and testing. The sample of the study initially comprised of 77 higher secondary students from four higher secondary schools of Bihar City. Collected data were treated with mean, standard deviation, t- test and product moment correlation. The major findings were after observing the six processes, it was found that the processes of prediction and interpretation were hardly found in teaching. More commonly used processes were inferring and classifying.

Rao (1988) attempted to explore certain intervention materials which enable in optimising learning science in schools. The objectives of the study were to find out the extent to which children entering class VI have assimilated science content up to class V, to develop achievement measures on science to cover the content up to class V in its structural and functional aspects, to develop scoring techniques to evaluate the degree of learning through achievement test in science, to develop entry behaviour test for evaluation of science learning, to find out whether instructional strategies used by the teacher influence the content and amount of learning and to build tangible hypothesis for an intervention programme to optimise science learning. The sample of the study comprised 50 elementary schools of Karnataka, Delhi and Bihar of the students studying in class VI. The statistical techniques were mean, SD, item analysis and KR-20. The major findings of the study were that it was observed 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.

Mohapatra (1989) studies the pupils' popular preconceived concepts about scientific events related to their day to day life observations and implications of the same for organising suitable teaching learning strategies through utilisation of their experiences. The objectives of the study were to review the related studies on the origin of scientific concepts formation in the minds of children, to discuss some of the major characteristics of different alternative concepts in the minds of children, to

identify the role of teacher and the learner in the teaching learning process in developing and modifying scientific concepts, and to determine the implications of various types of concepts development process in the teaching learning situations. The study is based on review of related literature regarding the origin of scientific concept formation in the minds of children. The researcher has tried to identify major characteristics of different alternative concepts in the minds of children and related it to the teaching learning situation. It was observed that children made a great deal of conceptualisation based on their observation of day to day happenings in the environment and in home situations. In this process, they formulated alternative concepts about things, objects and events. The science teacher had an important role in helping the child to develop proper concepts about objects and events by utilising children's personal experiences with the rational thinking process.

Brahma (1990) studied the effectiveness of concrete materials to enhance learning in science concepts at secondary level. The objective of the study was to study whether concretised instruction helps in learning formal level concepts. The concretised instruction in science was tried on class IX students in two different schools. The researcher prepared materials for concretised instruction for all the four formal level concepts. A test of multiple choice items was developed and administered to both the groups. The differences were qualitatively analysed. It was observed that the performance of student's learning by concretised instruction was better than those learning by traditional instruction and the average increment in scores of experimental group of students on concrete level items was 8.8% and that on formal level items was 8.4%. The use of concrete materials such as chats, models, analogies, more lucid examples and other manipulative materials based on concrete thoughts and sequencing of instruction were found to help the concrete level operators in understanding the formal level concepts more effectively.

Mohan (1991) attempted to examine the major concerns of science curriculum, namely the problems of generating an effective participatory learning process for the development of scientific concepts keeping in view the learner, the specific learning situation and the nature of concept, through the adoption of appropriate instructional technology. The objectives of the study were to make a rational analysis of the factors of learning context, instructional strategies, process of development of scientific concept, interaction process and the role of the learners in different learning

situations, to identify the steps for concretisation of concepts through a progression process from concrete to quasi concrete to abstract representation, to evolve a theoretical instructional model for effective utilisation of a variety of instructional tools for ensuring proper learning by the students. The researcher used rational analysis method for analysing research studies and attempted to present models of unstructured process through diagrams and visuals. It was observed that in planning instructional strategies, the socio cultural factors, the educational environment and the learner's style of learning have to be given due consideration. Blending a number of instructional media might be useful in generating a learning climate that fosters interaction of various components of learning process. In the selection of learning strategy, the active role of the learner, the place of teacher, learning materials and process of concretisation for concept development had to be cautiously designed.

Vaidya (1991) developed teaching learning strategies for enhancing student achievement in science. The objectives of the study were to collect and survey research findings relevant to classroom teaching in the area of motivation, reinforcement, thinking skills and classroom control, to relate these research findings to content in science by writing lesson plan and modules, to test the lesson plans/modules empirically under controlled conditions and to develop teaching learning strategies for the enhancement of achievement in science. A random sampling method was used to draw 33 students of grade VI. Relevant data was collected through questionnaire and the modules. The findings reveal that it was possible to discern a pattern of common thought with coefficients of fluctuations of thought remaining under the permissible limit of 10%. It was possible to accelerate thought under certain conditions such as arranging thought provoking problems in their hierarchical order but abstract schemes of thought were difficult to crack. It was possible for students to participate in the day to day teaching learning provided, the teacher did not always insist on the right answer. The wrong answer, in fact, revealed the evolving structures of the logical thought.

Bano (1995) studied the misconceptions concerning genetics and evolution in biology in relation to formal reasoning ability, cognitive style and achievement. The objectives of study were: To study the nature of misconceptions in biology at high school level, to study the misconceptions in relation to formal reasoning, cognitive style and achievement in biology before instruction, to study the impact of instruction

of misconceptions in terms of formal reasoning, cognitive style and achievement in biology, to study achievement in biology, the components of knowledge, understanding, application, under cognitive domain with respect to formal reasoning, cognitive style and misconception, to study the impact of instruction on misconceptions, formal reasoning and cognitive style with respect to knowledge, understanding and application levels of achievement. The sample comprised of 200 grade IX students selected through purposive sampling technique. The findings of study were: There was a negative significant correlation between number of misconception in biology and formal reasoning ability before instruction. There was a negative significant correlation between number of misconception in biology and cognitive style before instruction. There was a negative significant correlation between number of misconception is biology and achievement after instruction. There was no significant difference between the upper and lower groups of number of misconception in biology with respect to achievement. There was no significant difference between the upper and lower groups of number of misconception in biology with respect to knowledge level, understanding level and application level of achievement. There was a significant difference in number of misconception in biology before and after treatment. There was no significant correlation between pre-test and post-test scores in number of misconception in biology.

Kwatra (2000) conducted a study on the understanding of science process in relation to scientific creativity, intelligence and problem solving ability of middle school students. 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, intelligence and problem solving ability on the understanding of science process among students of high, middle and low groups for each science process separately, to study the implications of the findings of the study for the betterment of science education. The sample comprised of 631 students selected through Stratified Random Sampling Method. The statistical techniques used to analyze the data were mean, median, mode, SD, t-test, Pearson's Product Moment Correlation, Duncan's Test and Multiple Regression Analysis. The findings of study were: The higher group is superior to the lower and middle groups in understanding of science processes. Highly intelligent group had better performance in understanding of science process than lower and middle groups. Middle group has average performance in

understanding of science process. The high problem - solving group has better performance in understanding of science processes than the lower and middle groups. Boys are superior to girls with respect to science processes except predicting process. In predicting process, boys and girls do not differ from each other. There was significant correlation between the selected variables of the study on one another. There was significant correlation between science process and problem solving ability. There was significant correlation between scientific creativity and intelligence. There was significant correlation between scientific creativity and problem solving ability. There was significant correlation between intelligence and problem solving ability. Flexibility and problem solving ability contributed significantly to the quantifying process. Intelligence, flexibility problem solving ability contributed significantly to the measuring process. Intelligence, flexibility, problem - solving ability contributed significantly to the experimenting process. Intelligence, originality and problem solving ability contributed significantly to the inferring process. Intelligence and scientific creativity contributed significantly to the predicting process.

2.1.4 Studies on teaching & learning of physics

Kamalakanthan (1968) conducted a study titled "An experimental study of teaching physics by the traditional and problem solving methods". The study attempted to find out which of the two specific methods, traditional 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 heat consisting of sixty items as pre test was administered on the thirty two students on the basis of the scores obtained the students were divided into two groups, comprising sixteen students in each group. The control group was taught by the traditional method. The experimental group was taught by the problem solving method for a period of eight days at the rate of one hour. Data was analysed using t test on the score points in the three group test – base test, post test and delayed retest of identical nature to analyse the data. The findings of the study stated that the problem solving method had positive favourable points as compared to the traditional method of teaching. The difference in the percentage of retention was not statistically significant for both the groups.

Basu (1981) studied the effectiveness of multimedia programmed materials in the teaching of physics. The objectives of the study was to develop instructional material for the strategy of programmed class teaching and to study its effectiveness, to develop the programmed learning materials on light in school physics in four different styles- semi programme, linear programme, branching programme and hybrid programme, to develop a multimedia programme package using each style of programme in conjunction with audio visual media, to compare the relative effectiveness of different strategies of instruction employing multimedia programmed material and programmed class teaching on the criteria of immediate achievement, retention and delayed retention. The sample consisted of 400 learners of standard IX which comprised an equal number of boys and girls. Five treatment groups were T -1 having programmed lessons, teachers' resource book and guide, students' study guide for classroom demonstration. T -2 having a semi programmed text, tape slide, tape filmstrip, tape film, physics kit, and manual for performing experiments. T-3 with a linear programmed text, tape slide, work book, tape transparency, auto elucidation, test tape filmstrip, tape film, physics kit and manual. T-4 having a branching programmed text, tape slide, work book, tape transparency, auto elucidation test, tape filmstrip, tape film, physics kit and manual. T-5 having a hybrid programmed text, tape slide, work book, tape transparency, auto elucidation test, tape filmstrip, tape film, physics kit and manual. The experiment was performed in school for pretty long time in three phases, from March 1979 to December 1979. Some concepts and principles were first developed in the subject through the respective programmed texts, which were then concretized and strengthened through the tape slide. Work book or tape transparency or tape film presentation. Concepts and principles illustrated through these written and A-V media were then evaluated on a short auto elucidation test. Feedback was then provided by involving the subjects in experimental work with the help of the physics kit and manual. The experimental data were analysed by analysis of covariance and by 5x3x3 factorial experiment with nesting and crossing. The following were the findings of the study; there was no significant difference among the different strategy means on the criteria on overall achievement. It was found that on the criterion of overall achievement the multimedia semi programmed instruction was better than the strategy of programmed teaching, the multimedia branching, programmed instruction was better than the multimedia linear programmed instruction. The strategies of multimedia programmed instruction

enabled learners to reach the level of mastery learning. It was found that a significant difference existed in the achievement through the different strategies due to difference in ability.

Sivadasan (1981) conducted a study "Project on Developing Science Kits and Self-instructional Software for Audio –tutorial System". The main objectives of the project were to prepare materials for individualized instruction and to test them for their efficiency as learning strategy. The topic "light" in physics prescribed for standard IX in the schools of Kerala was selected for preparing audio lessons. By administrating diagnostic test on Reflection, Refraction, Mirrors and Lenses, the concepts that were not understood by the students were located. Six concepts in Reflection, five in Refraction and four in Mirror and Lenses were thus identified. Scripts for audio lessons in all the fifteen concepts were prepared following the Guided Discovery Approach as a strategy for learning. The lessons were recorded on tapes. Pupils' activities were given prominence in the audio lessons. A ray box was constructed in such a way that the box could be used as a kit. The kit contained an instruction sheet, equipment for experiments, a tape recorder, cassette containing taped lessons, learning aids and evaluation sheets. Pilot study on ten students was done and the lessons were revised on the basis of the results of observation of the students, interview with them and evaluation of their performance. The revised lessons were given to a group of twenty students for learning. The students' performance was evaluated after they had all the audio lessons. The findings of the study state that the audio tutorial system was an effective strategy for learning. The guided discovery approach was actually possible and effective. Students could learn at their own pace under this system the teacher's role was minimized and ray box could be used as a small science kit.

Jain (1982) studied the problem solving behaviour in physics among certain groups of adolescent pupils. The objectives of the study were to identify the basic problems in physics having a direct bearing on the various reasoning patterns. To study the nature of difficulty faced in the process of problem solving and the need for selected hints, at various stages of problem solving. To analyse and interpret the responses of the students on the problem solving ability with respect to certain selected variables of the study. The sample consisted of randomly selected 180 pupils of class XI. Piagetian tasks scores showed that out of 180 students only 65 were at formal level

and 32 were still at concrete level. A large number of students, who initially failed to solve problems correctly, were able to solve most of the problems completely correct or partially correct after being provided hints in relation the strategies for problem solving. Problems solving scores differed significantly among the three groups of I.Q levels and also among the three groups of the level of intellectual development. The study implies to recommend that for effective classroom instruction curriculum the methods of teaching have to be planned in such a way that the structure of content is in accordance with the level of intellectual development of students. The teachers need to help the students in solving particular problems by asking logically arranged questions that lead the students to think in the right direction. But there has to be a limit beyond which hints do not remain effective. The choice of curriculum and teaching method need to be matched so as to achieve the desired result in teaching science to adolescents.

Uchat (1982) studied the reactions regarding the various syllabi unit of biology, chemistry, mathematics and physics subjects of standard XII. The major objectives of inquiry were to determine the difficulty level of various units of the syllabi of biology, mathematics and physics subjects of standard XII as viewed by high achieving and low achieving students according to the results of SSC and results of the respective subjects of standard XII, to determine the difficulty level for various units of four science subjects of standard XII as viewed by all students and teachers of the respective subjects. The sample consisted of 485 students of standard XII from all the higher secondary schools of Rajkot. The sample consisted of 45 teachers of chemistry, 45 teachers of mathematics and 49 teachers of physics selected from higher secondary schools. With the help of textbooks, syllabi and qualified and experienced teachers of each subject, four lists of instructional units were carefully prepared. In all 173 units in biology, 142 units in chemistry, 100 units in mathematics and 143 units in physics were listed in the final schedules. A five point rating scale was used for getting the opinions regarding the difficulty level of various unit of each subject. The difficulty level of each unit was determined on the basis of these opinions. The major findings of the study were in the subject of biology out of 27 chapters, six were difficult while 50 units were found most difficult. In the subject of chemistry out of 15 chapters, seven were found difficult, while out of 142 units of the whole curriculum of chemistry, 50 units were found most difficult. In the subject of mathematics, out of 11

chapters, five were found difficult and out of 100 units, 40 units were most difficult. In the curriculum of physics, there were 18 chapters and 143 units. Among these, seven chapters and 53 units were found difficult. Among these four science subjects, physics was considered as the most difficult subject and biology was considered as the least difficult one.

Singhal (1983) conducted an investigation on physics education using non formal methods. The objectives of the study were to identify academic problems of science teachers and students at the higher secondary stage and first year colleges, to conduct action oriented programmes according to the requirements of the respondents. In order to identify the academic problems of students and teachers, a questionnaire was circulated among physicists educationalist working at higher secondary schools, colleges and research institutes in Rajasthan. After identifying the problems a number of programmes were organized to meet the requirement of the students and teachers. The programmes included competitions, inter disciplinary talks, physics through thought questions, short duration course, library use, arranging talks on modern topics at the schools and evaluation of the courses. The major conclusions of the study were students did not read beyond the syllabus and did not inculcate the habit of understanding the basic concept of physics. Science students were found very weak in numerical work. Expressions were weak as they did not prepare their own notes. Special classes by experts in their fields were needed to meet the requirement. Thought questions created interest in physics and a large number of respondents appreciated this effort. There was very little interest among students and teachers in taking books for reading even when arrangement were made to send books to their address. No logical and scientific way was found to improve the syllabus.

Vardhini (1983) developed a multimedia instructional strategy for teaching physics and chemistry at secondary level. The objectives of the study were to develop a validated multimedia instructional strategy for teaching physics and chemistry to standard VIII, to study relationship between achievement using the strategy and intelligence and scientific attitude, to develop alternative instructional inputs and study their effectiveness, to study the feasibility of the strategy in terms of time and cost. The design of the study was experimental. The inputs of the strategy were introduction, lecture, discussion sequence, guided discovery, audio –visual and biographic accounts, diagrams, exercises and assignments, criterion test and feedback.

Experiment was conducted for one academic year to cover nineteen units of the subject chosen for study. Descriptive statistical techniques and the t-test were used for analysis and hypothesis testing. The major findings of the study reveals that almost all the units indicated average/high level of performance on the total tests. The validity of the strategy was established from reactions expressed by students for its continuance and also their improvement in science achievement. The strategy was found feasible when seen in terms of its reproductively and the cost management by individual schools.

Saxena (1985) conducted a study on attitude towards physics and cognitive preference style among different groups of science students. The main objectives of the study were to develop physics cognitive preference style test and attitude towards physics scale, to assess cognitive preference styles of different groups of science students of both sex studying in class X and XI of central schools and schools of Rajasthan, to assess the students' attitude to physics, to study the attitude and cognitive preference styles. Factorial analysis was used for data analysis. One thousand and seventy six students constituted the sample of the study. Recall, Principles, Questioning and Application were the dimensions of the physics cognitive preference styles test whereas enthusiasm in physics learning, views on physics as a process, and attitude towards physicists' constituted the dimension of ATPS. The findings were that the cognitive preference style of the entire sample was found to be R-P-A-Q with maximum preference for 'Recall' and minimum preference to 'Questioning'. The science students of different groups differed only in their 'Principles' and 'Application' preferences for the second and third rank only. Science students had favourable attitude towards physics. The co relation co efficient between attitudes towards physics scores are respective R,P, A and Q, scores were found to be 0.58,0.102,-0.25 and 0.005 respectively.

Desai (1986) studied the effectiveness of programmed learning strategy in teaching of physics in the eleventh grade. The objectives of the study were to prepare programmed material on heat in physics for pupils studying in standard eleventh in the schools of Bombay, to try out the programme on a sample of pupils and test its effectiveness as auto − instructional material, to ascertain the achievement of the pupils after learning physics through a teacher made test and to find correlation between the achievement of pupils and their abilities and intelligence. The study

employed the experimental design. The method of cluster sampling was used for the selection of 200 pupils from four science classes of standard eleventh. The major findings of the study were that the pupils took active interest in reading and learning through programmed material. Pupils solved examples on conversion scales and on co efficient of linear and cubical expansion of solids. They found the programmed learning approach easy and interesting as each pupil had an opportunity to learn at his own speed and capacity. The programmed learning approach proved better than lecture method in the study of physics. Attitude to science had no direct effect upon the achievement of pupils in science.

Sharma (1986) conducted an experimental study of the performance of high school students of low, average and high creativity as a function of the instructional media and learning tasks in physics. The objectives of the study were to prepare instructional material for high school students in physics in the four media of print pictures, print picture work book, tape slides and tape slide work book, to study the effectiveness of the instructional media on performance gains of high school students in physics, to study the performance gains in physics students with low, average and high creativity levels on total verbal creativity, verbal flexibility, verbal originality, non verbal creativity, non verbal elaboration and verbal fluency. To study the performance gains of students on concept learning, principle learning and problem solving tasks in physics, to study the effectiveness of the instructional media on performance gains of high school students in physics, to study the effectiveness of instructional media for three learning tasks in physics in relation to different dimensions of verbal and non verbal creativity. The study was experimental one with 4x3x3 experimental design with repeated measures. The total sample consisted of 257 subjects of class VIII, IX and X. The findings state that the average gains in performance through the print picture work book as well as the tape slide work book media were found higher than the print picture medium followed by tape slide medium. The mean gains in performance on concept learning, principle learning and problem solving were found different from each other, the gain being highest on concept learning and lowest on problem solving. On concept learning tasks the students performed highest with the print picture and tape slide media. Problem solving was facilitated most by the tape slide work book medium followed by the print picture. The four instructional media were found equally effective for concept learning, principle learning and problem

solving with low, average and high creativity groups. With the tape slide work book medium, the high group performed higher on problem solving than on principle learning.

Agnihotri (1987) carried out a study of Influence of some of the methods of teaching physics on the achievement in physics of class X students in Delhi. The objectives of the study were to test hypothesis of there being no significant difference between the mean achievements in physics of different groups of students taught by different methods: lecture cum demonstration method, laboratory method, programmed instruction and assignment cum discussion method. The impact of interaction between teaching methods and the level of students. The investigation followed the pre test /post test experimental method of research where two units of physics were taught according to the design by different methods. Ten schools were selected and the students were divided into four groups of 130 students each. The achievement of the students in physics in each of the schools was similar prior to the experimental teaching. The tools used were achievement test, Programmed learning material and instructional material for different teaching methods. The major findings of the study were: - Traditional method or the lecture cum demonstration method followed by the verification type of laboratory work was more effective than the assignment cum discussion method but this method was less effective than the programmed instruction method for teaching of Physics. With respect to the achievement in physics, programmed instruction for the teaching of physics was less effective than the method of teaching physics was less effective than the method of teaching physics systematically designed by the investigator. The programmed instruction method was found to be more effective than the assignment cum discussion method and the traditional method of lecture demonstration method followed by verification type of laboratory work. The relative effectiveness of all the four methods with respect to achievement in physics was the same not only for all the schools but also for all the levels of students. With respect to rank it was found that the method of teaching physics systematically designed by the investigator ranked first, the programmed instruction modified by the investigator for teaching of physics was the second, the traditional method followed by the verification type laboratory work was the third and the assignment cum discussion method was the fourth.

Pillai (1987) conducted an experimental study of Gagne's conditions of learning for Instruction in physics at secondary level. The objectives of the study was to design and experimentally validate an instructional strategy based on Gagne's conditions of learning, to examine whether the instructional strategy adopted brought about any change in cognitive preference of the learner, to examine whether the acquisition of higher order capabilities necessarily included lower order capabilities also. Two divisions of the standard IX with 38 and 37 students in them, of a higher secondary school of Baroda affiliated to the central board of the secondary education, were randomly chosen as the experimental and control groups for the study. The experimental group was provided with instructional events in physics developed in accordance with the conditions of learning as enunciated by Gagne. The instructional events consists of: informing the learner of the objectives, stimulating the recall of pre-requisite learning, presenting the stimulus material by way of instruction, providing learning guidance by way of hints, eliciting performance through individual practice, providing feedback about the performance correctness, enhancing retention through self learning, providing feedback about individualized self learning exercise, assessing performance and providing feedback based on assessment. The major findings of the study were that the instructional strategy developed based on Gagne's condition of learning was found feasible for normal classroom teaching. It was found to be more effective than the traditional method of instruction in terms of student performance. Hierarchical relationship was found in the learning of intellectual skills with problem solving at the apex followed by rules and concepts. The instructional strategy based on Gagne's conditions of learning was found to change the cognitive preference from facts and application to principles and problem solving.

Goel & Agbebi (1990) attempted to compare the relative effectiveness of the individualised method of laboratory demonstration method of laboratory instruction on student acquisition of psychomotor and related cognitive skills when the specific behaviour of five physics experiment in the subject area of light were pre disclosed to students before instruction. The objective of the study was to compare the relative effectiveness of the individualised method on acquisition of psychomotor and related cognitive skills among pupils. Forty four female students of the age ranged from 15 years constituted the sample of the study. The data were collected with the help of a validated tool developed by Goel on Indian students. Mean, SD, t-test and analysis of

variance were used to analyse the collected data. The findings of the study specify a significant difference observed between the groups which followed the individual laboratory method and the lecture demonstration method. Two groups of students following the individual laboratory method achieved significantly better on the psychomotor skills than did the lecture demonstration group. Students who followed the lecture demonstration method achieved at a higher level related cognitive skills than did the group of students which followed the individual laboratory method.

Ayyappan (1997) conducted a study on developing the concept of Electronics at Higher Secondary Level. The objectives of the study were: To identify the concepts essential for understanding electronics at higher secondary level, to develop teaching learning packages for a good understanding of these concepts, to study the effectiveness of the packages in terms of pupils' achievement between experimental and control groups, to study the effectiveness of the packages in terms of pupils' achievement acquisition of knowledge, understanding and application of knowledge in electronics between the control and experimental groups, to study the achievement of the control group among the four objectives, viz., knowledge, understanding, application and skills. To study the achievement of the experimental group among the four objectives, viz., knowledge, understanding, application and skills. Purposive sampling was used for selecting the sample. One school was selected for the implementation and monitoring of the whole program. Five nearby higher secondary schools were selected for the experimental phase and the four schools were taken for the extension phase. All the students of physics from the selected five schools formed the sample. A total of 217 students formed the sample for the study. The tools for the study were an achievement Test in Electronics; Reaction Scale for testing students' reaction towards the packages; Attitude test for testing teachers' attitude towards the training program. The data were analyzed with the help of t-test. The findings of the study were: There is no significant difference in mean scores of control & experimental groups in the pre-test. The mean scores of performance in post-test between the control & experimental groups are highly significant. The mean scores of performance of the control group between the pre & post-tests are significant implying performance of experimental group to be greater than control group separately for all the four objects. Students of the experimental group show a high positive reaction towards the package.

Joseph (1998) studied the process outcomes in physics in relation to some selected variables. The objectives of the investigation were: To estimate the relationship between Process Outcomes in Physics and each of the select Cognitive, Affective, Social and Environmental Variables. To identify the select independent variables – Cognitive, Affective, Social and Environmental - which influence Process Outcomes in Physics in terms of their ability to discriminate between three levels of achievement based on Process Outcomes in Physics through paired comparisons of the mean scores of these groups. To develop multiple regression equation for predicting Process Outcomes in Physics with the help of a few independent variables that correlate highest with Process Outcomes in Physics from the set for selecting independent variables used in the study. To study the combined effect of select Cognitive, Affective, Social and Environmental variables or Process Outcomes in Physics using multiple correlation coefficient. The study was conducted on a sample of 900 ninth standard students of secondary schools of Kerala selected using proportionate stratified sampling technique. Statistical techniques used were Pearson's Product Moment correlation, t-test, and Multiple Regression Analysis and Multiple Correlation technique. The findings were: All the cognitive, affective and social variables correlated significantly with Process Outcomes in Physics. The correlation between Process Outcomes in Physics and the Environmental variables was not significant for the whole sample and for the three sub groups. The comparison of the mean scores of High Process Achievers and Average Process Achievers; Average Process Achiever and Low Process Achievers, and High Process Achiever and Low Process Achievers indicated that all the select Cognitive, Affective and Social variables were capable to discriminate between the pairs of achievement level. The multiple correlation coefficients between Process Outcomes in Physics and the four highly correlated independent variables indicated that the independent variables acting together extend a significant influence on 'Process Outcomes' in Physics.

Hanumanthaiah (2000) investigated the effectiveness of curricular creativity inputs in physics at the secondary school level. The objectives of the study were to prepare lesson plan in physics of X standard with curricular creative inputs, to teach physics for X standard over a period of time on the lines of these lesson plans, to study the effectiveness of such lessons on the students of X standard on subject terms of mental abilities, flexibility of time and reactions of students for such lessons in everyday

classroom. To study the impact of such lessons on general performance of the class and to study the possibility of extending such lessons in other subject areas. To study the possibility of suggesting the curriculum framers and examination boards to change their pattern of thinking. A purposive sample was chosen for the investigation. A total of seventy one students formed the sample for the study. The data was analysed using t test. The findings of the study states that all the students have responded positively to the curriculum creativity inputs, their creativity ability has increased considerably. The girls of high mental ability have failed badly on both the verbal and figural creativity. Boys of high and low mental abilities in prior high creative level and low creative level have not shown any significant improvement. Boys of prior average creative ability have shown considerable improvement. Girls with high mental abilities of both prior high and average creative abilities have shown no significant improvement, whereas, girls of low mental abilities with prior average and low creative abilities have shown significant improvement.

Misra (2005) studied the effectiveness of factors related to Achievement in Physics with special reference to secondary school students. The objectives of study were: To construct an achievement test in physics to assess achievement in physics. To study the association of achievement in physics with some social – psychological factors including socio – economic status, intelligence, scientific aptitude, achievement – motivation, attitude towards the subject physics and study habits. To assess the existing facilities of the institutions (like laboratory and library), and to relate these factors with achievement in physics. The Research was Ex- Post Facto in Nature. Sample comprised of 315 Boys and Girls from nine different Schools of Lucknow City. It was selected with the help of Two Stage Random Sampling Technique.. The data collected were analyzed by t – test and Coefficient of Correlation. The findings of study were: Intelligence gives a positive and significant correlation with achievement in physics in case of combined, boys and girls sample. Higher the level of intelligence higher is the level of achievement in physics. Scientific aptitude is positively and significantly associated with achievement in physics in case of combined, boys as well as girls sample. Achievement motivation gives a positive association with achievement in physics in case of combined, boys and girls sample, though it is not significant in each case. Attitude towards the subject physics is positively and significantly associated with achievement in physics in case of

combined, boys as well as for girls sample. Higher the level of attitude towards the subject physics, higher is the level of achievement in physics.

Sidhu & Singh (2005) compared the concept attainment model, advance organizer model and conventional method of teaching of physics in relation to intelligence and achievement motivation. The objectives of the study were to study the effect of Bruner's Concept Attainment model and Ausubel's Advance organiser model on scholastic achievement as compared to conventional method of teaching in physics in relation to intelligence and achievement motivation, to study the relative effectiveness of Bruner's concept attainment model and Ausubel's Advance organiser model on scholastic achievement in physics. The sample consisted of 240 students of class IX, enrolled in Government senior secondary schools. The students were divided into three groups (n = 80), two experimental groups and one control group. Pre test/post test quasi experimental design was employed. The statistical technique of three way analysis of variance was used on gain scores for finding out the main effect and interaction effect of teaching techniques, intelligence and achievement motivation on scholastic achievement in physics of class IX students. The experiment was conducted in three stages pre test treatment and post test treatment in all the three groups. It was found that there was no significant effect between various teaching techniques, intelligence and achievement motivation on scholastic achievement of students for learning of concepts in physics. There was a significant difference in the scholastic achievement scores between students taught by teaching technique and conventional methods.

Uplane (2011) developed textbook based computer multimedia software package for school children to enhance their academic achievement in physics. The objective of the study were to analyse the science textbook of upper primary stage VI,VII and VIII standards prescribed for English medium schools to identify the topics related to physics, to find out the problems of learning physics content of students at upper primary stage, to find out from the teachers of the problems the students face at upper primary stage face while learning physics content, to develop textbook based computer multimedia software packages for the topics of physics in the textbook of upper primary stage, to test effectiveness of the developed software package for enhancing the academic achievement of general class upper primary students in physics, to find out the retention of the content by the sample after a gap of one

month, to find out the opinion of the participant students regarding the developed software, to test the effectiveness of the developed software package for enhancing the academic achievement of low achievers in physics. The sample was selected through cluster sampling. The design of the study was experimental. The findings from the study reveal that there was a significant difference in the scores on academic achievement on general science of students of experimental group as compared with the control group. The major problems of students in learning physics content were: rare use of models and other supportive material, lack of demonstration of experiments, learning and reproducing definitions, learning and reproducing formulae, "states of matter and distance between particles" – difficult to understand, how to differentiate mass and weight, force and types of force, concept of accuracy and estimation, simple machines and concept of fluidity. From the interactions and focused group discussions with teachers it was found that students had problems in learning physics as – physics concepts are difficult, they need spatial imagination. It is not possible to teach by means of verbal usage and/or diagrams on blackboard i.e. with two dimensional diagrams, it is not possible to give demonstration in each and every period, enough pictures are not given in the science text books, it is difficult to prepare additional examples which are not in the textbook for simplification of difficult concepts/content. It is difficult to explain formulae in physics and further application in physics problems, too many facts need to be explained in a short time and is difficult to make all students to understand. The students who learned through the developed package had longer retention of the learnt concept even after one month as compared to the students of the control group. The developed software package was effective in enhancing the academic achievement of low achievers in physics.

2.2 SUMMARY OF STUDIES CONDUCTED IN INDIA

Seventy two studies were reviewed for the present study. Six studies were on status of science education in India. Aziz (1984) found that the average was too much and majority of the schools did not have the report of the existing curriculum and syllabus. Desai (1986) critically studied the science teaching programme in Karnataka and found that 63% of schools did not have science clubs and laboratory in school. Suthar (1998) surveyed the secondary schools of Gujarat with a sample size of 125 secondary schools. The study found that lecture method was used by majority of the secondary science teachers. The teachers felt the syllabus of standard IX science to be

difficult as compared with the syllabus of standard X science. Umasree (1999) found from her 240 classroom observations in 16 secondary schools of Vadodara city that students remained as passive listeners throughout the classroom proceedings. None of the classes under observation used problem solving or inquiry based teaching strategy. Pienyu (2004) found many of the science teachers at secondary schools in Nagaland were ignorant about the innovations in science teaching. Bhuyan (2005) found that 42% of teachers of secondary schools of Assam felt that in the textbook of class IX some concepts have been presented without using inductive approach. Shelat (2012) in her situational analysis phase of standard VII classroom observation found that no group discussions were carried out in class. None of the classroom observation, activity based teaching, inquiry based teaching or problem solving method was used. Majority of the teachers did not give time to students to think and the questions asked in the class were of knowledge level. The questions barely touched the understanding level of objective.

Thirty six studies were reviewed on effectiveness of different transactional modes in science teaching. The studies reviewed tried to either establish the effectiveness of the approach/ strategy/ method in teaching of science or establish its dominance over the traditional approach of teaching science. Few of the researches tried to compare two or more than two approaches in teaching science and proved the supremacy of one method over the other. During 1979 -1987, researchers have used the observational approach, the practical method, the problem solving approach, the project method, the environmental approach, a combination of methods, use of science kits as well as toys and motion pictures and finally the environmental approach in their individual studies. They then compared each of them with the traditional approach. Adhinarayan (1979) developed strategy for developing appropriate skills in students for conducting scientific investigations. The developed strategy was implemented on a sample size of hundred students of standard VII. The developed package was found to be effective in terms of significant raise in achievement score of the experimental group students. Sahajahan (1980) and Hopper (1982) attempted to teach science concepts through modules. The study proved to be effective and students had favourable attitude towards the developed modules. Deopuria (1984) taught science through environmental approach, Ramesh (1984) developed objective based curriculum, Dighal (1985) studied effectiveness of self activity method, life science club and audio visual method, Barve (1986) prepared field and testing of filmstrips and Joshi

(1987) developed instructional strategy for teaching science at various levels and proved the effectiveness of the approach for all levels of learners.

Sushma (1987) used concept attainment model and biological science Inquiry model for teaching biological sciences to class VIII students. The concept attainment model changed the attitude more favourably than the biological science inquiry model. Saxena (1988) examined the effect of teaching based on structural concepts in learning of chemistry. Aziz (1990) conducted a comparative study on the effectiveness of the information processing models of teaching in developing certain concepts in chemistry at the secondary stage. The sample comprised of 280 students of class IX selected randomly from the schools of Delhi. Concept attainment model and inductive thinking model both were effective for teaching science concepts. The study found that thinking could be taught if appropriate teaching strategies were used. A similar study was carried out by Remadevi (1998). Joshi (1995) compared the effectiveness of Audio- Visual stimuli in the context of science teaching. He found that students' interest increases when instructed through audio-visual media. Ramakrishnan (1996) studied the effectiveness of various instructional strategies (conventional learning method; programmed learning method; cooperative learning method; multi-media approach) on achievement in science. A total of 1395 students of standard VIII and IX took part in the study. It was found that the multimedia strategy resulted in higher achievement than other strategies. There was no significant difference between the achievement patterns of students on the basis of standards. Bala (1997) studied the effect the Mastery Learning Strategy and Concept Attainment Model on student's achievement in science. The sample constituted of 90 Pupils studying in three sections of class IX of a Government School in Delhi. The study found that the group of Pupils taught Science through Concept Attainment Model showed significantly higher mean gain scores in achievement than the group of Pupils taught Science through Mastery Learning Strategy. Thaker (2001) made a similar study using Mastery Learning Strategy. Joshi (1998) experimented on the Concept Attainment Model as a Technique of Remedial Teaching in Science. Kelkar (1998) analyzed the effectiveness of different methodologies in learning science subject. The study attempted to find out the concepts which were not clearly understood by the students by application of traditional methods and employed the strategy 'exploring the mind' in teaching those concepts to experimental group. The strategy proved to be

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effective. Tomar (1998) and Rathore (1999) prepared intervention in environmental science education and studied its effectiveness. It was found that if environment was taught with environmental aspects, the achievement of students improves. Thatte (1998) studied the relative effectiveness of Programmed Learning and Learning through Audio Visual (AV) Aids with reference to certain selected topics from the syllabus of science on the students of Std. V, VI, and VII. Both the approaches were more successful when the classes were small and at the same time they were more effective for average students. Pandit (2000) found that the students of standard VI taught without prescribed textbook, the teachers had better opportunities to help students to discover the facts in science. Upadhyaya (2001) and Sanjiwani (2005) found Inquiry training model to be superior to traditional method in bringing about significant favourable change in the student's attitude towards science.

Vijay Kumari (2002) studied the effect of different methods (teacher demonstration, guided discovery and cooperative learning) of teaching science on the achievement, basic process skills and scientific attitude of pupils with different achievement levels. Total of ninety six lessons of the duration of forty minutes each were taught by the investigator. Sample comprised of 96 students of standard VI. It was found that prolonged teacher initiated talk with respect to explanation of content, demonstrations and giving directions and student initiated talk followed by teacher acceptance were significantly higher in high achievers. Leuva (2002) found that the inductive thinking model has been found to develop the reasoning ability of the pupils of all the levels. The retention through the inductive thinking model has been found greater than through the traditional method. Sanjana (2003) and Agarwal (2007) found the effectiveness of computer managed instruction and learning material in raising the involvement of pupils. Parvathy (2004) found that the activity oriented method in teaching was effective for large group as well as small group varying with respect to achievement level of instructional objectives. Chako (2009) and Rawat (2009) found significant improvement in critical thinking skills of students taught through concept mapping approach. Ramkumar (2003) found that instructional programme in environmental studies facilitated the teacher in evolving teaching strategies for enhancing teacher pupil 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. Amin (2011) found activity based

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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 science teacher. It was also found that there was enhancement in understanding of the benefits of scientific activities among the student teachers. Bathari (2012) found improvised demonstration method superior to traditional demonstration approach. Parekh (2012) developed an wholistic science education programme and studied its effectiveness on standard IX students. Shelat (2012) developed an activity based instructional strategy on the selected chapters in science. The sample was selected through cluster sampling technique, consisted of 15 school teachers and 94 students studying in class VII. The strategy developed included activities/experiments by students, demonstrations, making toys from trash or low cost material, showing of animated films, power point presentation, making students predict, observe and explain by providing deficient situation. The instructional strategy had a significant effect on the comprehension in science of the experimental group students.

Eleven studies were reviewed on learning experience, scientific inquiry and conceptual understanding of science concepts. Khalwania (1986) verified the effectiveness of concept based curriculum in developing cognitive structure and acquisition of process skills. Mehna (1986) found abstract reasoning and numerical ability as a significant predictor in achievement of physics. Teacher needs adequate training to make science teaching interesting. Menon (1986) studied science education in the perspective of process of science and inquiry. He found that the skills of interpreting observational data were developed around fifteen years of age. The questions asked by teachers mostly listed the product aspects and not the process aspect of science. Grewal (1988) found that the process of prediction and interpretation were hardly found in teaching and that most commonly used processes were inferring and classifying. Roa (1988) found that the learning process scores and concept scores were low indicating that comprehension was not achieved by giving children bits of information about scientific facts. Science achievement test indicated that very little was retained by children by rote memory. Mohapatra (1989) found that children made a great deal of conceptualisation on the basis of their observation of day to day happenings in the environment and in home situations. Children's personal experiences can be used to develop concepts about objects with the help of rational

thinking process. Brahma (1999) found sequencing of instruction helped the concrete level operators in understanding the formal concepts more effectively. Mohan (1991) attempted to examine the problems of generating an effective participatory learning process for the development of scientific concepts keeping in view the learner, the specific learning situation and the nature of concept, through the adoption of appropriate instructional technology. He found that blending a number of instructional media might be useful in generating a learning climate that fosters interaction of various components of learning process. In the selection of learning strategy, the active role of the learner, the place of teacher, learning materials and process of concretisation for concept development had to be cautiously designed. Vaidya (1991) found that it was possible to accelerate thought under certain conditions such as arranging thought provoking problems in their hierarchical order but abstract schemes of thought were difficult to crack. It was possible for students to participate in the day to day teaching learning provided, the teacher did not always insist on the right answer. The wrong answer, in fact, revealed the evolving structures of the logical thought. Bano (1995) found no significant difference between the upper and lower groups of number of misconception in biology with respect to knowledge level, understanding level and application level of achievement. Kwatra (2000) found that intelligence, originality and problem solving ability contributed significantly to the inferring process. Intelligence and scientific creativity contributed significantly to the predicting process.

A total of nineteen studies were reviewed on teaching & learning of physics at secondary and higher secondary level. Kamalakantham (1968) experimented teaching physics by traditional method and problem solving method on thirty two students of class X. He found problem solving method had positive favourable points as compared to traditional method. Basu (1981) used multimedia programmed materials to teach physics to standard IX students. He found that the developed strategies enabled learners to reach the level of mastery learning. Sivadasan (1981) studied the effect of learning strategy based on science kits and self instructional software for audio tutorial system on the topic 'light' in physics for standard IX in the schools of Kerala. The concepts were identified on the basis of the diagnostic test and guided discovery approach was used as a strategy for learning. The study concluded that guided discovery was actually possible and effective. Jain (1982) studied the basic

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problems in physics having a direct bearing on various reasoning patterns. The study implied that for effective classroom instruction, curriculum the methods of teaching have to be planned in such a way that the structure of content is in accordance with the level of intellectual development of students. Uchat (1982) found that among the four science subjects, physics was felt the most difficult subject and biology was considered the least difficult one. Singhal (1983) studied physics education using non formal methods and developed programmes for teaching physics through questions, library use, arranging talks and competitions. Vardhini (1983) developed instructional strategy in physics and chemistry for standard VIII students. The design of the study was experimental. The inputs of the strategy were introduction, lecture, discussion sequence, guided discovery, audio –visual and biographic accounts, diagrams, exercises and assignments, criterion test and feedback. Experiment was conducted for one academic year to cover nineteen units of the subject chosen for study. The strategy was found to be effective in terms of performance scores of students. Saxena (1985) found that the cognitive preference style in physics of the students' studying in class X and XI of central schools and schools of Rajasthan sample was found to be Recall-Principles-Application-Questioning with maximum preference for 'Recall' and minimum preference to 'Questioning'. Desai (1986) found the programmed learning strategy in teaching of physics in the eleventh grade proved better than lecture method in the study of physics. Sharma (1986) prepared instructional material for high school students in physics in the four media of print pictures, print picture work book, tape slides and tape slide work book. The four instructional media were found equally effective for concept learning, principle learning and problem solving with low, average and high creativity groups. Agnihotri (1987) studied the influence of some of the methods of teaching physics on the achievement in physics of class X students in Delhi. The investigation followed the pre test /post test experimental method of research where two units of physics were taught according to the design by different methods. Pillai (1987) found that the instructional strategy based on Gagne's conditions of learning implemented on standard IX central board students, was found to change the cognitive preference from facts and application to principles and problem solving.

Goel & Agbebi (1990) found that students who followed the lecture demonstration method achieved at a higher level related cognitive skills than did the group of

students which followed the individual laboratory method. Ayyappan (1997) conducted a study on developing the concept of Electronics at higher secondary level and found that the experimental group performed better on the post test as compared to the control group. Joseph (1998) studied the process outcomes in physics in relation to some selected variables. Hanumanthaiah (2000) investigated the effectiveness of curricular creativity inputs in physics at the secondary school level and found that all the students have responded positively to the curriculum creativity inputs, their creativity ability has increased considerably. Misra (2005) found that at secondary school level, higher the level of attitude towards the subject physics, higher is the level of achievement in physics. Sidhu & Singh (2005) compared the concept attainment model, advance organizer model and conventional method of teaching of physics in relation to intelligence and achievement motivation. It was found that there was no significant effect between various teaching techniques, intelligence and achievement motivation on scholastic achievement of students of standard IX for learning of concepts in physics. Uplane (2011) investigated the major problems of students of upper primary stage VI, VII and VIII standards in learning physics content. From the interactions and focused group discussions with teachers it was found that students had problems in learning physics. The students who learned through the developed package had longer retention of the learnt concept even after one month as compared to the students of the control group. The developed software package was effective in enhancing the academic achievement of low achievers in physics.

2.3 Review of studies conducted Abroad

A total of thirty one studies conducted abroad in the area of science education were reviewed. The studies were further categorized into two sub categories: sixteen studies on the effectiveness of different instructional method/approach in teaching science and fifteen studies on teaching and learning of physics.

2.3.1 Study on the effectiveness of different transactional modes in teaching science

Deborah (2000) investigated the effect of traditional instruction verses instruction employing teacher constructed and student constructed instructional resources on the short and long term achievement and attitudes of tenth grade students. The sample

included 62 tenth grade students drawn from three heterogeneously grouped classes in a suburban high school. Students were assigned to the classes based on successful completion of ninth grade science, teacher recommendations, and guidance department scheduling logistics. A Counterbalance Research Design was employed. During the first week of the study, Group A received traditional instruction, Group B received instruction employing teacher constructed instructional resources, and Group C received instruction employing student constructed instructional resources for the unit of study. The second and third week of this study, the groups and the mode of instruction were exchanged. The results indicated significant differences among traditional instruction, teacher constructed and student constructed instructional resources. Results of this study supported the belief that instruction employing student constructed instructional resources yielded higher scores on science achievement tests.

Donald (2000) designed a study to examine the effect of concept mapping on science achievement of middle grade science students. The subjects were one hundred eighty two eighth grade students, distributed into eight intact science classes. Students were homogeneously grouped by above average and average ability levels. Students were divided into four treatment groups. Two teachers were involved in teaching a unit on weather for nine weeks. The treatment groups constructed concept maps, while the control group did not. Two testing instrument (a conventional weather test and six performance assessment items) were used to measure the achievement. Analysis of covariance indicated no significant overall effects of treatment on science achievement. The results of the research were somewhat mixed. The results suggest that the effect of concept mapping on science achievement is not clear and science educators should be cautious as to its practical use in the classroom.

David (2001) studied the value of storytelling in a science classroom. The story telling approach aims to present science concepts in a meaningful and memorable context and is a coherent and connected manner. The research program employed parallel curricula: science concepts were taught through stories and through lectures at different times, to eight different groups of seventh and eighth grade students. Students were assessed with pre and post tests and through individual interviews. Students learning and retention levels were qualitatively analysed. The results reveal that the students who were taught through stories learned the science concepts, on an

average 21% better and retained close to 48% more than the students who were taught through traditional lessons.

Michael (2001) investigated on hands-on science promoted as a method of science instruction. The study focuses on three research questions: Whether hands-on science is positively related to student achievement as measured by standardized test scores using both multiple choice and performance tests? Whether this relationship is stronger when using performance tests? Whether this relationship differs by student ability? Regression analysis was done on the data collected from 1400 eighth grade students and their teachers. The initial findings vary by source of report, student or teacher, on the level of hands-on science. The results find little difference for this relationship by type of test. Nor do they show a strong evidence for a differential relationship due to student ability. The findings support the promotion of hand-on science at the middle/high level while raising a concern about current science reform attempts to reduce and redirect its use. The study also provides little evidence to support performance test programs on the grounds that they better reflect what is learnt through hand-on instruction.

Lebak (2005) connected outdoor field experiences to classroom learning in science. The study aimed to address fundamental questions regarding science learning in an informal setting. It examines how the activity structures at an informal learning centre support or contradict the classroom activity structure. The study also examines how co generative dialogues between instructional stakeholders can serve as a catalyst to change structures in order to maximize the potential learning opportunities at informal learning centres. Multiple data sources including field notes, transcribed audio tapes, interviews and co generative dialogues were used to elicit and support findings. The findings provides evidence of the ways the informal learning field is shaped by participating teachers' and students cultural, historical and social factors and how these factors create borders for the participation and learning of science at the outdoor classroom.

Susan (2005) examined the use of stories in the introductory biology courses with a mixed method approach. The purpose of this study was to examine how instructors and students use stories in introductory biology courses, and the degree to which these stories are perceived to be effective. To examine this phenomenon, a nationwide

instructor survey, student survey, and multiple case studies were used. Two case studies included observation of lectures, interview with 36 students and interview with four instructors over two semesters of a biology course. Instructor survey participants were gathered by posting e mail invitations and student survey participants were volunteers from introductory biology courses. Several types of stories were observed, including personal experience stories, historical anecdotes and 'you' stories. Students reported increased affective learning when stories were told and remembered mostly humorous stories. In the instructor survey, no significant differences emerged between gender, type of biology taught, or communicator style and instructional story frequency. However, reports of personal experience story frequency did increase significantly. The multiple regression analysis indicated that there was a significant positive relationship between story use and cognitive and affective learning for all groups of students. The researcher suggest that stories can be effective tool to teach biology, particularly if the teacher is aware of her students profile and uses stories to help students understand how concepts are related to real life.

Brunsell (2006) studied an educational ethnography of teacher developed science curriculum implementation. The study provides an in depth description of the role of professional development in helping teachers how science inquiry can be used to improve instructional quality of students. In science classes that were not subjected to a high stake exam, the teachers shared instances where they engage students to inquire by reframing the focus to their curricula away from the decentralized factual information and onto how the information relates to human experience. As far as science classes subjected to high stake test, however the teachers confessed to having no choice but to utilize more teacher centred strategies focused on information transmission. The study provides an in depth teaching strategies within school science curriculum.

Gail (2006) conducted a study on 'understanding understanding in secondary school'. The study investigated the teaching of secondary school science with an emphasis on promoting students understanding. In particular, the investigator focussed on two research questions. What are the possible meanings of teaching for understanding? And how might one teach secondary school science for understanding? After semi structured interviews were conducted with 13 secondary school science teachers,

grounded theory methodology was used to interpret the data. As a result of the selective coding process, he was able to identify 14 connected components of teaching for understanding. The process involves: puzzle solving, a specific pedagogy and a conscious decision. The teacher must be reflective practitioner who has some knowledge of the facets of understanding. The teacher comes to a critical incident or crises in his or her pedagogy and adopts a mindset which highlights teaching for understanding as a personal problematic. Teachers operate with student centred rather than teacher centred metaphors. It requires a firm belief in and passion for the process, a positive attitude and excellent pedagogical content knowledge. It hinges on a performance view of understanding and demands risk taking in the science classroom. Abstracting these ideas to a theory led to the notion of purposive teaching. In their purposive driven role as pedagogues, these teachers have placed teaching for understanding at the core of their daily practice.

Gejda (2006) conducted a survey of teacher practice of Inquiry based instruction in secondary science classrooms. The purpose of this quantitative investigation was to describe the extent to which secondary science teachers, who were certified through Connecticut's Best portfolio assessment process between 1997 and 2004 and had taught secondary science during the past academic year, reported practicing the indicators of inquiry based instruction in the classroom and the factors that they perceived facilitated, obstructed or informed that practice. Indicators of inquiry based instruction were derived from the Biological sciences curriculum study 5E model. The method for data collection was a researcher made self report; questionnaire entitled 'Inquiry Based Instruction in Secondary Science Classrooms'. Almost all of the study participants reported practicing the 5Es of Inquiry based instruction in their science classrooms. Time, resources, the need to cover material for mandatory assessments, the science topics or concepts being taught, and professional development on inquiry based instruction were reported to be important consideration in participants' decisions to practice inquiry based instruction in their science classrooms. A majority of the secondary science teachers indicated they had time, access to resources and the professional development opportunities they needed to practice inquiry based instruction in their secondary classrooms. Study participants ranked having the time to teach in an inquiry based fashion and the need to cover material for mandated testing

as the biggest obstacle to their practice of inquiry based instruction in the secondary classroom.

Cook (2007) studied the effectiveness of constructivist science instructional methods on high school students' motivation. The study focused on the effectiveness of constructivist science instructional methods to motivate high school science students to complete classroom activities. A constant comparative analysis including open, axial and selective coding of participants' interview responses and classroom observations provided codes used to develop a substantive theory of motivation and personal investment in students' learning. The findings of this study were that teachers should provide students with constructivist lessons such as co operative groups, problem based learning and inquiry questions in which to learn content objectives. As social beings, students are more motivated to participate in activities that allow them to work with peers, contribute their own ideas and relate topics of interest to their own realities. Keeping these ideas in mind during lesson preparation, will increase students' motivation and achievement. Variation of instruction should include activities that reflect multiple intelligences and real world situation.

Helson (2008) studied science classroom action research as embedded professional development to improve student achievement in science. This research evaluated three years of data from a district wide teacher action research program in a large urban Midwestern city. Sixty seven teachers involved in an action research project focussed on science instruction, were included in this study. The purpose of action research programme was to improve student achievement, identify best instructional strategies for promoting student achievement and recognize, replicate and disseminate excellence in teaching. Determination of student achievement gain was conducted through comparing the mean difference between pre and post project standardized assessment data relative to school district averages. Standardized assessments were carried out annually. The result suggest that teachers who engage in classroom action research may improve students achievement in science as measured by standardized tests. In the 42 cases with complete data sets, the mean student achievement gain above the district average was 3.65 Normal Curve Equivalents and an effect size of 0.46 was found with a 7.96 standard deviation.

Kinoshita (2008) studied the science instructional strategy to develop meta-cognition. The aims of this study are to reveal the actual condition of meta-cognition of elementary school children and junior high school students in observation/ experiment activities and to elaborate the instructional strategy to develop meta-cognition of elementary school children and junior school students. In order to achieve the aim of this study, a questionnaire survey was conducted comprising 14 items for elementary school children and junior high school students. The instructional strategy was elaborated based on the result of met-cognition of elementary school children and junior high school students. The elaborated instructional strategy adopted five methods of instruction of the self control strategies, bulletining the learning plan, improvement of questioning technique, utilization of flash cards and devising worksheets. The instructional strategy was found to be effective in developing meta-cognition in elementary school children and junior high school students. The strategy was felt to be more effective on junior high school students as significant improvement was observed in their questioning technique.

Tsurusaki (2008) conducted a study on connecting school science and students' everyday lives. Science education faces two major challenges, the perceived relevance of science to people's everyday life and ensuring that all students can obtain high quality science instruction. This dissertation explores how making connections between school science and students' everyday lives can lead to higher quality science education. It explores how a class of 9th grade students makes connections between school science and their everyday lives. It examines when and how students and teachers drew on students' funds of knowledge and created hybrid spaces, how the students and teachers are positioned in the activity and the discourse structures. How the object of the activity and the participation framework and the interaction between the two aspects provided opportunities for the students and teachers to make connections between students' fund of knowledge and school science and merge them to create hybrid spaces.

Akom (2010) conducted a study on using formative assessment despite the constraints of high stakes testing and limited resources. The study explore changes in teachers' view and practices as they are introduced to formative assessment in a high stakes testing and limited resource environment. The study examines the extent to which teachers use the technique of formative assessment to engage students in

authentic learning even while not sacrificing high test scores on summative assessments. A case study methodology was employed and the science teachers were engaged in the process of lesson planning and implementation to collaboratively build lessons with large amounts of formative assessments. The findings revealed that though the teachers possess knowledge of a variety of assessment methods they do not systematically use these methods to collect information which could help in improving student learning. Oral questioning remained the dominant method of student assessment. The aspects which needed just behavioural adaptations the changes were significant but for these which needed acquisition of more pedagogic knowledge and skills the changes were minimal. The teachers cited large class size and lack of teaching material as common constraints in practice of formative assessment. The study revealed a need for the acquisition of inquiry skills by the teachers which can serve as a platform.

Trygstad (2010) conducted a study on 'Student engagement and student voices'. Through classroom observations, digital videos and face to face interviews, the study investigated the phenomenon of student engagement within one inquiry oriented secondary science classroom. The data suggest that students engage in very different ways and these individual approaches often do not match with the narrow vision of engagement held by classroom teachers and expressed in existing research literature. Classroom behaviours are frequently misread and misinterpreted when students are not given opportunities to explain what their behaviours mean. Furthermore, students cited an array of emotional, cognitive and intangible factors that significantly impact their behavioural engagement on a daily basis. Study reveals an in depth analysis and description of student engagement cross behavioural, emotional and cognitive dimensions that rely on both verbal ad non verbal aspects of student voices.

Yunker (2010) systematically examined the introduction of an outdoor learning based science curriculum to students, their teachers and the school principal. The researcher developed an eight week Earth systems science unit for grade IX students. One teacher enacted the unit with the grade IX students, whose learning gains and perspectives of the role and value of integrated outdoor learning experiences were explored using a mixed methods approach in a pre- post test study design, including individual interviews and instruments regarding students' perspectives of the outdoor component of the curricular enactment. The main finding from the study was that the

outdoor component of the curriculum enhanced coherence- connectedness across science concepts, activities and learning environments. Higher ability students were more aware of connections than lower ability students. Field experiences were seen as a tool for learning, and all students achieved substantial learning gains. The teacher viewed the role of the outdoor experiences as a way to engage students, and promote connections across the unit through first hand and relevant experiences. The study concludes that identifying outdoor learning experiences as one way to enhance intra unit coherence. It helps in highlighting variations in students' awareness of coherence while examining the teacher's experience.

2.3.2 Study on teaching and learning of physics

Beh (2000) investigated the effect of instruction in physics on the formation of mental models for problem solving in the context of simple electric circuits. This study was designed to explore the effect of a typical traditional method of instruction in physics on the formation of useful mental models for problem solving using simple electric circuits as a context. the study also aimed at providing a comprehensive description of the understanding regarding electric circuits among novice and experts. A student's survey to collect data from 268 physics students and an interview protocol to collect data from 23 physics students and 24 experts was done. From the major findings it was found that most students display good procedural understanding for solving problems concerning electric circuits but have no in depth conceptual understanding in terms of practical knowledge of current, voltage, resistance and circuit connections. Most student encounter difficulty in discerning parallel connections that are drawn in a non-conventional format. The difference and similarities between the physics students and the experts include, students perceive parallel circuits more in terms of 'branch', 'current', and 'resistors with the same resistance' while experts perceive parallel circuits more in terms of 'node', 'voltage', and 'less resistance'. Both use phrases such as 'side by side' and 'one on top of the other' in describing parallel circuits which emphasize the geometry of the standard circuit drawing when describing parallel resistors.

Andree (2002) studied students' attitude towards physics and classroom environment based on gender and grade level among secondary education students in Indonesia. The study also explores students' opinion about physics, and examines to what extent

their opinions influence their decision to choose or not to choose physics or physics related fields for their career choices in the future. A group of approximately 864 male and female students, equally proportional by gender were assigned to take part in this study. Two standardized instruments, namely the Individualized Classroom Environment Questionnaire and the Test of Science related Activities, have been employed to collect data. A combination of quantitative and qualitative methods was used to analyse the collected data. The study found that regardless of their gender and grade level differences, students expected a more positive classroom climate during learning physics. Also, it has been found that male students experience a more positive classroom climate during learning physics. The tenth grade students show a more positive attitude towards physics than ninth graders. The study found that most of the female students do not like physics based on several reasons such as physics is hard, monotonous and boring subject. A majority of tenth grade female students had no intentions to choose physics or physics related subjects either for their prospective major or for their career choices in the future.

Jean (2002) investigated the success of students in the introductory Physics courses with gender, high school preparation and student learning perceptions as variables. A survey of learning preference and perceptions was developed to collect the information for this study. A total of 267 students enrolled in six introductory physics courses participated in the study. The findings indicated that participant's educational goal and parent's educational level was positively related to performance while participant's age was negatively related. No significant difference was found between male and female students. However, there were significant gender differences in physics learning perceptions. Female participant tended to try to understand physics material and relate the physics problems to real world situations while their male counterparts tended to rely on rote learning and equation application. This study found that participants performed better by trying to understand the physics material and relate physics problems to real world situations. Participants who relied on rote learning did not perform well.

John (2003) conducted a study on overcoming misconceptions of interpretation of kinematics motion using calculator based rangers. The study was a quasi experimental of 261 high school students that analyses gain made through use of calculator based ranges attached to calculators. The study had qualitative component but is based on

quantitative tests. The population was divided into one group that predicted the results before and another that did not predict first but completed the same activities. The data for the groups was further disaggregated into learning style groups based on Kolb's learning styles Inventory, type of class and gender. For instructors who used the labs developed by the researcher for this study, created significant differences between the groups by instructor based interviews, participant observation and one way ANOVA. No significant differences were found between learning styles based on MANOVA. No significant differences were found between predict and non predict groups for the one way ANOVA and MANOVA, however, some differences do exists between gender and type of class. The advanced physics scored higher than general physics on all tests.

Jacob (2004) studied a framework for effective physics education applied to secondary and university physics courses. Physics education is in trouble. The number of physics major has been decreasing in recent years; even as the number of college students has grown physics is seen as a difficult subject which only a select few can understand. Introductory physics classes have been very successful at removing students from the science pipeline. This study poses a framework for understanding introductory physics education in high school and college and applies that framework to three courses studied through observation, interview and document analysis. Generally, the framework proposes that physics programs define a set of roles for teachers, students and groups to follow in the process of physics education. The roles are defined through explicit and implicit expectations for the behaviour of teachers and students in the classroom. The interactions among teachers, students and groups are central to the process of teaching and learning physics. Different programs encourage different kinds of interactions between the constituents, which is part of what makes some programs more effective than others. Any or all of the participants may accept or reject the role the program set for them, and that also determines how effective the program can be. Findings reveal that students remembered specific dramatic events from their physics classes, not the regular repetition of lab procedures, and this provides teachers with the opportunity to connect real physics knowledge to dramatic demonstrations or class events.

George (2005) conducted a study on 'looking inward, looking outward: developing knowledge through teacher research in a middle school science classroom during a

unit on magnetism and electricity'. The study aimed to understand effective teaching and learning in the context of middle school science classroom. The study was a multiple case analysis of two classes of students, one gifted and one academic, during a unit on magnetism and electricity. The study was conducted to investigate the development of teacher's knowledge, scientific pedagogical content and reflective- as a teacher. From the analysis of questionnaires, field notes, transcribes audio tapes of small and large group discussions and students anti facts, the researcher constructed an understanding of student's learning and his own growth as a teacher in several realms. Researcher's scientific knowledge goes both substantively and syntactically, elaborated his understanding of magnetism, rethought his delivery of electricity, realised a need for training in electronics, and refined his definitions of nature of science in research. He build his pedagogical content knowledge with regard to students idea about magnetism and electricity, learning characteristics of students, tools of inquiry that facilitate learning and methods to operationalize the situated learning model. The findings contributed to the understanding of teachers' research as well as various bodies of science education literature: students' idea about magnetism, the science learning characteristics of students, tools of inquiry in the science classroom and operationalization of the situated learning model.

Gaighu (2005) studied the effect of a structured problem solving strategy on performance and conceptual understanding in physics. The study intended to investigate the effect of a structured programme solving strategy in physics on performance and conceptual understanding. The schools selected for study were disadvantaged with regard to standards set by the apartheid education system as well as by instruction in English, the second language of the students and most of the teachers. The problem solving strategy incorporated the use of different representations, group work, verbal arguments, written explanations planning and interpretations of solutions. The strategy was implemented by a cascading model where the researcher interacted with the teachers while the teachers interacted with the students. The treatment group schools applied the strategy throughout the year while learning new content, there were no extra classes or additional work. Results were collected from normal classroom test and exams as well as video tapes and questionnaire. The treatment group performed significantly better than the control group, leading to a claim of enhanced problem solving skills. Evidence of enhanced

conceptual understanding amongst the treatment group was demonstrated by developing two new techniques. Firstly solution maps were constructed for specific problems. These maps were visual representations of concepts, formulae, assumptions, substitutions and numerical answers presented by students. The popularity of various routes on these maps was composed for the two groups as a measure of differences in conceptual understanding. Secondly a conceptual Index was defined to quantify the extent to which a group of students used a conceptual approach in their solutions. The Problem Solving Strategy fosters active mental engagement together with learner interaction. Implementing the strategy could enhance students Problem Solving Skills and understanding of Physics.

Bouchard (2006) studied physics students' approaches to learning and cognitive processes in solving physics problems. This study examined traditional instruction and problem based learning approaches to teaching and the extent to which they foster the development of desirable cognitive processes, including meta-cognition, critical thinking, physical intuition and problem solving among undergraduate physics students. The study also examined students' approaches to learning and their perceived role as physics students. The cognitive science, expertise, physics and science education, instructional psychology and discourse process literature provided the framework and structure of this study. A mixed model design including a survey, observation and problem sets were developed specifically for the study. A special one week long problem based learning intervention was also designed. Findings include evidence that students in general engage in meta-cognitive processes in the organization of their personal study time. However, this potential, including the development of other cognitive processes, might not be stimulated as much as it could in the traditional lecture instructional context. The problem based learning approach was deemed as more empowering for the students. An unexpected finding came from the realisation that a simple exposure to a structured exercise of Problem Solving (pre test) was sufficient to produce superior planning and solving strategies on a second exposure (post test) even for the students who had not been exposed to any special treatment. The intervention tends to foster the development of cognitive competencies particularly physical intuition, even if it was only implemented for a short period of time.

Rowley (2006) studied the effects of conceptual change coupled inquiry cycle investigation on student understanding of the interdependence of mass in rolling motion on an inclined plane. The purpose of this study was to examine the impact of the conceptual change coupled Inquiry cycle on school students' misconceptions of Newton's laws and incline motion. The study was a mixed method, quasi-experimental study with both quantitative and qualitative data analysis. Students' notebook and test data were collected and analysed quantitatively and qualitatively. A Stu-Art-Maxwell chi-square was used to assess the quantitative significance of changes in student conceptual understanding of incline motion at each phase of the conceptual change coupled inquiry cycle. Qualitative analysis of the notebooks provided important support of the quantitative findings. Results indicate that students' report a better understanding of incline motion and Newton's Laws as a result of completing a conceptual change coupled inquiry cycle investigation. Quantitative analysis indicate significant increase in students understanding of Newton's Laws and incline motion at $\alpha = 0.05$ level. Analysis of student test data was largely inconclusive. The study was effective and showed significant decrease in the number of students reporting misconceptions about incline motion. Evidence suggests that conceptual change coupled Inquiry cycle is effective learning cycle and that it can improve student understanding of science concepts.

Brain (2007) studied how students use representations in physics problem solving. The research work attempts to establish that representation is a major factor in student performance, and uncover some of the mechanisms by which representation can affect performance, to study the effect of different instructional environment on student learning of multiple representations during problem solving, and find that courses that are rich in representation can have significant impact on student skills. The findings report the significant role of meta- representational skills in solving physics problems at the introductory level, and found that the meta-representational abilities are poorly developed in introductory students. There exists characterized differences in representation use between expert and novice physics problem solvers and that the major differences appear not to lie in whether representations are used, but in how they are used.

Victor (2007) studied students' ideas about the kinematics concept of velocity and acceleration. The concepts of velocity and acceleration are within first where upon all

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courses of introductory physics begins, and later, they are continually applied in the development of the course when discussing dynamics, energy, electricity and waves among other subjects. Therefore, this pair of concepts deserves special attention in the process of teaching and learning of physics. In this study, the idea of the university students related to velocity and acceleration concepts were identified and analysed , and was determined the degree or level of understanding of such concepts. The study is of the descriptive nature, and the results from this study it is tried to improve an aspect of the teaching and learning process in the course of Physics Research questions: What are the previous conceptions on velocity and acceleration that students have from courses of General physics? What are the geneses of those conceptions? What are the conceptual categories that stand out in the previous ideas of the students on velocity and acceleration? What were the difficulties found by students in the process of learning the concepts of velocity and acceleration? What degree of understanding the students have about the concept of velocity and acceleration at the end of the semester compared to the beginning? The previous ideas the students had about the concepts of velocity and acceleration were identified by means of the analysis of data obtained through questionnaire and interviews. This information allowed to suggest changes in the content, and the methodology, so that it was more relevant and can be more effective in accomplishing objectives. The degree of understanding of the concepts of velocity and acceleration was determined by means of the criterion of the ability that the students' has to apply correctly such concepts in the interpretation of simple movements of objects. The findings from the study identified thirty two pre conceptions, of which four were correct, twenty two were not correct, and six were correct in certain cases. From those that were not correct eleven are related to velocity and eleven with acceleration.

Albert (2009) developed and evaluated clicker methodology for introductory physics courses. The researcher developed a comprehensive clicker methodology that created an active lecture environment for a broad spectrum of students taking introductory physics courses. The clickers are reliable tools allowing students to actively participate in lecture by answering multiple choice questions, motivating additional discussions which increase the opportunity for active learning. It was recognized that learning requires active construction; students need to be actively involved in their own learning process. Learning also depend on pre existing knowledge. Students

construct new knowledge and understanding based on what they already know and believe. Sequences of questions were developed, each involving the same concept but having different contexts. Answer choices were designed to address pre existing knowledge. These sequences were used with the clickers to promote active discussions and multiple assessments. The research found that using clickers with the question sequence significantly improved students' conceptual understanding. It was also found that students need to have full access to the question sequences after lectures to recap the maximum benefit.

Lee (2009) used computer simulations to facilitate conceptual understanding of electromagnetic induction. The research based approaches to integrate computer simulations in physics education forming a learning framework called CLCS. The study intended to empirically examine concept learning with computer simulations. All the participants were randomly assigned into two groups the experimental and control group. Research based computer simulations were used to tackle common conceptual difficulties in learning electromagnetic induction. While interacting with computer simulations the experimental group students were asked to answer reflective questions designed to stimulate qualitative reasoning and explanation. Students of the control group were not granted access to the developed material. At the end of the study a post test was given to both groups. Questions in the post test were divided into 'what' questions, 'how' questions and an open response questions. Analysis of students post test performance showed a mixed result. While control group students scored higher on 'what' questions, the experimental group students scored higher on the 'how' questions and the open response questions. The result suggested that the control group students knew what kinds of conditions may or may not cause electromagnetic induction without understanding how electromagnetic induction works. Results also suggested to improvement in the learning framework by providing students with background knowledge necessary to understand model reasoning and integration to various physics concepts. The reflective questions in the learning framework may be refined to better address student's difficulties.

Han (2010) conducted a study entitled 'Feel, imagine and learn! Haptic augmented simulation and embodied instruction in physics learning'. The purpose of this study was to investigate the potentials and effects of an embodied instructional model in abstract concept learning. This embodied instructional process included haptic

augmented educational simulation as an instruction tool to provide perceptual experiences as well as further instruction to activate those previous experiences with perceptual simulation. In order to verify the effectiveness of this instructional model, haptic augmented simulation with three different haptic levels (force and kinaesthetic, kinaesthetic and non haptic) and instructional materials (narrative and expository) were developed and their effectiveness tested. 220 Vth grade students were recruited to participate in the study from three elementary schools located in New York. The study was conducted for three consecutive weeks in regular class periods. The data was analysed using ANCOVA, ANOVA and MANOVA. The result indicate that haptic augmented simulations, both the force and kinaesthetic and kinaesthetic simulations was more effective than the non haptic simulation in providing perceptual experiences and helping elementary students to create multi model representation about machine movements. The force and kinaesthetic simulations was effective in providing cognitive grounding to comprehend a new learning context based on the multimodal representation created with enhanced force feedback. Regarding the instruction type, it was found that the narrative and the expository instructions did not make any difference in activating previous perceptual experiences. These findings suggest that it is important to help students to make a solid cognitive ground with perceptual anchor. Also, sequential abstraction process would deepen students' understanding by providing an opportunity to practice their mental simulation by removing sensory modalities used one by one and to gradually reach abstract level of understanding where students can imagine the machine's movement and working mechanisms with only abstract language without any perceptual supports.

Philippi (2010) examined students understanding of the use of models in science and conceptual understanding of electricity and magnetism. The purpose of this study was to inform instruction by increasing the body of knowledge regarding the relationship between college physics students' knowledge about models in science and their conceptual understanding with regard to electricity and magnetism. The data for this study was obtained through the administration of two instruments: conceptual survey of electricity and magnetism, a multiple choice assessment and student understanding of models in science, a Likert Scale survey. Both traditional statistics and an innovative technique called Model analysis were use to analyse the data. Analysis of the data revealed that there is a relationship between student understanding of models

in science and conceptual understanding of electricity and magnetism topics. However, the results of this study also suggest that without specific instruction on models in science, overall understanding of models in science does not improve after a traditional electricity and magnetism course. Additionally this study demonstrates that not only does student' s conceptual understanding improve after the course but also, students demonstrate more sophistication in their understanding of some electricity and magnetism topics. In the latter case, students showed improvement in their application of the concept rather than the naive model of electricity and magnetism topic.

2.4 SUMMARY OF STUDIES CONDUCTED ABROAD

Deborah (2000) studied the effect of traditional instruction verses instruction employing teacher constructed and student constructed instructional resources on the short and long term achievement and attitudes of tenth grade students. He found that instruction employing student constructed instructional resources yielded higher scores on science achievement tests. Donald (2000) studied the effect of concept mapping on science achievement of middle grade science students. The results suggest that the effect of concept mapping on science achievement is not clear and science educators should be cautious as to its practical use in the classroom. David (2001) & Susan (2005) examined the value of storytelling in teaching of science and found it to be effective in learning and retaining the concepts. Michael (2001) investigated on hands-on science; Lebak (2005) connected outdoor field experiences to classroom learning in science and both found that the new strategy to be effective in promoting science learning. Brunsell (2006) found that science classes subjected to high stake exams, the teachers confessed to have no choice rather than using teacher centred strategies focussed on information transmission. Gail (2006) suggested that the process of science teaching should involve puzzle solving, a specific pedagogy and a conscious decision. The science teacher must be reflective practitioner who has some knowledge of the facets of understanding. Gejda (2006) surveyed teacher practice of Inquiry based instruction and found that majority of the secondary science teachers indicated they had time, access to resources and the professional development opportunities they needed to practice inquiry based instruction in their secondary classrooms. The need to cover material for mandated testing proved to be the biggest obstacle to their practice of inquiry based instruction. Cook (2007) studied

the effectiveness of constructivist science instructional methods, Helson (2008) studied science classroom action research, Kinoshita (2008) studied the science instructional strategy to develop meta-cognition, Tsurusaki (2008) conducted a study on connecting school science and students' everyday lives and Yunker (2010) examined the introduction of an outdoor learning based science curriculum to students. Almost findings of all these studies revealed that variation of instruction should include activities that reflect multiple intelligences and real world situations. Akom (2010) and Tomita (2009) used formative assessment as an essential aspect of science classroom teaching. They found that though the teachers were aware of different techniques of assessment for improving students learning, still oral questions remained the dominant method of student assessment. Trygstad (2010) found that students engage in very different ways in an inquiry based science classroom and these individual approaches often do not match with the narrow vision of engagement held by classroom teachers.

Beh (2000) studied the effect of instruction in physics on the formation of mental models for problem solving in the context of simple electric circuits. It was found that most students display good procedural understanding for solving problems concerning electric circuits but have no in depth conceptual understanding in terms of practical knowledge of current, voltage, resistance and circuit connections. Andree (2002) studied students' attitude towards physics and found that most of the female students do not like physics based on several reasons such as physics is hard, monotonous and boring subject. A majority of tenth grade female students had no intentions to choose physics or physics related subjects either for their prospective major or for their career choices in the future. Jean (2002) found that participants performed better by trying to understand the physics material and relate physics problems to real world situations. Participants who relied on rote learning did not perform well. John (2003) attempted on overcoming misconceptions of interpretation of kinematics motion using calculator based rangers. Jacob (2004) emphasized on a framework for effective physics education and found that students remembered specific dramatic events from their physics classes, not the regular repetition of lab procedures, and this provides teachers with the opportunity to connect real physics knowledge to dramatic demonstrations or class events. George (2005) & Philippi (2010) aimed to understand effective teaching and learning in the context of middle school science classroom by taking up the unit of electricity and magnetism. They concluded that there are many variables

facilitating learning physics concepts in classroom. Demonstrations of models led to students' conceptual understanding of concepts and showed significant improvement in their application of the learnt concepts. Gaighu (2005) and Bouchard (2006) studied problem solving strategy on performance and conceptual understanding in physics. They found that the problem solving strategy fosters active mental engagement together with learner interaction. Implementing the strategy could enhance students' problem solving skills and understanding of physics.

Rowley (2006) examine the impact of the conceptual change coupled Inquiry cycle on school students' misconceptions of Newton's laws and incline motion. The study was effective and showed significant decrease in the number of students reporting misconceptions about incline motion. Brain (2007) studied representations in physics problem solving and found that the major differences do not lie in whether representations are used, but in how they are used. Victor (2007) studied students' ideas about the kinematics concept of velocity and acceleration. The study identified twenty two incorrect pre conceptions on velocity and acceleration. Albert (2009) found that using clickers with the question sequence significantly improved students' conceptual understanding. Lee (2009) used computer simulations to facilitate conceptual understanding of electromagnetic induction. Results suggested for improvement in the learning framework by providing students with background knowledge necessary to understand model reasoning and integration to various physics concepts. Han (2010) found that it is important to help students to make a solid cognitive ground with perceptual anchor. Sequential abstraction process strengthens students' understanding and help in gradually reaching the abstract level of understanding.

2.5 IMPLICATIONS FOR THE PRESENT STUDY

It has been found from the review of related literature that the status of classroom science teaching at school level is not up to the level of satisfactory Umasree (1999) and Shelat (2012). Researches in Science education are undergoing a paradigm shift and many new approaches and methods have been tried out at research level to bring in innovations in teaching learning process. But how far has the research findings reaching the actual classroom? Are teachers really using these approaches and strategies to create a child friendly classroom wherein the child feels his involvement

in the teaching learning process? Researchers have proved that the ground level reality is different.

Suthar (1998) reported that teachers of secondary level found the syllabus of standard IX science to be difficult as compared with the syllabus of standard X science. Having fears and frustrations while studying science concepts can lead to science anxiety; the reality is often poor performance, lowered self esteem, anger and avoidance of further science courses: Mark Austin (2000). The researcher was able to come across a number of studies wherein different strategies/methods/ approaches were tried out to improve the teaching learning process in science. Aziz (1990) conducted a study on the effectiveness of the information processing model in teaching of chemistry concepts to standard IX students and found thinking could actually be taught if appropriate strategy is used. Parvathy (2004) used activity oriented method in teaching biology to small group and large group students of standard VIII. The present study has resemblance to the studies of Aziz (1990) and Parvathy (2004) as the study takes up selected concepts in physics at secondary level the strategy used is activity oriented approach.

Locating the concept to be intervened is an essential component of the present research work, Kelkar (1998). The present study also looks into the process aspect of science teaching and student interaction, Vijay Kumari (2002) employed different strategies and visualized its effectiveness on the process skills of standard VI students, Menon (1986) found that questions asked by the teachers in evaluation listed the product aspect and not the process aspect of science, Mohapatra (1986) found child's personal experience could be used to develop conceptual understanding with the help of rational thinking process, Rao (1988) found conceptual understanding cannot be achieved by providing just the scientific facts to students, Mohan (1991) found generating an effective participatory learning process blending a number of instructional media might be useful in generating learning situations that fosters interaction of various components of learning process and Vaidhya (1991) established that abstract schemes of thought were difficult to crack. Teacher needs to direct the wrong responses of students in evolving structures of logical thoughts. The implications drawn from these studies helped in designing the intervention programme for the present study.

The studies of Kamalakanthan (1968), Basu (1981), Sivadasan (1981), Jain (1982), Singhal (1983), Agnihotri (1987), Goel & Agbebi (1990), Ayyappan (1997), Joseph (1998), Misra (2005), Gaighu (2005), Bouchard (2006), Rowley (2006) and Brain (2007) helped the researcher to explore the realm of physics teaching. Saxena (1985) found physics students of class X and class XI had maximum preference for 'Recall' and minimum preference to 'Questioning' as their preference style of learning.

The study also seeks inspiration from Vardhini (1983) who developed a multimedia strategy to teach physics and chemistry to standard VIII. Pillai (1987) found instructional strategy based on Gagne's condition of learning implemented on students of standard IX can change the cognitive preference from facts and application to principles and problem solving. The sample was taken from the central board of education. Hanumanthaiah (2000) proved curricular inputs in physics at secondary school level can bring positive creativity inputs and raise the creativity ability of students. Jean (2002) found students perform better by trying to understand the physics material and relate physics problem to the real world situations. Victor (2007) studied students' ideas on concept of velocity and acceleration, identified their misconceptions. Han (2010) found sequential abstraction process strengthens students' understanding and help in gradually reaching the abstract level of understanding.

Uplane (2011) identified the major problems of students in learning physics content in upper primary stage. The researcher then developed a textbook based computer multimedia software package for school students to enhance their academic achievement in physics. Shelat (2011) developed an instructional strategy and checked its effectiveness in achieving comprehension in science concepts of standard VII. The strategy developed included activities/ experiments by students, demonstrations, making toys from trash, showing animated films, power point presentation, making students predict, observe and explain by proving deficient situation. The tools used for the study were observation, field notes, interview schedule, science comprehension test in the form of stories and achievement test.

The researcher felt that "How do we know?" is more important than "What we know in science?". Reviews implies that secondary level science classes reflect the vast majority of effort devoted to helping students acquire information deemed as essential

part of the knowledge base of science. A small part of the class time is devoted to help students make sense of the new information and make connections among the various components of these elements of scientific knowledge in a way that leads to understanding. Moreover even less time is devoted to helping students learn how to apply the abstract, conceptual knowledge of science to the world they experience outside the school (Malhotra, 2006). The review from the various research works implies the effectiveness of different strategies in the achievement of students in science and a few explore into the concept of understanding in science. The researcher endeavours to look into the nature of content and then determine the mode of transaction. The present study attempts to conduct an intervention in the concepts of physics at secondary level using different instructional mode depending on the nature of concept.

The next chapter describes the detailed plan of action taken up for the present study.