CHAPTER – III

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Reference
CHAPTER – III

Review of Related Literature

3.1 Introduction:

The existence of the present always rests on the foundation of the past. A view of history always ascertains the firmness of our present situation. Hence, a summary of writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known and what is till unknown and yet to be testified. Since effective research is based upon past knowledge, this review helps to eliminate the duplication of what has already been done and provide useful directions and helpful suggestions for significant investigation.

Indeed, review of related literature provides academic guide to the researcher and that is why considered as one of the important step of the methodology of educational research. According to Good, C.V. (1959) “surveys of related literature help us to know whether evidence already available to solve problem adequately without future investigation and thus may save duplication. It may contribute to general scholastic ability if the investigator by providing ideas, theories and explanation, help in formulating the problem and may also suggest the approximate method of research”.

3.2 Detailed Review of Related Research Studies carried out in India:

Aziz, Talat (1990) studied on the comparative effectiveness of the information processing models of teaching in developing certain concepts in chemistry at the secondary stage with a view to

(a) Develop teaching programmes in specified content areas in chemistry to teach inductively through concept attainment and inductive thinking models and

(b) Compare the teaching programme based on information processing models with the traditional teaching programme in chemistry with regard to the concept attainment model.

In this study the researcher used 280 students of class IX as sample selected randomly. Researcher developed tools included an achievement test in chemistry and the group test of general mental ability by S.S. Jalota. Data had been analyzed by covariance technique (ANCOVA). The study found that
(a) The pupils exposed to the teaching programme based on information processing model of teaching performed significantly better than the pupils taught through the traditional lecture method,
(b) Chemistry could be effectively taught through the model approach,
(c) Models approach of teaching was better than the traditional approach of teaching,
(d) Concept attainment model and inductive thinking model were effective for teaching science concepts,
(e) Thinking could be taught if appropriate teaching strategies were used,
(f) Bruner’s concept attainment model was effective for attainment of concepts,
(g) Mental abilities of the students had no bars on the concept attainment so far as the students of higher average mental ability were concerned and
(h) Both information processing model were found superior to the traditional approach for teaching concept-based chemistry.

A parallel study was carried out by Joshi, P.K. (1989) on acquisition of chemistry concepts as related to the variables of educational environment with an aim to
(a) Find out the relationship between the variables of educational environment and the acquisition of chemistry concepts and
(b) Find out how far these variables contribute to the prediction of achievement on the chemistry concepts test.

Researcher used 470 grades X pupils from 15 English medium schools through stratified random sampling. Researcher prepared and standardized Teacher and School Proforma and Chemistry Concept Test and School Characteristics Index as tools. Moreover, he used Raven’s Standard Progressive Matrices, Kuppuswamy’s Socio-economic Status Scale and Teacher Attitude Scale by Grewal. Data collected was analyzed by descriptive statistics, correlation, factor analysis and multiple regression analysis. The study found that
(a) Intelligence and socio-economic status of the parents were significantly as well as positively correlated with acquisition of chemistry concepts,
(b) Variables related to teachers had a significant bearing on the performance of students on the chemistry concept test,
(c) The curricular and co-curricular were good predictors of criterion variance, other processes like those of classroom interaction, administration and tradition were not and
(d) Student teacher ratio, class size and total enrolment in school had a negative influence on the acquisition of chemistry concepts.

A similar study was conducted by Saxena, S. P. (1988) on sequential attainment of concept in chemistry through periodic table at the secondary stage with an aim to study the effect of concept-based instruction, using a control and experimental group design.

The study comprised 80 girls as sample. The researcher developed an achievement test as a tool. The data were analyzed statistically using mean, SD, and ‘t’ test.

The study found 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.

Mohapatra, J.K. (1989) conducted a study on 4-dimensions of the teaching-learning of science with a view to
(a) Study the review of related studies on the origin of scientific concepts formation in the minds of children,
(b) Discuss some of the major characteristics of different alternative concepts in the minds of children,
(c) Identify the role of the teacher and the learner in the teaching-learning process in developing and modifying scientific concepts and
(d) Determine the implications of various types of concepts development process in the teaching-learning situations. The study found that
(a) Children made a great deal of conceptualization on the basis of their observation of day-to-day happenings in the environment and in home situations and
(b) The science teacher had an important role in helping the child to develop proper concepts about objects and events by utilizing children’s personal experiences with the rational thinking process.
Similar type of research was conducted by Prakash, Brahma (1990) on effectiveness of concrete materials to enhance learning in physical science with an objective to study whether concretized instruction helps in learning formal level concepts.

The researcher used class IX standard students of two different schools as sample. Researcher developed a multiple choice items as tools and the data so collected are analyze qualitatively. The study found that
(a) The performance of students learning by concretized instruction was better than those learning by traditional instruction,
(b) The average increments in marks of the experimental group of students on concrete level items was 8.8% and that of formal level items, 8.4%,
(c) The use of concrete materials such as charts, models, analogies, more lucid examples and other manipulability materials based on concrete thoughts and sequencing of instruction in a 3-stage (introduction, concept formation, concept application) cycle were found to help the concrete level operators in understanding the formal level concepts more effectively.

A parallel investigation was conducted by Shishta, Rama (1990) on effectiveness of guided discovery learning vis-à-vis the conventional approach to the teaching of scientific concepts in life sciences with a view to
(a) Identify through the analysis of subject-matter, conceptual hierarchies of the concepts of leaf photosynthesis, food chain, purification of air, balance of nature and to identify behaviour specifications of each objective for teaching each concept,
(b) Develop a programmed which would help to encourage curiosity and spirit of inquiry amongst the students about the world in which they live and
(c) Compare the scholastic performance of concept achievement of pupils who undergo a teaching programmed based on guided approach of teaching scientific concepts in biology with pupils who undergo the conventional type of programmed.

The researcher used sample as students of class VII belonging to the Delhi Public School, R. K. Puram, New Delhi. To collect the data researcher used Advanced Progressive Matrices and Achievement Test. The study found that
(a) The performance of the experimental group was superior to that of the control group on the concept achievement test in photosynthesis and
(b) The treatment of teaching concepts of photosynthesis with blended strategies and different modes of teaching had brought significant difference in the achievement of biological concepts.

**Basu, C. K. (1977)** carried out a research on development of science and mathematics concepts in children at primary grades in India with a view to

(a) Investigate the differences in the timing and ways of acquisition of certain basic concepts in science and mathematics between urban and rural children at the primary grades (III to V) in the age group 7 – 11 years,

(b) Determine the sequence of development of science and mathematics concepts in urban and rural children and

(c) Develop strategies by which the results of the study may be used to guide curriculum development work in science and mathematics, especially in the areas of design and production of curriculum materials (texts, aids and apparatus) and the development of appropriate teaching methodology.

The study found that, on the whole, the urban children were faster in the acquisition of the science and mathematics concepts selected for the study. The urban children of all the grades performed better than the rural children of their respective grades on all the tasks designed to study the development of concepts. Among the concepts selected for the study, the performance of the rural children was found to be comparable to that of the urban children with regard to the development of the concept of weight. The easiest of all the concepts was the concept of number for the urban group while for the rural group the easiest was the concept of weight. The concept of energy was found to be the most difficult for both rural and urban children even at the fifth grade level.

**Agarwal, R. and Misra, K.S. (1988)** conducted a similar study for enhancing attainment of science concepts with a view to investigate the effectiveness of the Modified Reception Concept Attainment Model of Teaching (MRCAMOT) for enhancing the attainment of science concepts.

The researcher adopted random sampling method to select 18 students of class VII as sample of the study. The randomized control group pre-test and post-test design was used to collect the data which were treated using Mann-Whitney U-test.
The study found that
(a) The MRCAMOT was decidedly effective in increasing the knowledge and understanding of science concepts of class VII students and
(b) It helped in students’ concept attainment.

**Alexander, P (1989)** carried out a study on a classroom interaction in teaching science at higher secondary level with objectives to
(a) Observe science teachers in the classroom and record their teaching behaviours,
(b) Analyze the classroom behaviours of teachers in the science classes and
(c) Analyze the classroom behaviours of students in science classes.

The sample of the study comprised 40 science teachers and their students from various higher secondary schools in Dindigul, Anna District. The researcher developed a tool viz. Observation Schedule which was used for observing and coding classroom interaction in the science classes. For statistical analysis the frequency of the behaviour and behaviour ratios were computed. The study found that
(a) The most-occurred behaviours in the science class were explaining, illustrating, asking lower order questions, repeating, classifying and comparing, the students observing and the teachers responding,
(b) The least-occurred behaviours in the science class were appreciating, responding to student’s questions, showing exhibits, specimens, displaying models or charts and labeling parts,
(c) The behaviours, ‘asking questions by students’ and ‘using student’s responses’ occurred very rarely in the science class,
(d) Most science teachers asked lower-order questions very frequently and higher-order questions very rarely,
(e) Most science teachers revealed the ‘explaining’ behaviour but very few showed the ‘appreciating’ behaviour and
(f) Teacher-talk was more and student-talk was less in the science class. Teachers exerted a more direct influence in the science class.

A similar type of research was carried out by **Anwar, G. (1991)** on the effect of short-term content enrichment programme to overcome the deficiencies of trainees in
science subjects in TCH course with a view to improve the content competencies of TCH trainees in science subjects, with the help of a short-term content enrichment programme.

In this study researcher had taken randomly 160 students teachers from 5 Teacher Training Institutes. Tools used in the study included Diagnostic Achievement Test and Content Enrichment Programme in General science. The collected data were analyzed statistically using analysis of covariance. The study found that
(a) There was no significant difference among the experimental and control groups in the content competence in general science before the enrichment programme,
(b) There was a significant difference between the experimental and control groups in the content competencies in general science after the enrichment programme,
(c) There was no significant difference between the variables ---- sex, institution, location and SES of student-teachers in the learning of science subjects,
(d) There was no significant difference between experimental and control groups in the learning of science subjects in practice teaching before the enrichment programme and
(e) There was a significant difference between the experimental and control groups in the learning of science subjects and in practice teaching after the enrichment programme.

Awasthi, V. (1989) was conducted a parallel study on developing training strategy for science teaching by using Concept Attainment Model with an objective to
(a) Develop training strategies in teaching science concepts through the Concept Attainment Model and
(b) Study the relative effectiveness of the two training strategies namely continuous demonstration and intermittent demonstration.

The researcher used 22 B.Ed. science and home science trainees in two groups and 162 grade IX pupils as sample of the study. The tools used for the collection of data were Bruce Theory Check-up, Indore Theory Check-up, Teaching Analysis Guide, Reaction Scale and Willingness Scale, Concept Based Achievement Test in science and Pupil’s Reaction Scale. For analyzing the data the researcher used ANOVA and ‘t’ test.

The study found that
(a) Training techniques were equally effective in regard to the understanding of the concept attainment model,
(b) Intermittent demonstration was superior to the continuous demonstration as judged by the teaching competency score and
(c) The teaching competence scores of the two groups at the school stage were significantly higher than the ones obtained by them at the end of the laboratory phase.

**Begum, Khatija H. (1990)** conducted a research on problems of teaching new science syllabus for standard VII in Andra Pradesh and their impact on pupil’s achievement with a view to
(a) Examine the difficulty level and suitability level of all lessons and exercise included in the new science syllabus as perceived by science teachers,
(b) Examine the problems involved in the implementation of the students’ activities suggested in the new science textbook and the problem therein,
(c) Examine the problems faced by teachers about the content and teaching methods in the in-service training programmes,
(d) Study the nature of execution of the exercises faced by teachers within the context of content, teaching methods, audiovisual aids, suggested pupil activities, level of achievement and
(e) Suggest measures which would improve the quality of science teaching.

Using a multi-stage stratified random sampling technique, researcher taken a final sample of 300 teachers and 1500 students was selected from three regions representing Andra Pradesh. Questionnaires, check-lists and achievement tests were used for data collection. Data so collected were analyzed using percentages, chi-square, ‘t’ test analysis of variance and Kramer’s test. The major findings of the study were
(a) More than 60% of the teachers found that content in the recent syllabus new as well as overloaded,
(b) Dictation of notes by teachers was the dominant method of getting exercises done by the students,
(c) Lack of facilities for science teaching continued to bother teachers a lot,
(d) It was observed that achievement in science favoured significantly those students, whose teachers had attended an in-service education programme and
(e) It is proposed that school conditions need to be improved through, say supply of science kits and handbooks for teachers so that pupils may participate in the teaching-
learning process by practicing processes of science such as classifying, inquiring and experimenting etc.

A parallel study was conducted by Biswas, Anju (1989) on learning disabilities in critical thinking in some areas of physical science syllabus with a view to
(a) Diagnose the detailed pattern of disabilities in some areas of physical science and
(b) Try innovative teaching methods which could work as remedial tools.

The researcher used 250 students of class X from 4 schools of backward areas as sample of the study. The tools used included a diagnostic test, an intelligence test and the Academic Motivation Test of Bhattacharya. The collected data were treated with F-ratios and the Mann-Whitney U-test. The study found that
(a) 23 major patterns of disability were identified,
(b) The F-ratio between variance and within classes was significant and
(c) The U-value showed improvement in the achievement motivation of the experimental group.

A similar type of study on facilitations and hindrances to the modernization of chemistry teaching in the schools of Kerala was conducted by Cheriyian, Molley (1988) with a view to
(a) Find out the perceptions of modernization of the participants in education in Kerala,
(b) Measure the quantum of curricular up gradation and quality of conceptual processing in chemistry textbooks and
(c) Identify the major facilities and hindrances in the modernization of chemistry teaching.

The sample of the study comprised of 69 experts, 42 students and 91 teachers for measurement of attitude; 240 teachers for identification of facilities and hindrances in the modernization of chemistry teaching and finally 123 experts for curricular item validation.

The researcher used different types of tools and technique for collecting the data which are a multidimensional frame for text book analysis, attitude scale towards modernization, schedule to measure conceptual dimensions of modernization, questionnaire for information on facilitations and hindrances and curricular item rating
scale. The data so collected were analyzed using percentage, mean, SD, ‘t’ test, correlation and critical ratio. The study found that

(a) There was a gap of a decade between the introduction of modern concepts in chemistry and the corresponding modern pedagogical approaches,

(b) The overall attitude to the modernization of science was favourable,

(c) The correlation between age and attitude was positive for teachers and negative in the case of experts,

(d) Workshops and in service education programmes organized by the department of education received the top most rating within the context of modernization of chemistry teaching,

(e) Several facilitating and hindering factors were identified which related mainly to the administrative aspects.

Central Mechanical Engineering Research Institute, Durgapur (2005) conducted a seminar on science education programmed specially on foundation of physics. The view of the seminar was

(a) To inspire young minds in science,

(b) To first arrest and then reverse the alarming trend of brilliant minds being distanced from the fascinating world of science,

(c) To familiarize students with the conceptual foundations of physics so that this exposure helps the students to come out with a much better and deeper understanding of the most fundamental concepts of the basic branch of physical sciences,

(d) To assess the status of scientific awareness among the people, especially young minds.

The major outcomes that the seminar envisaged was

(a) Inculcation within the students a correct understanding of the process how scientific theories evolve,

(b) Possessing a better idea of the working of science can be of immense help to students during their future career.

A similar type of two day seminar was organized by The Indian National Science Academy (INSA), 2002 on the topic “Science Education Programme ---
Trends and Future Initiatives”. The seminar was mainly based on ‘experience sharing’ in science education bringing together
(a) Those responsible for improving curricula, science textbooks, educationists, teachers from both the formal and non-formal sector,
(b) Those responsible for the professional development of teachers of science,
(c) Those involved in assessment in science education and
(d) Also those interested in science popularization and dissemination of science.

Broadly, seminar focused on science teaching (changing emphasis for teaching, professional development for teachers) and science contents in different branches of science; assessment in science education; science popularization and dissemination.

The outcomes at the end of two day interactive seminar are given below:
INSA, to have a dedicated website on science education in the country that would also help in networking individuals and organizations through knowledge exchange and experience sharing for the improvement of science education with special emphasis on taking science to the masses and encouraging the participation of women towards careers in science. This would focus on issues such as experience sharing, towards improving science education in the country, information on use of experimental materials and inquiry based learning modules. Strategies would then be identified and implemented based on shared experiences. INSA will continue its efforts in the area of science capacity building through its interaction with NCERT, UGC and other national bodies for the promotion of science education.

A parallel seminar was organized by Centre for Cellular and Molecular Biology (2005) on Interdisciplinary approaches in Biology with a view to
(a) Introduce biology teachers to some of the aspects in relation to specific biological problems,
(b) Expose them to the interdisciplinary nature of modern biology with lectures, tutorials, hands-on problem-solving sessions and laboratory demonstrations,
(c) Prepare the biology teachers at the postgraduate level (who train our future generations of biologists) for teaching the new biology that is increasingly becoming interdisciplinary encompassing many fields within and outside biology.
The outcomes of the seminar were to transfer at least some of the excitements of interdisciplinary studies in modern biology to the participants who in turn would be able to pass on the same through their teaching to their students.

**Chandra and Pandya (1996)** studied the effect of video films for imparting legal education and found that students of science stream achieved higher than students from the art stream. Similarly, those students who had studied in English medium schools did better than those who had studied in vernacular schools.

Similar research was carried out by **Kalimuthu, T. (1991)** on developing a video programme on environmental pollution in biology for higher secondary students with an aim to

(a) Prepare a video programme on environmental pollution for instructional use for higher secondary students and

(b) Find out whether the video method is more effective than the traditional lecture method in teaching the concepts on environmental pollution.

The researcher used 60 students of standard XI as sample of the study and prepared a video lesson on environmental pollution of 36 minutes for the study. Mean, SD and ‘t’ test were applied for statistical analysis. The study found that

(a) The higher secondary students taught through the video programme learnt more of the concepts on environmental pollution than those who were taught by the lecture method and

(b) The higher secondary students improved their achievement on environmental pollution after viewing the video programme.

A parallel study was conducted by **Sinnathambi, V. (1991)** on developing a video programme on energetics in chemistry for higher secondary students with a view to

(a) Prepare a video programme on ‘energetics for instructional use for higher secondary students,

(b) Find out experimentally whether the video method is more effective than the traditional lecture method in teaching the concepts on ‘energetics’ and

(c) Find out whether the higher secondary students improve their achievement after viewing the video programme on ‘energetics.
The researcher used sample consists of 60 students from class XII at K.R. Government Higher Secondary School, Oddanchatram and at S.M. Girls’ Higher Secondary School, Chatrapatty in Anna District. The researcher prepared a video lesson on ‘energetics’ lasting for 46 minutes. Data had been analysis by ‘t’ test. The study found that (a) The students who were taught by the video method learned more concepts on ‘energetics’ than those who were taught by the lecture method and (b) The students improved their achievement on ‘energetics’ after viewing the video programme.

**Joshi, V. (1987)** conducted a study of the effectiveness of school television programmes in science at the secondary school level with objectives to (a) Study the STV programmes in science in terms of instructional objectives, number of programmes, content coverage, its suitability and resources required, (b) Study the impact of STV programmes on the scholastic achievement and scientific attitude of students and (c) Study the effect of intervention activities on the achievement and attitudes of students.

The sample included all the personnel from the production end of STV programmes to the utilization end, covering 50 school principals, 180 school teachers and 200 students. The tools used by the researcher included Questionnaire, check-list, unstructured Interviews, Raven’s Progressive Matrices and Vardhini and Ravindranath’s scientific Attitude Scale. The collected data were treated by content analysis, percentages and ANCOVA. The major findings of the study were (a) The STV programmes had not changed over the years and the coverage of different science subjects was inappropriate although 40% of the total course was covered, (b) The time given for preparation of STV programmes was insufficient, (c) The quantity of STV programmes was poor although the timing and duration were appropriate, (d) No significant difference was found in the scientific attitude of students exposed and students not exposed to STV programmes in the three groups and (e) No significant difference was found in the scholastic achievement of students in the three groups.
A similar study was conducted by Kothari and Chowdhari (1995) on behaviour of students of different age levels due to the impact of T. V. programmes and they found that girls had more positive effect on their emotional and creative behaviour than boys. As regard the impact of T.V. programmes on moral behaviour, negative effect was more than the positive one.

Bhattacharya, Madhusima (1989) worked on a critical review of work done on the use of computer as an instructional tool for teaching chemistry with an aim to develop tools for evaluating the effectiveness of available software in chemistry along with suggestions in regard to the development of software in other areas of chemistry which are likely to be included in the curriculum.

The researcher developed a questionnaire for collecting the data. The research found that
(a) The available software in chemistry were of good quality,
(b) Background knowledge was inferred in most of the chemistry software,
(c) It was not always possible to maintain the sequence of content, especially in games,
(d) Most of the available software adopted lecture-cum-demonstration method in a class of 20-40 minutes,
(e) Most of the software contained knowledge and discovery level of teaching but they lacked in reflective level,
(f) Computer assisted instruction could be applied most effectively to an individual or to small groups,
(g) The majority of the software could be used for concept development,
(h) The softwares that have been selected for classroom teaching mainly provided simulation of a real situation thereby assisting students in long-term retention,
(i) The students got proper feedback and
(j) Technical quality of the majority of software was satisfactory.

Sahni, Renu (1991) conducted a similar study on cognitive and non-cognitive factors leading to success in computer science on senior secondary schools in Delhi with a view to
(a) Study the gender differences in performance, attitude, intellectual commitment and cognitive ability in computer science,0
(b) Study the relationship between some specific cognitive skills and performance in computer science, viz. algebra and arithmetic problem-solving skills, procedure and direction following skills, logical reasoning ability,
(c) Study the relationship between
(i) Students’ attitude towards computer science and their performance in it,
(ii) Intellectual commitment and performance,
(iii) Performance in computer science and in mathematics, physics, chemistry, English and overall percentage,
(iv) Family income and performance
(d) Determine the significant prediction of success in computer science,
(e) Study the use of computer at home, using calculators and time worked on computer on the performance in computer science.

The study comprised 614 students as sample from different schools like Central Board of Secondary Education and the Indian School Certificate Examination. The tools used by the researcher in the study included battery of seven cognitive abilities tests, intellectual commitment scale, proforma for demographic information of the students, proforma for the teachers of computer science, the list of marks in computer science, mathematics, physics, chemistry, English and the overall percentage were also considered. The collected data had been analyzed by different statistical techniques like mean, SD, ‘t’ test, coefficient of variance, correlation and multiple regressions.

The study found that
(a) The performance of male and female students in computer science showed no significant difference,
(b) The difference between the scores of male and female students on the attitude scale was not significant,
(c) The performance of male students was superior to female students on the tests of algebra problem-solving, arithmetic problem-solving, spatial ability and verbal reasoning,
(d) No significant difference was observed in the performance on procedure following test, direction following test and logical reasoning test,
(e) Males and females were found to possess highly positive attitude towards computer and computer science and their scores on the attitude scale were equivalent,
There was no gender difference in intellectual commitment: both pursued their studies with equal sincerity,

The results revealed that both specific and general cognitive skills had highly significant relationship with performance in computer science. Both males and females had highly positive attitude towards computer science,

The correlation between performance in computer science, mathematics, physics, chemistry, English and overall percentage were highly positive and significant,

The correlation between family income and performance in computer science was not significant for experimental group I and was negative and significant for group II,

The correlation between educational level of parents and their children’s performance was not significant for both the groups,

The performance of students having a computer at home was marginally higher than those who did not have one, using or not using a calculator did not emerge as a potent factor predicting performance,

The performance improved when computer time used per week increased beyond 1-2 hours, confirming the effects of practice.

Mitra, J. (1989) conducted a study on experimental project to develop need-based and community oriented self-learning instructional materials in biology for the elementary level rural pupils of the formal system and drop-out children at this stage with a view to

(a) Conduct a community survey for identifying various areas of community problems and needs which have direct or indirect relevance to biology education,

(b) Collect resource materials to be used in developing self-learning instructional materials and

(c) Develop need-based and community oriented self-learning instructional materials.

Researcher adopted a survey method to draw the sample from 8 villages which included 10 to 25 parents / adult males and females ranging from illiterates to people having education up to elementary school and a few matriculates.

The researcher developed a questionnaire to collect the data and arranged a 6 day workshop for getting the feedback.
The study found that various areas of community problems and needs which had a direct or indirect relevance to biology education.

**Deshmuk, A.L. (1991)** carried out a research on science education as a means of social change with special respect to health and hygienic habits with a view to

(a) Find out to what extent the objectives of science education related to health and hygiene were realized,
(b) Find out the difficulties faced by the families in developing appropriate health habits,
(c) Find out the difficulties faced by the teachers in developing appropriate health habits among pupils,
(d) To prepare a programmed for modifying existing health habits of students and
(e) To examine how far students are able to transfer the ideas and principles of health habits to their homes.

In this study, researcher taken a survey of 368 students from standards I-IV and 482 students from standards V-VII. For the experiment, the study sample comprised 160 students taken at random from 16 different schools situated in different localities classified as moderate, better and rural. 104 parents were also interviewed. The tools used for the collection of data were check-up sheets, family health cards and observation schedules and check- lists specially developed by the investigator.

The out comes of the study were
(a) Using pre-test post-test control group experimental design, the programmed so developed was found to be effective as judged by gains in scores favouring the experimental groups and
(b) However, it was noticed that there were some serious difficulties such as loaded curriculum, lack of physical amenities and time, ignorance of parents and failure to practice by the students in their homes what they had otherwise understood in the classroom.

A parallel study was conducted by **Ghosh, A.M. (1990)** on non-formal Science Education and development of inexpensive resource materials with a view to develop a programme and investigate some topics such as nutrition (inexpensive balanced diet), use of water hyacinth as a plant growth promoter and the physical properties of wood.
The target group chosen for participation in these studies was selected essentially from socially disadvantaged groups who had little or no possibility of being exposed to further formal education. Both urban and rural participants were involved in the project. The tools used to collect the data included a questionnaire and district health records. The collected data were treated qualitatively and quantitatively. The study found that

(a) Several participants were actually utilizing their knowledge in the preparation of daily food of the family even several months after the termination of the programme,

(b) The growth rate increased for leafy vegetables, varying from marginal to 30% depending on the type of plants and the extract used. It also established the general methodology of basic agricultural studies,

(c) Traditional method which emphasized familiarity gained through practices was in no way inferior to the methods proposed in the project. On the other hand, persuasion of scientific methods of structural industries at a still higher level would be only rarely needed in actual practice and this did not encourage enthusiastic participation in the programme and

(d) A positive correlation was established between the onset of pulmonary diseases and the presence of nitrous fumes among workers in jewellery manufacturing shops. However, the remedies suggested were not acceptable because they hampered production.

A similar study was conducted by Mohan, Radha. (1991) on effective concept learning in science education--- a theoretical instructional mode with a view to

(a) Make a rational analysis of the factors of learning context, instructional strategies, process of development of scientific concept, interaction process and the role of learners in different learning situations,

(b) Identify the steps for concretization of concepts through a progression process from concrete to quasi-concrete to abstract representation and

(c) Evolve a theoretical instructional model for effective utilization of a variety of instructional tools for ensuring proper learning by students.

The researcher used rational analysis method of analyzing research studies and attempted to present models of unstructured process through diagrams and visuals.

The study found that
(a) In planning instructional strategies, the sociocultural factors, the educational environment and the learner’s style of learning have to be given due consideration,
(b) Blending a number of instructional media might be useful in generating a learning climate that fosters interaction of various components of learning process,
(c) In the selection of learning strategy, the active role of the learner, the place of teacher, learning materials and process of concretizations for concept development had to be cautiously designed keeping in view the learning theory evolved by psychologists and educationists like Bruner, Ausubel, Dienes and Piaget and
(d) While determining locus of control in the teaching learning process, the impact of external factors outside the learner as well as internal factors within him/her had to be carefully considered.

Sharma, R.K.(1978) conducted a similar study to investigate the relation between ‘Output’ and ‘Input’ on science education of higher secondary schools of Delhi Administration, Govt. Boy’s higher secondary school, Bijwasin.

The objectives of the study were to
(a) Know the position in respect of provision of opportunities in respect of areas, viz. urban and rural and in respect of boys and girls schools comparatively,
(b) Compare unit costs of urban schools with those of the rural boys vs. girls and to know their relative position in it and
(c) Compare costs with the performance in the public examination in different categories of schools included in the sample of the study to know cost effectiveness and performance efficiency.

The researcher developed information blank comprising two major sections was designed to collect detailed information in respect of educational cost (input) and performance (output) of science education in higher secondary schools. Part I contained items regarding cost (expenditure) incurred and part II contained items regarding class XI students’ performance in public examination of old higher secondary scheme of CBSE, Delhi. The sample consisted of 39 schools drawn out of 185 schools by stratified random sampling technique. The study found that
(a) Taking into consideration population density, the provision of science education facilities area wise was adequate,
(b) Unit costs worked out for the two areas revealed that the unit cost in the rural areas was much higher as compared to urban area schools, both boys and girls,
(c) ‘Output’ in science education in higher secondary schools of Delhi Administration was found to be commensurate with the ‘input’—— man and material resources,
(d) The quality of educational ‘output’ was found to be better in the case of girls,
(e) The quality of results in urban areas (both boys and girls) was found to be superior to the performance of the students in the rural areas,
(f) Costs were proportionally the same for the schools teaching Science according to their size, i.e. the enrolment of students, the courses provided vis-à-vis the medical and non-medical either or both and
(g) In rural schools, the teaching of science was uneconomical in terms of enrolment in science courses and performance as well in public examination.

Dubey, K.K. (1992) carried out a study of the scientific temper and its measurement. The objectives of the study were
(a) To develop a scale for measuring scientific temper along with its appropriate working definition and determination of its ingredients using factor analysis and
(b) To compare the incidence of scientific temper as judged by scores on the scientific temper test among different groups of teachers and students, such as male and female, urban and rural and Science and non-science students as well as teachers.

The researcher adapted a two-stage stratified sampling method to select class XI Science and non-science students. It also included two groups of teachers, i.e. Science and non-science teachers. The scientific temper scale devised on the Likert method of summated ratings was used to collect the data. The study found that
(a) All the groups of students and teachers manifested scientific temper,
(b) Significant differences in scientific temper were noticed between male Science teachers and male non-science teachers; female teachers and male teachers, rural girls and urban girls, urban boys and urban girls and finally, male Science students and female Science students,
(c) No significant differences appeared between female Science and non-science teachers as well as Science students and non-science students and
(d) The mathematical structure of tools and tasks as used in this study showed the existence of two factors, namely curiosity and aversion to superstition.

**Javlekar, V.D. (1988)** evaluated the effectiveness of exhibits of the Nehru Science Centre with a view to develop scientific concepts among class VIII students.

He found that participatory museum displays convey scientific concepts more effectively than other methods, regardless of socio-economic status.

A parallel investigation was carried out by **Javlekar, V.D. (1988)** on problem of evaluation of the educational importance of exhibits of Nehru science centre, Bombay and its effectiveness in making children of standard VIII understand scientific concepts with a view to
(a) Examine the effectiveness of a participatory exhibit in conveying the scientific concept,
(b) Assess the instructional value of the exhibit,
(c) Assess the general effect of socio-economic background of children on learning through this technique and
(d) Assess the appropriateness of the exhibit from the view point of label, length of level and nature of exhibit.

In the first phase, the investigator assigned 50 students randomly to 4 different experimental conditions. The final phase followed the pre-test and post-test control group design where 190 students were randomly assigned to the experimental and control groups. Regarding exhibits, 5 were passive, 62 were active and the remaining 7 were interactive. The pre-test and post-test means were compared. The study found that
(a) Participatory museum display helped in conveying scientific concepts more effectively than the other methods,
(b) The instructional power of interactive exhibit was found to be greater than that of active exhibits, though the degree of learning was limited,
(c) The socio-economic status of students did not affect learning through exhibits and
(d) No uniform pattern for locating the text of the label was discovered.

**Darchingpui (1989)** carried out a study of science achievement, science attitude and problem solving ability among secondary school students in Aizawal.

The objectives of the study were
(a) To study the science achievement, attitude towards science and problem-solving ability of high school students,
(b) To find the interrelationships of science achievement attitude towards science vis-à-vis problem-solving ability and
(c) To examine the relative effect of sex, socio-economic status, parental education, parental occupation, family facility and type of school on science achievement, science attitude and problem solving ability.

In this study the researcher taken a sample comprised of 812 students of class IX selected randomly after giving weightage to outside factors such as location and typology of school attended. The tools used to collect the data were the science test developed by the investigator, the science attitude scale developed by Grewal and problem solving ability test developed by the investigator. The study found that
(a) There was a significant relationship between scores on scientific attitude and achievement in Science,
(b) Significant sex differences in achievement in science and problem-solving ability existed and
(c) High socio-economic status, family facility and type of school attended favoured achievement in sciences, scientific attitude and problem-solving ability.

Kar, D.K. (1990) carried out a similar research on relationship between attitude towards and achievement in general science of class IX students of Cuttack city to assess the relationship between the attitude and achievement in general science of class IX students of Cuttack city.

The sample of the study comprised 700 students studying in class X from 10 high schools of Cuttack city and also included 74 science teachers and some science experts, professors, educationists and headmasters of the schools, who were selected through random stratified sampling method. The tools used to collect the data were questionnaire, interview schedule, achievement test in science and attitude scale. The collected data were analyzed statistically using measures of central tendency, variability and correlation coefficient. The study found that
(a) The distribution of the attitude score was negatively skewed,
(b) Boys were found to be more favorably disposed towards science than girls and
There was a positive relationship between attitude and achievement.

Kumar, Udaya Sam (1991) did a similar investigation on the development of scientific attitude in secondary school students in relation to achievement in general science with an objective to

(a) Find out the extent of scientific attitude of the secondary school students,
(b) Find out whether there was any significant difference in the perception of teaching science and scientific attitudes of pupils of low effective group, high effective group and average effective group and
(c) Find out the nature of relationship between the scientific attitudes and achievement of the secondary school students in general science.

The researcher used 402 students as sample drawn at random from 8 different schools. The tools used in the study included the Scientific Attitude Test (SAT) by F. M. Phateed and Pupils’ Perception of Teaching Science constructed by the researcher. To interpreting the data, researcher used mean, SD, ‘t’ test, correlation and chi-square tests.

The study found that
(a) There was a significant difference between the mean scores of boys in the average effective group in respect of perception of teaching of science,
(b) The urban and rural pupils of average group differed in respect of perception of teaching of science,
(c) There was no significant difference between the mean scores of scientific attitude of secondary school students of boys and girls in the high effective group in respect of perception of teaching science,
(d) There was no significant difference between the mean scores of perception of teaching of pupils of urban and rural areas in the high group,
(e) The scientific attitude test scores of boys and girls of the average group differed significantly and there was no significant difference between the means of scientific attitude test scores of the pupils of urban and rural areas of the average group,
(f) The mean scores of the scientific attitude test of boys and girls did not differ significantly in the high group and the mean scores of the scientific attitude test of the pupils of urban and rural areas in the high group differed significantly,
(g) There existed a relationship between urban boys and urban girls in scientific attitude test scores,
(h) The science test scores of urban boys and urban girls were positively correlated,
(i) The means of boys and girls in low group did not differ significantly in respect of scientific attitudes,
(j) There was a significant difference between the means of the boys and girls in the low group in respect of perception of teaching of science and
(k) There was a significant difference between the means of the pupils’ of urban and rural areas in the low group in respect of perception of teaching of science.

A parallel investigation was carried out by Malviya, Dharma Shila (1991) on student’s attitude towards science and interest in science of school going adolescents with a view to
(a) Develop an instrument to measure students’ and teachers’ attitude towards science,
(b) Measure the students’ interest in science,
(c) Study the relationship of attitude towards science and interest in science,
(d) Compare different factors of attitude towards science boys and girls and
(e) Compare the attitude towards science of teachers and students.

The sample of the study comprised 193 teachers and 820 students of class X from 20 schools. The researcher used Attitude Scale (Likert method of summated rating scale 5 point and Interest Inventory by Raghu Raj Pal Singh) as tools to collect the data which were analyzed by using mean, mode, median, ‘t’ test, one way analysis of variance and correlation. The study found that
(a) A positive attitude towards science as observed among all the students,
(b) Significant difference between means of rural school and urban school boys and girls revealed that attitude towards science differed in respect of sex in early ages,
(c) No significant difference between male and female teachers’ attitude towards science revealed that sex had no effect on the attitude towards science in the later years,
(d) Significant difference between means of rural school and urban school boys and girls revealed that attitude towards science differed in respect of area,
(e) No significant difference between experienced and new teachers revealed that an increase in age had no effect on attitude towards science,
(f) Coefficient of correlation between the difference factors of interest showed moderate correlation with each other,

(g) Coefficient of correlation between the difference factors of attitude towards science showed moderate correlation with each other,

(h) The students who had got higher positive attitude towards science would also have higher scientific interest,

(i) Attitude and different factors of interest i.e. mechanical, business, scientific, aesthetic were significantly correlated and

(j) A ‘t’ test analysis of attitude scale showed significant positive gains in attitude towards science for the entire groups of students.

Mandila, Shyam Singh, (1988) did a similar research on attitudes of secondary stage students towards science curriculum and its relationship with achievement motivation with a view to

(a) Determine the attitude of Science students about Science curriculum,

(b) Compare the differences between urban and rural, intelligent and weak, male and female students about the attitudes towards Science curricula and

(c) Determine the extent and direction of relationship between attitude and achievement.

The researcher had taken a sample of 500 students which was drawn through the survey method. The tools included in the study were an Attitude Scale by the investigator and Achievement Motivation Test by Prayag Mehta. The collected data were analyzed qualitatively and quantitatively. The study found that

(a) Students from rural and urban schools as well as male and female had favourable attitude towards Science curriculum,

(b) There were significant differences in some aspect such as scientific temper and teaching methods,

(c) Students from urban schools scored highest on the achievement test,

(d) Most of the weak students scored less on the achievement test,

(e) Female students scored higher than their male counterparts and

(f) Enrich academic programmes helped in developing favourable attitudes.
A parallel investigation was carried out by Sam, Udaya Kumar (1992) on the teaching of general science and the development of scientific attitude in secondary school students in relation to achievement in general science with an objectives to

(a) Find out the extent, to which the secondary school students were having scientific attitudes,

(b) Find out whether there was any significant difference in the perception of teaching science and scientific attitudes of pupils of low effective group and high effective group and

(c) Find out the relationship between the scientific attitudes and achievement of the secondary school students in general science.

The sample comprised 402 students selected randomly from 8 schools in Cuddalore Educational District. Tools used included Scientific Attitude Test of P.M. Phateed and Pupils’ Perception of Teaching of Science by the researcher. Mean, SD, correlation analysis, ‘t’ test and chi-square test were used to treat the data. The study found that

(a) There was significant difference between mean perception scores of boys and girls in average effective group in respect of teaching of science,

(b) The urban and rural pupils of average group differed in their perception of teaching of science,

(c) There was no significant difference between mean perception scores of boys and girls in the high group in respect of teaching of science,

(d) There was no significant difference in perception of teaching of science by pupils of urban and rural schools in the high group,

(e) The scientific attitude test scores of boys and girls of the average group differed significantly and there was no significant difference between the means of scientific attitude test scores of the pupils of urban and rural areas of the average group,

(f) The mean scores of the scientific attitude test of boys and girls did not differ significantly in the high group and the mean scores of the scientific attitude test of the pupils of urban and rural areas in high group differed significantly,

(g) The means of boys and girls in low group did not differ significantly in respect of scientific attitude,
(h) There was significant difference between the means of the boys and girls in low group in respect of perception of teaching of science and
(i) There was significant difference between means of the pupils of urban and rural areas in low group in respect of perception of teaching of science.

A similar investigation was carried out by Rao, Bhaskara; D. Joseph; Raju, B. and Rao, Sundara G. (1989) on scientific attitudes of in-service and pre-service science teachers with an attempt to identify the nature and quality of scientific attitudes possessed by in-service and pre-service science teachers.

The researcher used 183 teachers covering 36 in-service and 147 pre-service teachers. Different types of tools viz. Cause Effect Relationship of D. Gopal Krishna, the Open Mindedness of M. James Kozlow and Marshall A. Nay. For treating the data mean, SD and chi-square were calculated. The study found that
(a) The distribution of scientific attitudes namely freedom from superstition, ability to identify the cause-and-effect relationship and open-mindedness was not normal,
(b) There was not much difference in the attitude between in-service and pre-service science teachers,
(c) 34.43% teachers were not superstitions,
(d) 54.25% of the sample was able to identify the cause-and-effect relationship,
(e) 24.04% of the sample was open-mindedness,
(f) None of the variables were associated with the attitudes except the medium of instruction and
(g) Scientific attitudes were distributed independently in the sample and were independent of each other.

Kayathri Alias Usha, S. (1989) did an investigation into the effectiveness of Jerry Luca’s Memory Model in learning Botany with a view to
(a) Develop and test the effectiveness of memory training model in studying Botany along the lines of Jerry Luca’s Memory Model and
(b) Assess the effectiveness of this memory training model in improving the achievement of students in Botany and also the effectiveness of Luca’s memory training model over the traditional memory training techniques.
The sample of the study comprised 60 science students of Higher Secondary School standard. The data were analyzed using statistical techniques such as mean, SD and ‘t’ test. The findings of the study were:
(a) Training through Jerry Luca’s Memory Model positively influenced retention of what was learnt in cytology and taxonomy in Botany and
(b) Students who had been trained through Jerry Luca’s Memory Training Model differed significantly in their achievement in Botany from those students who had been trained through the traditional memory training techniques.

**Malhotra V.K. (1988)** conducted a critical study of the existing facilities of science teaching and construction of evaluation instruments for its supervision in different types of secondary schools in Delhi with a view to
(a) Construct and standardize evaluation instruments for various studies, e.g. existing facility, supervisory practices, process and organization of faculty meetings, various growth efforts of the principals, supervisory practices etc. and
(b) Study the existing condition of teachings of science in different types of schools with special reference to supervisory practices.

The researcher used sample comprised of 75 students drawn through stratified random sampling method from 15 schools viz. public, Govt. and central schools. The tools used were evaluation instruments of two parts to be used by subject supervisors and education officer. The collected data were treated using mean, S.D., ‘t’ test and F-ratio.

The study found that the 3 types of schools differed significantly in many cases like
(a) Existing facilities for science based co-curricular activities,
(b) Existing human facilities,
(c) The supervision of the theory classes,
(d) The supervision of the practical classes,
(e) The supervision of science based co-curricular activities,
(f) Supervisory practices of the faculty meetings,
(g) Related facilities for the supervisory practices.
(h) Welfare of the students and
(i) The public schools scored high uniformly.
A parallel investigation was carried out by **Sundararajan, S. (1988)** conducted a study on an evaluation of the teaching of biology at higher secondary stage in Tamil Nadu with a view to

(a) Determine the extent of awareness as well as the realization of the objectives of teaching biology on the part of the teachers of biology at the higher secondary stage,

(b) Find out the teaching strategies employed, identify the teaching model used, if any and also examine the problems faced by them in their teaching of biology,

(c) Determine the adequacy or otherwise of the practical activities organized for the +2 stage biology students,

(d) Evaluate the physical facilities available in schools for the teaching of biology,

(e) Evaluate the biology syllabus at the +2 stage in respect of its objectives, selection and organization of content,

(f) Evaluate the biology textbook used at the higher secondary stage in Tamil Nadu,

(g) Identify the weakness inherent in the present system of external examinations in biology at the +2 stage, both written and practical,

(h) Evaluate the students’ achievement in biology and identify the areas of their weakness, if any,

(i) Find out the extent to which students at the +2 stage are favourably disposed towards the study of biology,

(j) Determine if boys and girls studying in urban and rural schools have the same level of achievement in biology or not and also, if they are similarly disposed towards its study and

(k) Determine if there is any relationship between the students’ achievement in biology and their attitude towards its study.

The researcher selected 1000 students from 105 higher secondary schools by the random selection method as sample. The sample also included 278 biology teachers and 60 experts. The tools used by the researcher were Questionnaire, a Perception Scale, an Inventory of Physical Facilities, an Opinionnaire, an Achievement Test and an Attitude Scale. The collected were analyzed with means, percentages, product-moment correlation and chi-square. The major findings of the study were
(a) Hierarchy of the objective related to the teacher gave more importance to the knowledge, followed by understanding, application and skills,
(b) General teachers were found to follow only the expository type of teaching strategies in their teaching of biology. They did not encourage discussion among the students and other student-centred teaching techniques,
(c) The higher secondary biology syllabus was only related to the students’ abilities and to their real life. It was not conducive to the students learning to the scientific method, the development of scientific interests and a favourable attitude towards the study of biology in them and their appreciating the contribution of biology to human civilization. It was overloaded with facts, traditional and product oriented,
(d) The biology text book too was found to be defective in many respects,
(e) The biology laboratories were in a bad shape,
(f) Objective type questions were not asked in the final higher secondary examinations conducted by the Government of Tamil Nadu and there were no questions testing the ‘Application’ objective in biology,
(g) The urban boys did not show greater achievement in biology than the rural boys and the urban girls respectively. But the urban girls showed greater achievement in biology than the rural girls and the rural boys too showed greater achievement in biology than the rural girls in respect of knowledge, understanding, application and skills,
(h) The majority of +2 biology students had a favourable attitude towards the study of biology and
(i) There existed a positive relationship between the higher secondary students’ attitude towards the study of biology and their achievement in it.

Mohanty, S. (1988) conducted a similar research on an appraisal of teaching science in the high schools of Cuttack city with a view to
(a) Asses the existing position of teaching science in the high schools of Cuttack city and
(b) Recommend appropriate remedial measures for improving the quality of instruction to increase the efficiency of students in science.

The researcher used sample comprised of 370 students studying in class X and science teachers from 28 schools of Cuttack city were also included. The tools used in the study included questionnaire, interview schedule and achievement test in general science.
The collected data were analyzed statistically by using mean, median, mode, S.D. and Q.D. The study found that

(a) After administering tests in two subsequent years, the performance of the students in the second test was slightly inferior to the first test,
(b) Though various factors like pupil ability, the teacher’s teaching methods and laboratory facilities were almost the same from year to year,
(c) According to the expert, the present syllabus was very tough and it was very difficult to grasp all the concepts in 10 years of schooling. They also opined that the board of secondary education, Orissa should appoint mere experts in science to improve science teaching in the state and also to revise the science syllabus keeping in view the teacher’s position, laboratory facilities and the standard of the students,
(d) As regards the equipment and laboratory, all the schools were deficient. All the teachers followed the demonstration-cum-discussion method for teaching science which was suitable for their condition,
(e) The schools were deficient in audio-visual aids like projectors, overhead projectors, television sets etc,
(f) The outcomes of learning were not properly assessed by the schools. The questionnaire revealed that the outcomes of cognitive domain were assessed to some extent and the outcomes of affective domain were not assessed at all and
(g) The science funds available to the schools were very meager. So the schools could not do a lot for the development of science education by organizing science fairs and science exhibitions in the schools.

**Manocha, Vineeta.** (1991) carried out a study on development of textual material in biology for class IX using Bruner’s Concept Attainment Model of teaching with a view to

(a) Develop textual material on biology concepts for class IX on Bruner’s Concept Attainment Model (CAM) of teaching and
(b) Determine the comparative effectiveness of the developed textual material in terms of Reception vs. Traditional, Selection vs. Traditional and Reception vs. Selection strategies.
The researcher used class IX students of a higher secondary school of Indore as sample of the study. The tools developed by the researcher for collecting the data were Achievement Test, Student Willingness Reaction Scale, Willingness Scale for teachers and Reaction Scale of CAM for Trainee-Teachers. Mean, SD, ‘t’ test and ANCOVA were used for the analysis of data. The major findings of the study were
(a) The reception strategy of CAM was significantly superior to the conventional group when matched on the pre-test achievement scores,
(b) The CAM was found to be significantly superior to the conventional method in teaching biology to class IX students when compared to the pre-test achievement scores,
(c) The selection strategy was superior to the conventional group when matched on the pre-test achievement scores,
(d) There was no significant difference between selection and reception strategies with respect to achievement scores,
(e) The pupils’ reactions to reception and selection strategies were highly favourable and
(f) The teachers’ reactions to and willingness for the CAM were highly favourable.

Muruganandam, S. (1990) conducted a study on development of teaching-learning strategies in teaching science for visually impaired children with a view to
(a) Prepare teaching-learning packages in science for teaching visually impaired children and
(b) Compare the effectiveness of teaching with prepared packages on achievement over the traditional method of teaching.

The sample comprised 27 visually impaired children of class VI and VII in the Government School for the Blind, Madurai and St. Joseph’s School for the Blind, Paravai. The researcher constructed and used various tools like Multi- Sensory Skill Test, Criterion Test and Reaction Scale. The collected data were treated with mean, SD and ‘t’ test. The study found that
(a) The visually impaired children learned more science concepts when they were taught through the specially prepared teaching-learning materials and
(b) The learning package on science teaching for visually impaired children was found effective.
A parallel investigation was carried out by **Vaidya, N. (1991)** on developing teaching-learning strategies for enhancing student achievement in science with a view to
(a) Collect and survey research findings to classroom teaching in the area of motivation, reinforcement, thinking skills and classroom control,
(b) Relate these research findings to content in science by writing lesson plans and modules,
(c) Test the lesson plans/modules empirically under controlled conditions and
(d) Develop teaching-learning strategies for the enhancement of achievement in science.

The researcher adopted 33 children of grade VI by random sampling method as sample of the study. Questionnaire and the modules had been used to collect the data which had been analyzed with percentage. The study found that
(a) It was possible to discern a pattern of common thought with coefficients of fluctuations of thought remaining under the permissible limit of 10%,
(b) It was possible to accelerate thought under certain conditions such as arranging thought-provoking problems in their hierarchical order but abstract Piagetian schemes of thought were difficult to crack and
(c) It was very much possible for children to help themselves in their day-to-day teaching-learning provided, the teacher did not always insist on the right answer. The wrong answers, in fact, revealed the evolving structures of their logical thought.

**Pandit, B.L. (1989)** conducted a study on identification and measurement of chemistry laboratory skills of senior secondary school students of Delhi with a view to
(a) Identify chemistry laboratory skills at class XII in senior secondary schools,
(b) Construct tests to measure the achievement of students in the chemistry laboratory skills and
(c) Find the effect of factors such as type of school, sex, type of examination, socio-economic status and out-of-school activities on the development of chemistry laboratory skills.

The researcher used 3 types of schools namely public school, K.V. and Delhi administration schools and from each of these schools, students of one section were randomly chosen.
The researcher used tools as Entry Level Test, Terminal Level Test, Theory Tests and bio-data sheets. To analyze the data, ANOVA, ‘t’ test and ‘z’ tests were used.

The study found that
(a) From the cognitive and psychomotor domains of learning, a comprehensive list of chemistry laboratory skills were prepared which were needed for class XII students,
(b) It was possible to construct tests for measuring various chemistry laboratory skills with a high degree of reliability and validity,
(c) It was possible to classify several chemistry laboratory skills into major skills,
(d) A significant correlation was found between the ability to learn the subject-matter content and the ability to learn cognitive as well as manipulative laboratory skills,
(e) There existed a significant school variation in the achievement of chemistry laboratory skills and
(f) It was observed that factors such as type of schools, sex, etc. had significant effect on the acquisition of laboratory skills.

Radhamonyamma (1988) studied on evolving instructional techniques appropriate to the development of various scientific skills among secondary school pupils in Kerala with a view to
(a) Find out the methods adopted for teaching science in secondary schools,
(b) List the scientific skills that can be developed through science teaching,
(c) Construct an achievement test based on scientific skills,
(d) Find out the general nature of attainment of pupils in scientific skills,
(e) Plan a suitable method for developing scientific skills,
(f) Prepare lesson plans for selected topics,
(g) Try out the method on a representative sample and
(h) Test the effectiveness of the new method.

The sample comprised 50 pupils selected through stratified random sampling technique. The researcher used tools and technique viz. observation of classes, an opinionnaire and an achievement test in science developed by him. Data so collected had been analyzed by central tendencies, mean, SD, CR values and Pearson product-moment correlations. The major findings of the study were
(a) The newly evolved method for teaching of scientific skills through tested lesson plans was more effective than the traditional method and (b) The correlation between marks scored in different science subjects were higher for the experimental group as compared to the control group.

Rao, K.N. and Gupta, M.K. (1990) developed a study on science laboratories in secondary schools in selected states with an aim to (a) Identify the deficiencies and inadequacies in the existing laboratory facilities, (b) Ascertain if the required number of teacher demonstrations and student practical are performed, (c) Examine if the laboratory is adequately utilized, (d) See if the schools are providing separate laboratories, (e) Find out if there is any provision for improvisation of science equipment.

The researcher used multi-stage stratified sampling method in drawing the sample of schools for the study. The tool used in the study included a questionnaire.

The study found that in Maharashtra (a) Out of 111 secondary schools, 105 were reported to have science laboratories, (b) Out of 70 higher secondary schools, 59 had science laboratories, (c) Out of 105 secondary schools, only 26 had separate laboratories, (d) Out of 58 secondary schools in rural areas, about 60% used one to three hours/week for teacher demonstrations, 20% used 4 to 5 hours time and remaining 20% used 7 hours and more for teacher demonstrations. In urban schools, 40% schools used laboratories for 1 to 3 hours, 20% used it for 4 to 6 hours and 40% used it for 7 hours and above, (e) Time devoted to science practical differed in urban and rural schools, (f) In higher secondary classes 60% of schools in class IX and 70% of schools in class X performed teacher demonstrations. The position in respect of students’ practical was highly satisfactory in class XI and 89% in class XII performed more than 15 student practical, (g) In Rajasthan’s secondary school 92.1% rural schools had laboratory as compared to 83.3% urban schools. In the case of higher secondary schools, 94.6% rural schools had these facilities as compared to 90.9% in urban schools,
(h) The facility of separate laboratory was available in 91.9% urban schools as compared to 85.7% rural schools,
(i) About 50% of school students had the facility of performing experiments individually in physics, 74.74% in chemistry and 81.72% in biology,
(j) For performing science practical, in case of private aided and private unaided schools, only 80% and 66.7% schools respectively allotted adequate time for performing science practical,
(k) Only 27.8% of Government schools had the facility for repairing and improving of science equipment and
(l) 7.5% of Government school charged 6 to 10 rupees as science fee and 75.3% in case of higher secondary schools.

Rao, Shardamba (1998) did an investigation on explorations in optimizing learning science in schools with a view to
(a) Find out the extent, to which children entering class VI have assimilated science content up to class V,
(b) Develop achievement measures in science to cover the content up to class V in its structural and functional aspects,
(c) Develop scoring techniques to evaluate the degree of learning through achievement tests in science developed in 3 language--- English, Hindi and the regional language Kannada,
(d) Develop entry behaviour tests for evaluation of science learning,
(e) Study the difference in the amount and content of learning of children from different socio-cultural backgrounds,
(f) Study the science achievement of children with varying background support at home,
(g) Study whether the type of school has any influence on the method and amount of science learning,
(h) Find out whether instructional strategies used by the teacher influence the content and amount of learning and
(i) Build tangible hypotheses for an intervention programme to optimize science learning.

The sample of the study comprised 50 elementary schools of Karnataka, Delhi and Bihar of the students studying in class VI.
Investigator developed tools for collecting the data which are science information test, science achievement test and science skill test. The data had been analyzed statistically using mean, SD, item analysis and KR-20.

The study found that
(a) 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,
(b) Science achievement test indicated that very little was retained by children by rote memory,
(c) The positive relationship in general between science achievement test scores of children and the educational level of parents provided reasons to believe that strengthening of educational level and also science background of the parents was likely to enhance the science achievement of the children and
(d) On science achievement items related to grade III, IV and V for earth science, physical science and biological science, it was found that irrespective of the region, the scores on earth science in items related to grade V were invariably higher than the scores in items related to grade III, whereas in physical science the reverse was true. In biological science, there was more or less uniform distribution of scores over grades III, IV and V.

**Sharma, Munishwar Kumar (1990)** conducted a study of scientific literacy, attitudes towards science and personality traits of students and teachers with a view to
(a) Study the level of scientific literacy of different groups of students and teachers,
(b) Study attitudes to science of different groups of students and teachers and
(c) Study personality traits of students and teachers.

The researcher used science students and teachers as sample of the study. The tools used in the study included Scientific Literacy Scale, Attitude to Science Scale and Cattell’s 16 personalities Factors Questionnaire. The collected data were treated with ANOVA. The major findings of the study were
(a) The total sample had higher level of scientific literacy than the theoretical mean,
(b) There was significant difference between the general group and the SC/ST group,
(c) The total sample had favourable attitude towards science,
(d) There was effect of type of school and sex on attitude towards science and
(e) There was no significant difference between students and teachers on personality factors.

A parallel research was carried out by Singh, Prabhakar. (1988) on teaching behaviour of science teachers with a view to study the problem of teaching effectiveness through factor analyzing the teaching behaviour.

The sample constitutes 60 science teachers randomly selected from 20 secondary schools of Varanasi region. The tools employed were the Teaching Behaviour Observation Schedule (TBOS) developed by the investigator and an audio tape-recorder to record teachers’ verbal behaviours. The data had been treated by factor analysis.

The study found that
(a) The 10 skills of science teachers namely blackboard writing, questioning, introduction, reinforcement, summarization, using teaching aids, explanation, illustration with examples, attending difficulties and guiding students and maintaining classroom discipline ----- were identified as sharing 82.3% of the total variance,
(b) On the teaching behaviour, all the teaching skills could be used for the teaching of social sciences and languages as well and
(c) Teaching skills like demonstration of experiments and stimulus variation ---- especially useful in science teaching ----- did not emerge due to lack of representation of related component teaching behaviours in TBOS.

Thamilmani, P. (1990) worked on teacher competency and teacher personality in relation to achievement of high school students in science with an objective to
(a) Assess the relationship between teacher competency and achievement of students and
(b) Assess the relationship between teacher personality and achievement of students.

The sample of this study comprised 450 students of standard IX and 50 science teachers from various higher secondary schools in Madurai. The researcher developed tools of different types viz. Students’ Ratings on Teacher Competency, Students’ Ratings on Teacher Personality, Teacher Competency Self Appraisal Scale and Students’
Achievement Test for the collection of data which were analyzed by Pearson’s product-moment correlation and ‘t’ test. The study found that
(a) Teaching competencies of science teachers were related to the academic achievement of high school students,
(b) Teacher personality was not related to student’s academic achievement in science and
(c) Both male and female science teachers were similar in their teaching competencies and personality, human relation and interpersonal skills.

Sivadasan, K.R. (1988) carried out a study on linking class teaching with science club programme in Kerala with a view to review some studies carried out to examine the development of scientific process skills, scientific attitude and performance skills through teaching of science and science clubs.

The study is chiefly a review study which considered various variables including scientific skills, scientific attitude and performance skills. The study found that
(a) The teaching-learning strategies now adopted in schools are not oriented to the development of scientific process,
(b) Members and non-members of science clubs were found having low and non-significant difference under the majority of categories of scientific attitude and
(c) The science club members were found significantly better than the non-members in composite performance skill.

Sood, J.K. (1992) carried out a study on public understanding of science. The objectives of the study were to
(a) Develop instruments to determine the public understanding of science,
(b) Determine the levels of public understanding of science among different groups of students and the public,
(c) Develop an instrument to determine attitudes towards science,
(d) Determine the attitudes towards science among different groups of students and the public,
(e) Find out the differences in attitudes towards science in different groups and
(f) Find out the difference in the understanding of science among different groups.

The researcher adapted a sample comprised of 308 randomly selected students from public schools (88 students) from the rural areas (112 students) and from the general
public (108 students). The sample covered 234 males and 74 females. The tools used in the study included the public understanding of Science scale and attitudes towards Science scale developed by the investigator. Mean, S.D., ‘t’ test and Pearson product-moment correlation of coefficient were used to analyze the collected data.

The major findings of the study were
(a) The public understanding of Science was higher than the theoretical mean of the scale,
(b) The public understanding of Science students and the general public had been higher than the theoretical mean. But the public understanding of Science of the general public was higher than that of the students,
(c) There had been a significant difference between students from public schools and students from rural areas regarding their understanding of Science. The students of public schools had a high level of understanding of Science,
(d) Male and female student differed significantly regarding their understanding of Science,
(e) There had been a significant difference between the general public and students regarding attitude towards Science,
(f) There was a significant difference between students from public schools and students from rural areas regarding attitudes towards teaching,
(g) There was a significant difference between males and females regarding attitudes Science and
(h) There was a significant relationship between public understanding of Science and attitude towards Science.

Srivastava, Veena. (1992) carried out a research on a study of creativity among higher secondary students in relation to scientific aptitude and attitude towards science with a view to
(a) Test the significance of difference of creativity scores of the boys of the two groups having more scientific aptitude and less scientific aptitude,
(b) Test the significance of difference of creativity scores of two groups having favourable and unfavourable attitude towards science and
(c) Test the significance of difference between the mean of creativity scores, scientific aptitude scores and science attitude scores of boys and girls.

The researcher used 1200 students of higher secondary school as sample of the study. The tools used in the study were Creativity test by Chauhan and Tiwari, Scientific Aptitude Test Battery by K. K. Agarwal, Samoohik Mansik Yogyata Pariksha by R.K. Tandon and Scientific Attitude Scale by A. Grewal. The data were analyzed statistically using mean, SD and CR. The study found that
(a) The science students of higher secondary classes having more scientific aptitude were more creative than those having less scientific aptitude,
(b) In the field of creativity, the boys having favourable attitude towards science were slightly better than those having unfavourable attitude towards science whereas the girls with favourable and unfavourable attitude towards science did not differ,
(c) The girls were more creative than boys,
(d) The boys had more scientific aptitude than the girls and
(e) The girls had more favourable attitude towards science than the boys.

A research was designed on **Status and Quality of Teaching and Learning of Science in Australian Schools** with a view to establish two pictures:
(a) The reality of what is actually happening in Australian schools and
(b) The ideal regarding the teaching and learning of science.

Data collected from reviewing reports and research literature, analyzing Australian science syllabuses and curriculum frameworks, focus group meetings with teachers and other stakeholders, survey of students and telephone interviews with teachers provide triangulation of perspectives and findings. The study found that
(a) The picture of the curriculum emerging from this research reveals a gap between the intended curriculum of today’s science curriculum frameworks and the actual implemented curriculum. At the secondary level, in particular, science is traditional, discipline-based and dominated by content,
(b) There is concern that, in some schools, the type of science being taught and the learning outcomes being achieved are not those that prepare students, the science they are taught lacks relevance to their needs and interests and fails to develop key aspects of scientific literacy,
(c) The heavy content burden at the secondary level with teachers and students rushing superficially through content so that it is covered for the test,
(d) The broad content areas of biology, physical and earth sciences are all substantially represented in the curriculum,
(e) The implementation of the curriculum through teaching, learning and assessment is quite different in primary and secondary schools. In primary level, 1/3rd of students indicate that they never go on excursions to explore the natural environment, 50% never visit zoos, museums, science centres, 64% of students indicate that they never have visiting speakers to talk to them about science. More than half of the primary students indicated that in science, they never use computers to do their work or find information on the internet. In secondary level, 61% of secondary students who indicated that they copy notes from the teacher nearly every lesson; the 59% who indicated that the teacher never allows students to choose their own topics to investigate and the 33% who are never allowed to plan and do their own experiments,
(f) Assessment and reporting of student achievement in secondary science is far more formal than in primary science. Traditional assessment practices remain as one of the most significant barriers to educational reform in secondary schools where teachers are required to cover too much content to prepare students for “the test”,
(g) Resource limitations are a significant constraint on the quality of teaching and learning.
(h) The differential rates of enrolment in biology, chemistry, physics and geology by male and female students has been reduced so that under-representation of males in biology and the under-representation of females in chemistry, physics and geology have been reduced,
(i) There appears to be, on a comparative basis with other countries, a lower level of achievement in lower secondary science than in primary science in Australia,
(j) Limitations in science budgets, consumables, equipment and facilities are a significant constraint on the quality of science teaching.
(k) In primary schools, 40% of teachers named resources as a major factor limiting science teaching, limited equipment (19%), access to a suitable science teaching space
(71%) and lack of support staff to assist with organizing and storing materials (5%) were the other limiting resource factors cited by teachers.

(l) Inadequate resources were a major limiting factor, inadequate science budget (19%), poor access to laboratories (13%), inadequate equipment (12%) and poor access to computers (9%) were other limiting factors cited by teachers.

(m) Large class sizes posed particular problems for group-based practical work, not only from an occupational health and safety perspective, but also in terms of adequate teaching space,

(n) Due to various reasons like poor pay, low morale, little public recognition, work imposing itself on family life preparation, school sports and increased administrative duties, 45% of Australian primary and 50% of Australian secondary teachers indicated they would like to change career and get out of teaching,

(o) There is a need to upgrade existing teachers’ skills and attract more younger and better teachers into the profession if science education is to be revitalized.

(p) Many secondary science teachers lack the knowledge and skills to use relevant content and contexts and teaching-learning strategies that effectively engage students in learning science that deals with their interests, needs and concerns and

(q) There is a lack of national focus in science education amongst the ‘systems’ with states/territories having developed their own syllabuses and curriculum frameworks and embarking on few collaborative innovations that have the potential to develop world class curriculum resources or professional development programs.
3.3 Review of Related Research Programmes carried out Abroad:

Jan H. van Driel, Douwe Beijaard, Nico Verloop (2000) carried out a study on professional development and reform in science education with a view to develop teachers’ practical knowledge which integrates experiential knowledge, formal knowledge and personal beliefs.

To achieve lasting changes in teachers’ practical knowledge, long-term professional development programs are needed. The following strategies are potentially powerful.

(a) Learning in networks
(b) Peer coaching
(c) Collaborative action research

The study recommended that the reform project may benefit from teachers’ expertise if teachers’ practical knowledge be investigated at the start of a reform project and be monitored throughout the project.

A parallel study was conducted by Okhee Lee, Juliet E. Hart, Peggy Cuevas; Craig Enders (2004) on professional development in inquiry-based science for elementary teachers of diverse student groups with an objective to

(a) Describe teachers’ initial beliefs and practices about inquiry-based science and
(b) Examine the impact of the professional development intervention on teachers’ beliefs and practices related to inquiry-based science.

The research involved 53 third- and fourth- grade teachers at 6 elementary schools in a large urban school district.

At the end of the school year, teachers reported enhanced knowledge of science content and stronger beliefs about the importance of science instruction with diverse student groups, although their actual practices did not change significantly.

Hsin-Kai Wu, Joseph S. Krajcik (2006) carried out a similar investigation on exploring middle school students’ use of inscriptions in project-based science classrooms with a view to explore 7th graders’ use of inscriptions in a teacher-designed project-based science unit.
To investigate students’ learning practices during the 8 month water quality unit, researchers collected multiple sources of data e.g. classroom video recordings, student artifacts and teacher interviews and employed analytical methods that drew from a naturalistic approach. The study finds that

(a) 7th graders were able to use various inscriptions e.g. digital pictures, web pages and models to demonstrate meaningful inscriptive practices such as creating and using inscriptions to make arguments, to represent conceptual understandings, and to engage in thoughtful discussions and

(b) Inscriptions and associated practices provided students with experiences and understandings about certain ways to organize transform and link data or scientific ideas.

**Fouad Abd-El-Khalick and Saouma Bou Jaoude (1997)** did a research on exploratory study of the knowledge base for science teaching. The purpose of the study was

(a) To describe the knowledge base of a group of science teachers in terms of their knowledge of the structure, function and development of their disciplines and their understanding of the nature of science and

(b) To relate the teachers’ knowledge base to their level of education, years of teaching experience and the class level(s) that they teach.

Twenty in-service science teachers were selected to respond to a modified version of the Views on Science Technology-Society (VOSTS) questionnaire to assess their understanding of the nature of science and the teachers were also interviewed.

The outcomes of the study were

(a) The teachers’ knowledge base was lacking in all respect,

(b) Teachers held several naïve views about the nature of science and did not demonstrate adequate knowledge and understanding of the structure, function and development of their disciplines and

(c) The teachers’ knowledge base did not relate to their years of teaching experience, the class level(s) that teach and their level of education.

**Makkar, S.L. (1991)** carried out a research on education and scientific research in Japan with a view to provide information regarding educational facilities at various levels of education in Japan.
The researcher studied the education system of Japan as it exists and presented the picture. The study found that
(a) Whereas formal education begins at 6+, it is compulsory for 9 years, the pattern of education being 6+3+3,
(b) Most of the high schools are co-educational and grouped as general schools (providing all round education including Science for all) and special schools (providing instruction in practical subjects such as agriculture, commerce and technology),
(c) There are excellent separate Science laboratories for the various Sciences,
(d) Surprisingly enough, junior high school students are introduced to the methods of science while exploring natural phenomena (earth science too is included),
(e) Admission to the universities is highly competitive. Specialization begins at the graduate level and
(f) Research facilities are excellent in this country.

James A. Shymansky, George Woodworth, Obed Norman, John Dunkhase, Charles Matthews, Chin-Tang Liu (1993) carried out a study of changes in middle school teachers’ understanding of selected ideas in science as a function of an in-service program focusing on student preconceptions. This article examines the impact of a specially designed in-service model on teacher understanding of selected science concepts. Concepts on topics from the life, earth and physical sciences served as the content focus and middle school grades 4-9 served as the context for this study.

The teachers used concept mapping strategies learned in the in-service to facilitate the interviews. Concept maps were used to study changes in teacher understanding across the phases of the in-service in a repeated measures design.

Analysis of the maps showed significant growth in the number of valid propositions expressed by teachers between the initial and final mappings in all topic groups.

A similar research was conducted by Paul E. Adams and Gerald H. Krockover (1997) on beginning science teacher cognition and its origins in the pre-service secondary science teacher program with an objective to
(a) Identify the major tenets of a preservice secondary science education program as expressed by science education faculty,
(b) Identify knowledge structures that beginning secondary science teachers have constructed about the teaching and learning of science and
(c) Identify the correlatives that exist between the first two objectives.

The researchers used science teachers and science education faculty as samples of the study. Interview and observation are used as tools to collect the data which were analyzed by combining the methods of single and cross-case analytic induction. The study found that
(a) Aspects of the program such as student-centered learning, cooperative learning, general pedagogical knowledge and pedagogical content knowledge, were adopted into the schema of the beginning teachers and
(b) The degree of adoption appeared to be linked to the individual’s most significant learning experiences and the constraints of the school situation.

**Sandra K. Abell, Edward L. Pizzini (1990)** carried out a similar study on the effect of a problem-solving in-service program on the classroom behaviors and attitudes of middle school science teachers with a view to examines the effect of an in-service education program emphasizing problem solving on teacher attitudes toward teaching science and on teaching behaviors.

The researcher used 22 middle school science teachers to participate in the program and another 22 served as the control group. The two groups were similar in terms of gender, teaching status, educational background and professional activity during the treatment period. The study found that
(a) No difference was noted between the groups on the attitude measure,
(b) A multivariate analysis of variance performed on the observational data showed a significant difference between the groups on the post workshop measure and
(c) An extended in-service educational program can affect the teaching behaviors of science teachers in the middle groups.

**Aranha, Joyce (1988)** conducted a research on an experiment in mastery learning in science with a view to
(a) Develop a mastery learning strategy in science for class V,
(b) Find out the change in academic motivation and study habits of the pupils due to the strategy and 
(c) Find out the relationship between a set of pupil characteristics and their achievement through mastery learning strategy.

The researcher used 58 slow learners studying in class V selected through cluster sampling procedure as sample of the study. The investigator developed tools for collecting the data which are shah’s Non-verbal group test of intelligence, Jack Frymier’s motivation Scale and Writing Comprehension Test and Study Habit Inventor. Correlations were used to analyze the data. The findings of the study were

(a) Pupils achieved higher scores on final tests in each of the 5 units,
(b) Pupils improved in academic motivation and self-concept but with no improvement in their study habits,
(c) Pupils liked the learning activities and it reduced rote learning,
(d) The MLS (mastery learning strategy) generated group cooperation rather than competition while learning,
(e) In MLS, the teacher’s involvement was much more and this affected the pupils’ initiative to learn, learning process and learning outcomes for the better and
(f) There was no significant relation between pupils’ I.Q., study habits and language ability and achievement on MLS and non-MLS.

A parallel study was done by Randy K. Yerrick (2000) on lower track science students’ argumentation and open inquiry instruction with a purpose to examine the effects of open inquiry instruction with low achieving, marginalized high school students.

Researcher used students with long histories of scholastic failure as sample and asked them to participate in question generation, experimental design and argument construction as a part of their general science course instruction.

Videotapes were collected from daily science instruction and entrance and exit instruction interviews were conducted using identical open-ended problems. From this dataset, comparisons were made between students’ entrance and exit interview response representing change over time. Shifts in student responses coincided with renegotiated
classroom norms for scientific discourse. Students’ arguments were observed to shift toward those more consistent with the nature of the scientific arguments including:

(i) Students’ tentativeness of knowledge claims,

(ii) Students’ use of evidence and 

(iii) Students’ views regarding the source of scientific authority.

**Dale Baker, Rosemary Leary (1994)** worked on letting girls speak out about science with a view to try to determine what influences girls to choose science.

The researcher interviewed 40 girls in grades 2, 5, 8, 11 using a semi structured protocol. The interview focused on feeling about science, science careers, peer and parental support and how science is taught. The outcomes of the study were that

(a) The girls were highly self-confident and positive about science and

(b) The girls liked learning science in an interactive social context rather than participating in activities that isolated them such as independent reading, writing or note taking.

**James Levin and H. Seymour Fowler (1983)** jointly carried out a similar research on sex, grade and course differences in attitudes that are related to cognitive performance in secondary science with a view to

(a) Collect and analyze data on sexual differences in secondary school students’ attitudes towards science and

(b) Analyze attitudinal differences for the independent variables of science programs and grade levels.

The researchers used 988 students as sample to collect data and used a modified version of the Fennema-Sherman Mathematics Attitude Scales to represent attitudes toward science. Multivariate analysis of variance (MAOVA) was also used to analyze the data for the main and interaction effects of the independent variables of sex (male, female), grade level (10th, 11th, 12th) and science program (advanced placement, academic, and general, terminal). The study found that

(a) Reliabilities of the modified science subscales all high (> 0.83),

(b) Significant differences (p< 0.05) were indicated for all main effects (sex, grade, science programme),

(c) Interaction effects were not found,
(d) Females evidenced a significantly more positive attitude ($p \leq 0.01$) than males on three subscales: Attitude toward Success in Science Scale, Science as a Male Domain Scale and Teacher Scale,

(e) 11\textsuperscript{th} graders evidenced significantly more positive attitudes than 10\textsuperscript{th} graders on all but the Effectance Motivation Scale,

(f) Students in 11\textsuperscript{th} grade had more positive attitudes than 12\textsuperscript{th} grade students on all scales but science as a Male Domain Scale,

(g) 10\textsuperscript{th} graders differed significantly from 12\textsuperscript{th} graders on three subscales: Science Usefulness Scale, Confidence in Learning Science Scale and Teacher Scale,

(h) Positive attitudes decreased from advanced placement to terminal programs,

(i) Academic students did not differ significantly from general students except on the Father Scale; however, they were significantly different (more positive) from the terminal students for all subscales,

(j) General students were also significantly different from terminal students except on the three subscales of Attitudes toward Success in Science, Science as a Male Domain and Effectance Motivation.

A similar type of study was carried out jointly by Jazlin V. Ebenezer and Uri Zoller (1991) on grade 10 students’ perceptions of and attitudes towards science teaching and school science with a view to

(a) Assess the 10 grade students’ attitudes towards science teaching and school science and

(b) Assess the 10 grade students’ perceptions of class room practices and activities.

The researcher taken 10 grade students’ from westend school district (pseudonym) in British Columbia as sample and used both quantitative (statistics of Likert-type scales) and qualitative (critical interpretive analysis of interview data) methods. The major findings of the study were

(a) Students do not appreciate the most prevailing contemporary practices in science classes,

(b) Teaching style appears to be the major determinant of high school students’ attitudes toward science and science teaching and
(c) No change in students’ perceptions of and attitudes toward science teaching and school science could be detected in spite of the impact made by advocated constructivist and science-technology-society (STS) approaches on science curriculum and science education.

**Malcolm B. Butler (1998)** carried out a similar type of research on factors associated with students’ intentions to engage in science learning activities with a view to assess students on their laboratory and non laboratory behavioral intentions.

Researchers used 254 students from 4th, 5th, 6th, 7th & 8th grade and used Ajzen and Fishbein’s theory of research action to collect data. With respect to the family’s annual income and attitude towards science, researcher identified 5 external variables namely gender, grade, race/ethnicity, socio-economic status and also two determinants included in the theory (attitude towards the behaviour and subjective norm). The study found that
(a) For laboratory learning activities, the two determinants were found to contribute collectively to the prediction of behavioural intention, accounting for almost a fourth of the variance,
(b) For non laboratory learning activities the two determinants accounted for over a fourth of the variance in behavioural intention and
(c) For both laboratory and non laboratory behavioural intentions, no interaction terms were significant.

**Martina Nieswandt (2000)** worked on problems and possibilities for learning in an introductory chemistry course from a conceptual change perspective with a view to focus on 4 common everyday conceptions about two basic chemistry concepts viz. changes of substances and the particle model of matter.

Questionnaire data were collected in four classes over one school year at six time points. The questionnaire items were tasks pertaining mostly to everyday problems.

The findings of the study were
(a) Some erosion of students’ everyday conceptions in favor of scientific concepts, especially in their understanding of changes of properties of a substance as an indication that a new substance has been created,
(b) Some students’ notions can be described as a mixture of everyday descriptions and scientific explanations,
(c) A chemical concept needs to be taught in different contexts and
(d) Knowledge of students’ “mixed” conceptions allows teachers to develop more individual learning environments and also gives students an opportunity to understand their current location in their learning process.

**Michael P. Kelly and John R. Staver (2004)** jointly carried out a study of one school system’s adoption and implementation of an elementary science program with a view to examine and discover the characteristics of the processes used by a Midwestern U.S. school system to adopt and implement a new K-6 science curriculum.

The researchers used standardized science achievement test for the collection of data yielded several results. The study found that
(a) Elementary teachers received a hands-on science program with texts and kits,
(b) Teachers as a group remained in the early stages of the Concerns-Based Adoption Model profile of concerns,
(c) Many K-6 teachers remained uncomfortable with teaching science,
(d) Teachers’ attitudes regarding the new program were positive and they taught more science,
(e) Traditional science teaching remained the norm and
(f) Administrative support was positive but insufficient to facilitate full implementation of the new program and more substantial change in teaching.

At last it is concluded that a systematic, ongoing program of professional development is necessary to address teachers’ concerns and help the district realize its goal of standards-based K-6 science instruction.

**Julie A. Bianchini, Eric M. Solomon** studied on constructing views of science tied to issues of equity and diversity with an objective to
(a) Examine the discursive and social practices of a teacher educator and her eight beginning science teachers in a course on the nature of science and issues of equity and diversity and
(b) Investigate on beginning science teachers’ views of science and science teaching
Researchers organized their discussion of the nature of science, teacher learning and grounds for views along 3 dimensions viz. personal, social and political. The study found that
(a) Beginning teachers routinely drew from only one of these 3 dimensions to support their views of the nature of science and ways to represent science to all students,
(b) Teacher educators encourage teacher learners to examine personal, social and political grounds carefully and critically in the process of constructing or revising their views and
(c) Attention to these 3 dimensions of ground for views will assist beginning teachers in adopting nature of science positions which reflect the goals of equity and excellence.

Okhee Lee (1996) published one similar article entitled diversity and equity for Asian American students in science education which addresses issues of diversity and equity with Asian American students in science education. The article describes
(a) Barriers as well as promising practices in science learning with Asian American students,
(b) Current science education reforms and its implications for Asian American students and
(c) Equity agenda with Asian American students in science education are proposed.

The literature on achievement tests and attitude surveys provides little specific information about effective instructional program with the Asian American student population. Science educators need to look beyond stereotypes for a better understanding of the strengths and limitations of Asian American students for science achievement, as well as ways to enhance their social and emotional adjustment.

An investigation on science inquiry and student diversity, enhanced abilities and continuing difficulties after an instructional intervention was carried out by Okhee Lee, Cory Buxton, Scott Lewis, Kathryn LeRoy (2005) to examine elementary students abilities to conduct science inquiry through their participation in an instructional intervention over a school year.

In this study researcher involved 25 third- and fourth-grade students from 6 elementary schools representing diverse linguistic and cultural groups. The study found that
(a) Students demonstrated enhanced abilities with some aspects of the inquiry task, but continued to have difficulties with other aspects of the task even after instruction and
(b) Although students from all demographic subgroups showed substantial gains, students from non-mainstream and less privileged backgrounds in science showed greater gains in inquiry abilities than their more privileged counterparts.

Irene W. Gaskins, John T. Guthrie, Eric Satlow, Joyce Ostertag, Linda Six, Janice Byrne, Beth Connor (1993) carried out a study on integrating instruction of science, reading and writing with a view to integrate the teaching of science, reading and writing processes in a conceptually based, constructivist curriculum for middle school students who read below grade level.

Researchers designed a performance-based assessment and implemented to determine the level of student awareness and control over the processes taught during a unit of instruction.

Interviews with science teachers and supervisors revealed the important interaction of curricula goals, the performance assessment and instructional practice.

A literature was published by Le’onard P. Rivard (1993) on writing to learn in science with a view to develop a conceptual framework for science readers.

To publish this literature researcher consulted different professional journals, books, ERIC documents and doctoral dissertations.

The study found that carefully designed studies, both qualitative and quantitative, are still required to provide data from a variety of perspectives.

Le’onard P. Rivard, Stanley B. straw (1999) did an similar type of investigation on the effect of talk and writing on learning science with a purpose to
(a) Explore the effect of talk, writing,
(b) Talk and writing on the learning and retention of simple and integrated knowledge and
(c) Describe the mechanisms by which talk and writing mediate these processes.

43 students were randomly assigned to four groups, all stratified for gender and ability. Students in the talk-only treatment group (T) discussed the problem tasks in small peer groups. Students in the writing-only treatment group (W) individually wrote
responses for each of the tasks but without first talking to other students. Students in the combined talk and writing treatment group (TW) discussed the problems in groups prior to individually writing their explanations. Dependent variables included simple, integrated, and total knowledge scores based on multiple-choice tests, essay questions and concept maps obtained at three time points during the study: a pretest; an immediate posttest and a delayed posttest. The findings suggest that
(a) Talk is important for sharing, clarifying and distributing knowledge among peers,
(b) Asking questions, hypothesizing, explaining and formulating ideas together are all important mechanisms during peer discussions,
(c) Analytical writing is an important tool for transforming rudimentary ideas into knowledge that is more coherent and structured,
(d) Talk combined with writing appears to enhance the retention of science learning over time and
(e) Gender and ability may be important mediating variables that determine the effectiveness of talk and writing for enhancing learning.

Christina V. Schwarz, Kristin L. Gunckel, Ed L. Smith, Beth A. Covitt, Minjung Bae, Mark Enfield, Blakely K. Tsurusaki (2007) worked on helping elementary preservice teachers learn to use curriculum materials for effective science teaching with the purpose to learn preservice teachers how to use curriculum materials for effective science learning.

To address this concern, the authors conducted a study in which 3 teacher educators taught elementary science methods courses incorporating a major focus on curriculum analysis and modification based on Project 2061 Instructional Analysis Criteria. The study found that
(a) Analysis of pre-post assessments, classroom artifacts, classroom dialogue and post course interviews indicated that preservice teachers accurately applied and appropriated a modest set of criteria whose intended meanings most closely matched their own understandings, were most closely aligned with their own goals and criteria or were made accessible through systematic use and attention within the methods sections,
(b) Many did not find the materials analysis criteria useful or comprehensible and based their curricular decisions on their own criteria and
(c) A revised theoretical framework and new approaches to better support preservice teachers’ effective participation with curriculum materials is required.

A similar research was conducted by **Elizabeth A. Davis (2005)** on preservice elementary teachers’ critique of instructional materials for science with a view to develop proficiency of adapting curriculum materials in science teaching.

20 participating preservice elementary teachers held a sophisticated set of criteria for critiquing instructional materials viz. they paid attention to scientific inquiry and instructional goals.

The study found that critique activities used in science methods courses should be authentic and scaffold to be optimally effective. Critique along especially challenging dimensions needs systematic, explicit and perhaps more consistent support.

**Deborah R. Dillon, David G. O’Brien, Elizabeth B. Moje, Roger A. Stewart (1993)** worked on literacy learning in secondary school science classroom with a purpose to illustrate how and why literacy was incorporated into science teaching and learning in 3 secondary classrooms.

Researchers used different types of tools in the form of field notes, interviews and artifacts for collecting the data. The methodology of ethnography and the theoretical framework of symbolic interactionism were employed in the 3 studies on which the cross-case analysis was based. Data were analyzed using the constant comparative method (Glaser & Strauss, 1967) to determine patterns in the teachers’ beliefs about learning and how these influenced their choice of literacy activities. The study found that
(a) Each teachers’ use of literacy activities varied based on his or her beliefs about teaching science concepts and
(b) Reading, writing and oral language were important vehicles to learning science concepts within daily classroom activities in the 3 classrooms.

**Le’onard P. Rivard (2003)** did a parallel research on whether language-based activities in science effective for all students including low achievers with a view to investigate achievement status as a factor determining the use of language-based activities for learning science.
A total of 154 eighth-grade students were randomly assigned to four groups, all stratified for gender and achievement level. The treatments involved various combinations of talk and writing, and descriptive and explanatory tasks. The dependent measures included scores on multiple choice tests obtained at three times during the study. Records of student talk and writing were also analyzed to identify patterns of differences between groups of achievers. The study found that
(a) Low achievers complete more problems and develop better understanding and comprehension of ecology concepts when they have engaged in peer discussions of explanatory tasks and
(b) In comparison, high achievers benefit more from writing than talking and writing explanations enhances comprehension more than restricted writing activities.

Carolyn S. Wallace, Nam-Hwa Kang (2004) did an investigation of experienced secondary science teachers’ beliefs about inquiry with a view to investigate the beliefs of 6 experienced high school science teachers about
(i) What is successful science learning?
(ii) What are the purposes of laboratory in science teaching and
(iii) How inquiry is implemented in the classroom. An interpretive multiple case study with an ethnographic orientation was used.

The study found that the teachers’ beliefs about successful science learning were substantively linked to their beliefs about laboratory and inquiry implementation.

Ekpo, Johnson (1991) worked on chemistry laboratory safety skills and practices: students’ self-evaluation in selected secondary schools in Akwa, Ibom state with a view to
(a) Assess the chemistry laboratory safety skills by students and
(b) Assess the chemistry laboratory safety practices adopted by students.

The researcher used 300 senior secondary students from 30 randomly selected secondary schools. The researcher developed a questionnaire for the collected of data and data were analyzed statistically using percentages and means. The study found that
(a) More than 70% students failed to protect their eyes, face, hands and even their body too,
(b) They did not wear aprons and gloves while engaged in chemical experimentation,
(c) They had poor knowledge about identified emergency facilities and equipment and
(d) It also revealed evidence of poor experimental techniques.

**Judith Bennett, Fred Lubben, Sylvia Hogarth (2006)** worked on entitled bringing science to life, a synthesis of the research evidence on the effects of context based and STS (science technology society) approaches to science teaching in high school with a view to
(a) Foster more positive attitudes to science and
(b) Provide a sound basis of scientific understanding for further study.

The researcher used 17 experimental studies undertaken in 8 different countries on the effects of context-based and STS approaches. The study found that
(a) Context-based / STS approaches result in improvement in attitudes to science and that the understanding of scientific ideas developed is comparable to that of conventional approaches and
(b) The approaches also result in more positive attitudes to science in both girls and boys and reduce the gender differences in attitudes.

**Roy W. Hurst and Marlene M. Milkent (1995)** conduct a study on facilitating successful prediction problem solving in biology through application of skill theory with a purpose to identify cognitive factors associated with differences in prediction problem-solving success among high school biology students and to determine whether guided practice facilitated successful prediction.

The Group-Assessment of Logical Thinking was used to evaluate subject’s cognitive operational level, written prediction worksheets and think-aloud interviews were used to measure predictive success and identify problem-solving tendencies.

The study found that
(a) Predictive reasoning success showed a significant correlation (p<.01) to both formal operational development and five specific cognitive skills viz. identifying relevant knowledge in long-term memory, using a systematic problem-solving strategy, applying cause-effect reasoning, reviewing solutions for logical inconsistency and evaluating alternative solutions and
(b) Analysis of covariance indicated significantly increased prediction success for treatment group subjects following practice in the five identified skills.
Shari L. Britner (2007) worked on motivation in high school science students —— a comparison of gender differences in life, physical and earth science classes with an objective to
(a) Examine self-efficacy and other motivation variables among high school science students,
(b) Determine the degree to which each of the four hypothesized sources of self-efficacy makes an independent contribution to students science self-efficacy beliefs,
(c) Examine possible differences between life, physical and earth science classes and
(d) Investigate patterns of gender differences that may vary among the fields of science.

The researcher used 502 number of high school science students as sample. The study found that
(a) In earth science classes, girls earned higher grades and reported stronger science self-efficacy,
(b) In life science classes, girls earned higher grades but did not report stronger self-efficacy and did report higher science anxiety,
(c) In physical science, there were no gender differences in grades or self-efficacy but girls again reported higher levels of science anxiety,
(d) For boys across science fields, science self-efficacy significantly predicted course grades and mastery experiences was the only significant predictor of self-efficacy and
(e) For girls, self-efficacy was also the strongest predictor of science grade across fields. Mastery experiences significantly predicted self-efficacy in earth science for girls, but social persuasions, vicarious experiences and physiological states were better predictors of science self-efficacy in life and physical science classes.

Sofia Kesidu, Jo Ellen Roseman (2001) carried out a study entitled how well do middle school science programs measure up, the purposes of which were to examine how well middle school programs support the attainment of key scientific ideas specified in national science standards and to identify typical strengths and weakness of these programs using research-based criteria. Nine widely used programs were examined by teams of teachers and specialists in research on teaching and learning. The study found that
(a) Whereas key ideas were generally present in the programs, they were typically buried between detailed or even unrelated ideas and
(b) Programs only rarely provided students with a sense of purpose for the units of study, took account of student beliefs that interfere with learning, engaged students with relevant phenomena to make abstract scientific ideas plausible, modeled the use of scientific knowledge so that students could apply what they learned in everyday situations or scaffolded student efforts to make meaning of key phenomena and ideas presented in the programs.

Valarie L. Akerson, Lawrence B. Flick, Norman G. Lederman (1999) carried out a study on the influence of primary children’s ideas in science on teaching practice with a purpose to
(a) Explore how children’s ideas in science affects science instruction in the primary grades and
(b) Investigate whether and how primary teachers recognize student ideas and whether and how they react to student ideas.

Two experienced second-grade teachers and one intern teacher were observed and videotaped as they taught 8-week astronomy units. Teachers and students from each classroom were pre- and post instruction interviewed for their content knowledge of and view points on teaching and the importance of student ideas. Mid unit stimulated recall interviews were used to gain understanding of teachers’ perceptions of their instruction regarding student ideas. Transcripts of lessons and interviews were coded and analyzed for patterns of eliciting and addressing student ideas. The study found that
(a) All teachers used discussions in a variety of ways to identify and elicit student ideas,
(b) The experienced teacher with the highest level of content knowledge had the largest repertoire for eliciting and addressing student ideas and
(c) The intern teacher addressed student ideas in ways that discouraged students from continuing to share their ideas.

Victor Sampson, Douglas B. Clark (2008) reviewed a study on assessment of the ways students generate arguments in science education, current perspectives and recommendations for future directions with an intention to provide an overview of several analytic frameworks that science educators use to assess and
characterize the nature of or quality of scientific arguments in terms of three focal issues: structure, justification and content. To highlight the foci, affordances and constraints of these different analytic methods, the review of each framework includes an analysis of a sample argument.

The review concludes with a synthesis of the three focal issues and outlines several recommendations for future work. Ultimately, this examination and synthesis of these frameworks in terms of how each conceptualizes argument structure, justification and content is intended to provide a theoretical foundation for future research on argument in science education.

3.4 Implication in Present Study:

Review of the related literature; besides, allowing the researcher to acquaint himself with current knowledge in the field or area in which he proposed to conduct his research, served the following purposes ----

The review of related literature enabled the researcher to define the limits of his field. It helped the researcher to delimit and define his problem. The knowledge of related literature, brought the researcher up-to-date on the work which others had done and thus to state the objectives clearly and concisely.

By reviewing the related literature the researcher had avoided unfruitful and useless problem areas. He also avoided unintentional duplication of well established findings. It indicated a clear picture to the researcher of the problem to be solved.

The review of related literature had given the researcher an understanding of the research methodology which refers to the way the study has to be conducted. It helped the researcher to know about the tools and instruments which proved to be useful and promising in the previous studies.

Finally review of related literature helped the researcher to know about the recommendations of previous researchers list in their studies for further research.
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