CHAPTER III
REVIEW OF RELATED LITERATURE
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CHAPTER III
REVIEW OF RELATED LITERATURE

Literature reviews are important as research tool, especially in emerging areas, with populations that typically yield small samples, or areas that represent value-laden position adopted by advocacy groups. Literature reviews are also valuable in light of the knowledge explosion and the consequent impossibility of reading everything.

-Mertens (1998)

A summary of the writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known and what is still unknown and untested. Since effective research is based upon past knowledge, this step helps to eliminate the duplication of what has been done and provides useful hypotheses and helpful suggestions for significant investigation. Citing studies that show substantial agreement and those seem to present conflicting conclusions helps to sharpen and define understanding of existing knowledge in the problem area, provides a background for the research project, and makes the reader aware of the status of the issue.

-Best and Kahn (1996)

INTRODUCTION

The aim of this chapter is to record briefly the findings of a few research studies conducted in India and abroad on topics, which are related to the problem under study. This will help in understanding the various aspects of the problem. Besides it widens the prospective of the research.
The research studies reviewed here include conceptual literature as well as research literature. Closely related investigations, which have been carried out in India and Abroad on various dimensions of the research problem are reviewed and reported in this chapter. Many similar results, which are described in technical reports of various journals and papers delivered at various conferences, are also reviewed at relevant places.

CLASSIFICATION OF RELATED STUDIES

Closely related to the current theme of research, relevant studies were classified into three major heads. They were as follows:

1. Researches on Instructional Strategies and Media.
2. Researches on Practical Activities and Skills.
3. Researches on Perceptions of Teachers and Students regarding Science Programmes.

RESEARCHES ON INSTRUCTIONAL STRATEGIES AND MEDIA

Muddu (1978) studied the effectiveness of the use of Motion Pictures as Aids in the Teaching of Biological Science as compared to the usual methods. It was found that there was significant improvement in the post-test performance of both the group over the pretest and the improvement was higher particularly in the case of experimental group. The use of films in teaching of biological science helped in more learning in lesser time and better retention of what was learnt. Instruction films stimulated the scientific interest of the students.

Sharma (1978) conducted an experimental study of teaching natural sciences at the primary level in central schools. It was found that most of the teachers adopted traditional method, the teachers were not well equipped for teaching science at this level, it was admitted by most of the teachers that
activity should be the basis of teaching natural sciences at the primary level, guided activity was more effective than self-activity in respect of concept formation, development of scientific attitude, acquisition of scientific knowledge, and the training in scientific skill.

Swarnamma (1978) made an attempt to study the process of teaching of biology in the upper primary schools of Kerala. It was reported that lack of facilities in schools, lack of mastery over the subject matter by the teacher, lack of experimentation in the classroom, over dependence of the teacher on textbooks, and overcrowding in the class rooms were the problems. It was also reported that most teachers adopted lecture-demonstrated method in teaching biology in the upper primary classes.

Jha (1979) compared the different methods of teaching High School Biology. It was found that there was strong evidence in favour of activity-based approach in teaching school science in respect of acquisition of knowledge, application of the scientific knowledge and development of scientific skill.

Basu (1981) studied the effectiveness of multi media programmed materials in the teaching of Physics. It was found that a significant difference existed in the achievement though the different strategies due to difference in ability. It was also found that multimedia branching programmed instruction was better than the multimedia linear programmed instruction and multi media semi-programmed instruction. Multimedia hybrid programmed instruction was better than multimedia branching programmed instruction.

Joshi (1981) studied the development of science education for upper-primary classes based on the Environmental Approach. It was found that environmental education at the upper primary level was essential and vital to
develop insight and skill needed to influence not only the environmental attitudes and behaviours in the students, but also to stimulate their reorientation of values regarding the importance of environmental studies. Children at the primary stage were interested in and learnt from experience with real things that they could manipulate in some way, the teachers did not identify the objects outside the classroom, which might be usually brought inside for study, the environment outside the school was potentially significant for educational purposes, and the syllabus was not environmentally oriented which lacked infield studies.

Hopper (1982) studied the use of modular approach for teaching Biology in standard XI. It was concluded that all the three structural modular approaches namely self-learning, peer group learning and peer group learning with teacher intervention of teaching were effective in terms of mean gain in cognitive achievement, attainment of mean gain in higher mental abilities and significant increase in the academic motivation of the students.

Kalacherry (1982) conducted a study on the preparation of an Experimental Try-out of programmed Instruction material in the syllabus of chemistry prescribed for class VIII in Maharstra. It was estimated that 83% learners were able to respond correctly to 83% of the frames, the value of measure of density for the whole programme was found to be 0.36. It was also found that a few students who scored below 50 percent in the traditional system score above 85 percent through programmed material.

Vardhini (1983) conducted an experimental study of development of a multimedia instructional strategy for Teaching Science (Physical Science) at secondary level. The strategy was found valid against the criterion of scientific attitude with significantly higher performance was noted. Intelligence and
achievement using these strategy presented a significant relationship was found between scientific attitude and achievement for the experimental group and control group. Visual projections with teachers' explanation and those with taped commentary were equally effective in terms of achievement. Programmed material and discussion sequence were equally effective on the total test, and the strategy was found feasible when seem in terms of its reproductively and the cost management by individual schools.

Bhargava (1983) conducted a study on some cognitive process in science learning with reference to physics for students of higher secondary classes. It was found that a moderate relationship of achievement in physics was observed with three processes of science, namely, observing, measuring and drawing inferences. Boys were found to be superior to girls on the processes of observing, measuring and drawing inferences. With growth in age, a decline in ability to perform on science processes was observed, and urban students out performed their counter parts in rural areas on science processes.

Anjaria (1984) conducted a study on system approach in teaching of science. It was concluded that the experimental group scored higher than control group, the system approach was more effective than traditional approach, and the system approach was found effective in planning the design of the experiment.

Deopuria (1984) compared teaching of science through environmental and traditional approach in schools of Madya Pradesh. It was found that the students of experimental group obtained higher achievement scores due to environmental approach. Environmental approach showed greater cognitive gain among students, the students of experimental group showed
considerable improvement towards environmental awareness. The obtained 't' showed significant positive gain in attitudes towards the environment for the entire experimental group. It was also found that there is no significant difference between male and female teachers' attitude towards environmental approach.

Dighal (1985) conducted a study on improved method of teaching Biological science in schools Tripura and West Bengal. It was found that there was a significant difference in the effectiveness of 'self-activity method, life science club method and Audio-visual method. Two or three methods when combined formed an improvement on the basis of their similar nature. Continuation of method could be made according to the need of the teacher. Preparation of charts and models, collection of specimens thro local excursion organization of science exhibitions by the students, arrangement of film shows by the school and orientation programmes for life science teachers brought better results.

Desai (1985) conducted an Investigation into efficacy to different Instructional Media in the Teaching Science to the pupils of class VIII in Relation to certain variables. It was concluded that the programmed learning approach, the slide with discussion approach and the experimental approach were more effective than the traditional method. In the teaching of science, the experimental approach was most effective of all approaches. The programmed learning approach and slides with discussion approach were equally effective.

Desai (1986) made an attempt to study the effectiveness of programmed learning strategy in teaching of physics in the eleventh grade. It was found that the programmed learning approach was easy and interesting
as each pupil had an opportunity to learn at his/her own speed and capacity. The programmed learning approach proved better than the lecture method in the study of physics. It was also found that the pupils who scored high on the Intelligence Test also scored high in the post-test and pretest. The scores on the post-test had no bearing on the performance of pupils on the science attitude scale.

Barve (1986) made a study on preparation and field-testing of filmstrips for teaching of science course in standard IX and a study of their comparative effectiveness in the teaching-learning process as compared to traditional practice. It was found that the teaching with the filmstrips was more effective than the traditional method for teaching facts principles and concepts in science. Filmstrips and traditional methods were equally effective for teaching abstract concepts in science. Filmstrip was an effective teaching aid for all levels of learners in low, medium and high achiever. It was more effective for learners between 13 and 16 years than 17 and 21 years of age and it was more effective for both sexes of boys and girls.

Sharma (1986) conducted an experimental study of performance of high school students of low, average and high creativity as a function of the instructional media and learning tasks in physics. It was found that the four instructional media namely print-pictures, print-picture work book, tape-slides, tape-slide workbook were found equally effective for concept learning principle learning and problem solving with low average and high creating groups. The average gains in performance though print-picture workbook and tape-slide work book media were found higher than the other two methods. With the print-picture workbook medium the performance gains of the high creativity group on concept learning, principle learning and problem solving
were similar. With the tape-slide workbook medium the high group performed higher on problem solving than on principle learning.

Pillai (1987) conducted an experimental study of Gagne’s conditions of learning for instruction in Physics at secondary level. It was found that the Instructional strategy developed based on Gagne’s conditions of learning was found feasible for normal classroom teaching. It was also found more effective than the traditional method in terms of student’s performance. Successful problem solvers were those who had shown better performance at the concept and the rule levels. The hierarchy in learning did not depend on the type of instructional input and their sequencing. The Instructional strategy was found to change the cognitive preference from facts and applications to principles and problem solving.

Sushma (1987) compared the effectiveness of concept attainment model and biological science Inquiry models of teaching Biological Sciences to class VIII students. It was found that the two models of teaching were more effective than traditional method. The concept attainment model was found to be more effective than biological science Inquiry model. The mean attitude scores of pretest and posttest of both models had significant effects. The concept attainment model changed the attitude more favorably than the Biological science Inquiry model. No significant difference was found between the gain scores of attitude with Biological Science Inquiry model based teaching and conventional teaching.

Agnihotry (1987) conducted a study of influence of some methods of teaching physics on the achievement of class X students in Delhi. It was found that out of the four methods viz., lecture-cum demo method, Laboratory method, programmed instruction and assignment cum- discussion method the
method of teaching systematically developed by the investigator was found to be most effective. Lecture-cum-demo method followed by verification type of lab work – more effective than assignment-cum-discussion method. With respect to achievement in physics, the programmed instruction method was less effective than the method systematically developed by the investigator. The following was the ranking 1. Method developed by investigator. 2. Programmed instruction modified by the investigator. 3. Lecture-cum-demo method followed by verification type of lab work. 4. Assignment-cum-discussion method.

Mohapatra (1988) used a pragmatic approach to teach the process of experimental work in physics to pupils of rural schools. The investigator found that the process based laboratory experimental method had the scope to arouse curiosity among the students. It is also found that this method can be preferred in rural schools and it needs no financial commitment.

Hsu, Shun-Yi (1989) analysed a model for developing instructional material for teaching physical science concepts for grade 8 students in the republic of China. An instrumental model based on a learning cycle including correlation, Analysis and Generalisation (CAG) was developed as applied to design of instructional module for grade eight students in Taiwan. The CAG model was based on Piagetian theory and a concept model. The module developed for heat and temperatures was administered to test its effects by comparing its use with the same unit in the New Physical Science Curriculum (NPSC). The major findings are presented as follows: (1) The CAG module tended to move science learning in an effective way. The experimental group performed significantly better than the control group on almost half the items in the posttest and 75 percent of the items in the follow up test. The control
group did not achieve significantly higher on any of the items of the posttest and follow-up test. (2) Academic ability and reasoning skills of students were related significantly to achievement. It is recommended that instructional materials be developed that are appropriate for each specific grade level. (3) Concrete written materials tended to have a positive impact on the science achievement for eighth grade students. (4) Piagetian logical thinking was found to be a significant predictor for science achievement. Students performed well on both the concrete and transitional levels of the contents. Items on the formal level were difficult. (5) Several students' misconceptions related to the topics were detected in the tests and interview analyses.

Goel et al. (1990) conducted a study on learning physics through lecture demonstration method and individualized instruction method. It was reported that the acquisition of psychomotor skills favoured the group, which followed the individualized laboratory method rather than the lecture demonstration method.

Gurumurthy (1990) compared the effectiveness of guided discovery approach and instructed performance approach in doing physics experiments. It was found that the guided discovery approach was superior to the instructed performance approach in the development of cognitive abilities and practical skills.

Rumer, Shirley Haynes (1990) conducted a case study of the effectiveness of concept mapping and vee diagramming in middle school science education. One hundred fifty-eight (158) seventh grade students and one hundred forty-two (142) eight-grade students made up the population studied. Both grades were divided into classtypes, school and regular (below average and average) according to testing and sorting procedures of the
school Guidance Department. The classtypes were either treated with an experimental unit of study (using concept mapping and vee diagramming techniques) or a control unit of traditional curriculum study. The teaching unit for the seventh students dealt with vascular and nonvascular plants. The teaching unit for the eighth grade study concerned chemical solutions. The effectiveness of concept mapping and vee diagramming was measured by administering a pre and posttest designed for each unit. Embedded questions on concept mapping and vee diagramming were incorporated in the instrument. The mean test scores on the posttests for the experimental groups were higher than those for the control groups in both grades and for all classtypes. A statistical analysis to investigate the hypothesis that concept mapping and vee diagramming would improve learning revealed that treatment group (i.e., experimental versus control) was a factor. The findings from the analysis of variance indicated that the improved performance on the posttest by the 7th grade students (as a whole) could be attributed, in part, to the use of concept mapping and vee diagramming in the classroom. Treatment group was found not to be a significant contributing factor to the improved performance for the 8th grade level as a whole; however, it was a factor for the school classtype at that grade level. The study findings suggested that use of concept mapping and vee diagramming in the classroom will improve learning. These tools offer an important avenue for achieving educational reform.

Miller, Anne-Courtney Seigler (1990) Studied the effects of hands-on, activity-based science and a supportive instructional environment on at-risk sixth-grade students' attitude toward science, achievement in science, goal orientation, and cognitive engagement in science. A pretest-posttest design
was used with each student serving as his or her own control. Staff development services were provided to the teachers who participated in the study, in order to provide materials, strategies, and training in the use of hands-on, activity-based science and in developing supportive instructional environments in the science classroom. No significant differences in the students’ grade in science, with a decrease in grades during the study. A significant effect was found on both task mastery goal orientation and cognitive engagement of the at-risk students, with both having significant increases during the study. An additional element of the study was the description of the instructional environment of the classroom as it related to cognitive engagement of all students in the class. The classes that had a more supportive instructional environment had higher student cognitive engagement than classes that had a less supportive instructional environment.

May, Patricia Nell (1991) conducted a Field analysis of the Integrated Activity Learning Sequence approach to science instruction at the elementary school level. Part 1: Student Performance. The IALS consisted of six lessons taught in a 8 week period. A Student Activity Book containing the activities of the IALS was included to serve as a means of collecting student responses to those activities. Also included was a Teacher's Guide including related objectives, goals, materials, preparation, investigative procedures, and content. All materials were provided in a classroom kit. The major conclusions showed that the students using the IALS approach experienced the greatest success in strengthening mathematics skills. Students using both the IALS and textbook approaches learned the intended science knowledge and writing skills. The IALS approach resulted in significant academic gains for all
genders, ethnic groups, academic standings, instructional programs, and learning preference with the following exceptions: gains in science knowledge were comparatively lower for ESL students, as were gains in mathematics skills for the gifted. Additionally, the overall study determined that an IALS could be developed and effectively implemented by elementary teachers among diverse groups of fourth grade students.

Kamen, Michael (1991) made an attempt to study the effect of Creative drama and the enhancement of elementary school students understanding of science concepts. The results supported the use of creative drama in science classrooms. The students' achievement improved on the content tests. Both the students and the teachers reported benefits from creative drama, including a better understanding of the concepts and an improved motivation and interest in learning science. The teachers cautioned, however, that creative drama activities need to be well-planned to avoid behavior problems and to maximize the educational value. Also, limitations of space and time may deter teachers from using creative drama. The student enjoyed the use of creative drama and felt they learned more when it was included. The creative drama activities were integrated with other types of instruction, and the data indicated that creative drama is most effective in helping children understand science concepts when integrated with other teaching strategies. Recommendations include the inclusion of creative drama techniques in elementary science methods classes and continued research into the support needed by teachers to use creative drama effectively and appropriately in teaching science.

Boone, William John (1991) conducted a study on Improving Elementary School Science by application of Item Calibration Mapping. To
improve elementary science education, this project has used objective measurement (Rasch Measurement) to: (1) evaluate the actual student mastered curricula by determining the difficulty ordering of topics for 4th and 5th grade science students; (2) evaluate unexpected answers of students to science items; (3) show how objective measurement can improve the design of science tests and measurement of students; (4) demonstrate how the tools of objective measurement can be used by administrators and counselors to quickly identify and investigate students and schools; (5) compare teachers' predictions of science item difficulty with student performance. This project provided a quantitative analysis of science test data demonstrating how objective measurement can efficiently guide the teaching and learning of elementary school science. Techniques, which allow teachers, counselors, and administrators to quickly and time efficiently identify students and schools performing in a particular manner (i.e., unexpected responses to some test items) has been outlined. Additionally this research reports on how these data were used to instruct pre-service elementary education majors in (1) the presentation of science topics and (2) the interconnection between a theory of cognitive development and classroom science instruction.

Carter, Earlcine Brooks (1991) studied the effects of teaching the Learning Strategies Intervention Model in a sixth-grade science class. The premises for this study were represented by seven hypotheses. Based on the data collected during this study, these hypotheses were rejected. Significant evidence to retain the hypothesis was not observed. Data collected regarding strategy mastery were insufficient to conclude that the strategies could be successfully taught to mastery in the sixth-grade regular education science classroom. Student attitude data showed no significant changes in the
experimental group's attitudes toward their science class. There was evidence of a positive change in the control group's attitude scores. This may have been a result of the change in science teachers. No significant difference was found between the experimental and control groups' overall academic performances or study habits, or in their proficiency of answering true-false test-items. A significant difference was noted in the control and experimental groups' answering of fill-in the blank test items. This difference indicated a loss in answering proficiency. The experimental group also demonstrated a positive significant change in their answering of multiple-choice test-items.

Maurer, William Paul (1991) studied the effectiveness of a Mastery Learning Strategy in enhancing cognitive achievement and problem solving skills in an introductory chemistry programme. Those students that received the mastery-learning strategy (treatment group) had a significantly better cognitive achievement than those students that did not receive the treatment (control group). However, the mastery-learning strategy did not significantly improve the cognitive relation of the treatment group.

Ó-Saki, Kalafunja Mlang'a (1991) conducted a study on the factors influencing the use of the environment in science teaching: A study of biology teaching in Tanzania. The study concludes that environmental education and other issues approaches in science teaching are unlikely to succeed at classroom level if the notion of curriculum as mere prescription of goals continues to be perpetuated. Instead, a social constructionist perspective is envisaged in which new curriculum proposals must be built in grassroots support systems including collaboratively designed teaching / learning resources, and professional development programs. This implies a strong
involvement of classroom teachers in the development of teaching materials. Suggestions for future research to realize these objectives are made.

Gangoli and Gurumurthy (1995) conducted an experimental study to find out the effectiveness of a guided open-ended approach to physics experiments. They have compared traditional laboratory approach and guided open-ended approach in doing physics experiments. It was found that the guided open-ended approach was superior in developing cognitive abilities and laboratory skills. No definite conclusion was made regarding the superiority in the development of creative abilities of the students.

Lalitha (1996) conducted a study of the vocabulary required by class III students to achieve mastery level in environmental studies II as per minimum level of learning. It was concluded that the specially designed activities were effective. There was high correlation between the vocabulary level and achievement level in environment studies. The vocabulary required by the students to achieve mastery level in environment studies, were identified.

Padhi (1996) conducted a study on the effect of competency based, activity centered approach to teaching on attainment of mastery level learning in environmental studies. It was found that competency based, activity centered approach in environmental studies was more effective than traditional approach.

Saxena (1996) conducted a study to identify the difficulties faced by a teacher to get first hand experience to visualize effective teaching method. Activity approach was followed using locally available resources. It was found that activity learning was increased substantially. Difficulties were identified.
consequently during demonstration and students' participations were incorporated.

Janakavalli et. al. (1998) conducted a study on the impact of multimedia approach in teaching environmental studies at secondary level. It was found that audio-visual approach and multimedia approach were more effective than traditional approach. There was no significant difference between the pre and posttest of control group taught by traditional method.

Sharda (1998) conducted a study on activity-based teaching learning strategies (ABTS) in a large sized class in a primary stage. It was found that proper pre-planning was required to implement ABTS in a large sized class. Learning situations were managed with well-planned activities and by keeping enough materials needed to develop the required competencies. Learning strategies became successful since activities were drawn from or related to the child's experience/environment. The pupil enjoyed 'learning by doing'. The ABTS created confidence about learning even among non-masters. ABTS helped the children to engage themselves in activities even in the absence of the teacher. ABTS motivated children to concentrate on expected competencies and hence to achieve them at mastery level. ABTS were effective in a large sized class and helped the learner in concept attainment and ability development. Activities involving children in teaching learning process motivates the child to learn better and hence leads to retention and achievement, which is essential for universalization of elementary education.

Ajitha, Nair & Shankar, Subha (1999) conducted an experimental study to estimate the effectiveness of self-learning instructional materials in teaching Biology. It was found that learning through self-learning instructional materials was more effective than traditional method. It was also found that
(1) self-learning instructional materials recorded higher achievement scores in realizing the instructional objectives, (2) self-learning instructional materials are more effective in realizing higher order objectives like application and skill and (3) the control and experimental groups did not differ significantly with respect to retention test scores.

Gongoli (2000) carried out a study on transaction of science curriculum using textbook based on open-ended approach. After conducting a series of pretests and posttests it had been concluded that guided open-ended approach of doing experiments was superior to the traditional approach in the development of (1) cognitive abilities such as knowledge, understanding and application and (2) practical skills such as (a) use of instrument (b) organizational skills (c) manipulative skills and (d) communicative skills. These findings remained unchanged when the groups were divided according to intelligence level, socio-economic level and sex difference.

Rama (2003) studied the effectiveness of play-way technique in teaching of science at upper primary stage. It was concluded that play-way technique of teaching science was superior to formal method.

**RESEARCHES ON PRACTICAL ACTIVITIES AND SKILLS**

Adinarayana (1979) conducted a detailed study on teaching-strategy for Developing Appropriate skills required in students for conducting scientific investigations. It was found that the performance of the experimental group taught by the methods of learning package is significantly greater than control group taught by conventional method. VII standard students have favourable reaction towards learning packages. Also it was found that the effectiveness of learning through the package does not differ from unit to unit, class to class and teacher to teacher when examined in terms of acquisition of knowledge.
Ogunniyi (1983) conducted an analysis of laboratory activities in selected Nigerian secondary schools. It was concluded that the teachers involved in the study dominate the laboratory periods. It was suggested that laboratory should be more than extension of lecture class.

Adinarayana (1984) conducted a study on science teaching in primary schools. Instructional packages were prepared for two units in class IV and class V and a training programme was conducted to the teachers of 24 experimental schools. A total of 760 pupils were involved in the study. It was found that there was a significant development of skills among the experimental groups. Nine schools in class IV and eleven schools in class V of experimental group showed significant improvement in observation skill. Investigatory skill was developed significantly in eleven schools. Ten schools in class IV and seven schools in class V of experimental group showed significant improvement in inquiry skill and the experimental group greatly favored science activities.

Padilla et al. (1984) carried out a study on the effects of instruction on integrated processing skill achievement. It was found that middle school aged students can learn to use certain integrated process skills. This was heartened especially considering the theoretical importance of integrated process skills in science education. There were no significant differences on the two process skill subtests dealing with measuring and experimenting or graphing and interpreting data. It was not surprising that significant differences were found primarily on the hypothesis and identifying variables subtests. The correlation between process skill and logical ability is strong and the abilities seem logically related. The most important finding from the study related how process skills should be integrated into the curriculum.
Burns et. al. (1985) conducted a study on the development of an integrated process skill test (TIPS II). It was found that TIPS II provided another reliable instrument for assessing students' competence in the integrated science process skills. The test was not specific to a given curriculum or content area, so it may be used across the various disciplines of science. TIPS II reflects students' ability to apply the logic required to conduct fair investigations.

Berger et. al. (1986) conducted a study on the attainment of skill in using science processes II Grade and task effects. Microcomputer simulation was used to collect data on student estimation of skill. It was found that age and amount of information presented in the task affected the performance of the students. Younger students did not perform as well as the old students. This study demonstrated developmental differences but does not provide any direct explanation for the differences.

Menon (1986) made an attempt to study the system of Science Education in the perspective of the process of Science Inquiry. It was concluded that the overall proficiency in the process skills steadily increased as students went up from standard to standard. There was a sudden transition in the overall development of process skills between standards X and XI. The skill of identifying variables had been developed by the time students reached standard VIII. The skill of interpreting observational data was developed around 15 years. The skill of controlling the variables did not develop among the student in the system of 17 years of age. Children of the schools affiliated to the CBSE were found better in the development of the process skills. Textbooks were the only curriculum materials through which the curriculum
guidelines percolated up to practicing schools and questions mostly tested the product aspects and not the process aspects.

Barge, Zane Lee (1988) studied the Effect of group size, gender, and ability grouping on learning science process skills using microcomputers. Two response variables, The test of Integrated Process Skills and a researcher developed test that students had during the intervention, were measured using a pre-test and post-test. Two hundred and forty-five, seventh and eight grade students' subjects were the focus of this study. Analyses indicated that the only statistically significant result was a main effect on ability for both response measures. However, the two post-test measures showed opposite trends in gain scores by low, middle, and high ability students. Speculation concerning this ability by post-test interaction was discussed. Other major conclusions included were (1) teams of two and four members working together solved problems as effectively as individuals, (2) the lessons and procedures implemented in the manner described, generated gender-neutral activities in science, and (3) microcomputers, using a file management program and structured activities, can be used as a tool to promote student learning of science process skills.

Dwiredi (1988) investigated the effectiveness of microteaching and the development of psychomotor skills in biology practical. It was found that the skills relating to collecting, mounting, preserving and the skills related to observation and information locating is better developed by microteaching than by conventional teaching.

Vensel, George (1988) conducted a study on the effects of computer delivered science simulations on the acquisition of process skills for gifted and general population fourth and fifth graders. All students were pre and post
tested with the Test of Basic Process Skills. Treatment group membership,
gifted group membership, and hours of simulation use made statistically
significant contributions to the prediction of posttest score. However, the
proportion of explained variance was low, about one percent for each of the
three variables. Further studies using multiple measures of science process
skills and greater control of classroom use of the simulations are
recommended.

Barbara Strawitz (1989) conducted a study effect of testing of science
processing skills achievement using self-instructional materials. It was found
that the self-instructional materials increased the effect of Testing of Science
Processing skills Achievement.

Pandit (1989) identified eight major laboratory skills in chemistry in
their hierarchical order. The study revealed that a significant relationship
between the ability to learn the content in chemistry and the ability to acquire
cognitive and manipulative skills.

Bishop, Ronald Dean (1990) made an attempt to study the effect of
laboratory activity ordering on achievement and retention. Two teachers and
six classes of eighth grade earth science students participated in this study.
Three classes were designated as control group and had concepts and
laboratory activities presented in the order, which was suggested by the
textbook (i.e., readings, assignments, and lectures introduced the concepts
before the laboratory activity was done). The laboratory activity only served as
a verification lab. The remaining three classes were the experimental group.
The laboratory activity was done as a directed discovery lab before the
readings, assignments, and lectures were presented. Data was statistically
analysed to control for student ability and prior knowledge differences. There
was no significant difference (NSD) in achievement nor retention between directed discovery labs and verification labs for the classes as a whole. The secondary question, which compared results by gender, showed NSD except that males in the experimental group scored significantly higher than the females of the experimental group on the tests for retention. When dividing the groups by ability, the top and bottom quartiles were compared. The top quartile (Q1) of control group scored significantly better on the retention test than the experimental Q1 group. All other comparisons showed NSD.

**Baker et. al.** (1991) made an attempt to estimate the process skill acquisition, cognitive growth and attitudinal change of ninth grade students in a scientific literacy course. The results of the study indicated that it was possible to teach scientific skills directly, and to influence the way students perform on more general measurement of cognitive ability. It was also concluded that it was possible to change the attitude of students.

**Roger Lock** (1992) made an attempt to study the gender and practical skill development in science. Four problem-solving tasks were given as one to one testing. The practical skills like observation manipulation, interpretation, planning, reporting and self-reliance were tested. This study found little evidence to gender difference in performance. Few significant differences in the performance were also found.

**Anita Roychoudhury et.al.** (1993) made an investigation to find out the development of Science process skills in authentic contexts. It was estimated that student centred open-ended laboratory experiments facilities the learning of higher order science processing skills like identifying variables, interpretation of data, hypothesis defining and experimentation. It was also found that weak as well as strong students showed such development.
Srivastava (1997) conducted a study on analysis and interpretation skills in physics of Twelfth Grade students. The students found the items of task testing the prediction skill most difficult. In the whole test it was found that the gender difference was not significant. In the process skill of determining the relationship, interpretation and prediction, the average score of boys was more than girls. Though there was variation in achievement of students from school to school, but a definite pattern showing correlation between school and achievement of its students did not emerge from the study. It was found that the presently used curriculum of physics practical has failed to develop the analysis and interpretation skills in students up to a reasonable level. An analysis of the currently used physics practical curriculum shows that the two main reasons for the poor performance are (i) The type of laboratory extreme used in the course work (ii) the nature of assessment in practical.

Thaker (2002) conducted a study on inquiry for the science laboratory effectiveness of secondary schools. It was found that secondary schools did not score high on effectiveness of science laboratories. There was no significant difference in the mean scores of science laboratory effectiveness between the rural and urban secondary schools. There was no significant difference in the mean scores of the level of planning on the science laboratory effectiveness between the rural and urban secondary schools. There was no significant difference in the mean scores of the level of the utility on the science laboratory effectiveness between the rural and urban secondary schools.
Muddu (1978) made a study on prevalent status of instructional procedures in biology in High school students. It was estimated that 59 percent of teachers stated that did not have adequate classroom to teach biology, 85 percent of teachers stated that instructional procedures followed by them were not according to the aims and objectives of biology teaching, most of the teachers preferred only the lecture-demonstration method, and 30 percent schools have improvised laboratory facilities for biological instruments.

SCERT (AP) (1982) evaluated the in-service training of secondary school science teachers in improvisation techniques in science teaching courses. It was found that most of the teaching activities being practiced during in-service programme were not usually applicable in classroom situation, improvisation of the science apparatus was a good activity but it was not fully relevant to environmental setup of the schools in which they worked, the improvisation of science apparatus was not possible as much of the time was used in covering the prescribed syllabus, the improvisation of science apparatus as taught in the course was mostly for the cheaper items for costlier items of improvisation was rarely used.

Natarajan (1983) evaluated the district level science fair and educational exhibitions. It was found that students felt that science fair not only motivated them but also motivated their teachers to use innovations in classroom. Students and teachers felt science fair helped in using local resources easily. The teacher-student interaction and participation of both students and teachers increased. It helped in building rapport among
administrators, teachers and pupils, and it increased the cognitive insight of teachers and students.

Dunny (1986) made a survey that what pupils think regarding science practical. In the findings of the study the pupil stated that they spent just over half of their time in science lessons for doing practical. Clear message emerged from the students that they associate practical with the development of manipulation skill. The students felt that they were attending practical class for relaxing burden and for general interest. They also felt that it is for discussing new ideas and testing them. It was concluded that pupil should be considered as pupil not as scientist.

Shanthadevi (1986) conducted a critical study of Science teaching programme at middle school level in Kamataka state. It was found that the Headmasters and Assistant Headmasters agreed in their opinion to say that the schools did not have science clubs, schools had no laboratory, experiments performed by teachers were helpful in learning, there was no help from higher authorities to improve the laboratory, scientific knowledge in the science text was suitable in day-to-day life, teachers were not specialized to teach science subjects and the science textbook was attractive.

Blakely, Raymond Edward, (1987) compared the understanding of the nature of science held by various groups of middle school teachers and also identified specific areas of misunderstanding of the nature of science held by science teachers. It was found that the science teachers scored significantly higher than the nonscience teachers on both the total score and the Methods and Aims of Science subtest. However, when the nonscience teachers’ scores were compared with those of the degree subgroups of science teachers, only the secondary science education/lab science group
scored significantly higher. Comparisons were also made among the science teacher subgroups, with the only significant difference being that the secondary science education/lab science group scored higher than the middle grades education group. Additionally, the study found no significant difference in TOUS scores based on the number of courses in middle grades science teaching methods or on whether or not the subjects have middle grades certification. The item analysis showed that at least 25% of the science teachers confuse science and technology; misunderstand how scientists cooperate with one another; believe that trial and error and chance are major factors in scientific research; fail to discriminate among laws, theories, and hypotheses; and are unsure of the purpose of scientific experiments and the aims of science. The study concluded that many middle school science teachers are poorly prepared to present to their students an accurate view of the nature of science and indicates a need for an increased emphasis on this topic in training programs for middle school science teachers.

Abdi, S. Wali (1988) conducted a study to estimate the degree of Science interests of sixth grade students. The following were the conclusions drawn in this investigation (1) Students were generally interested in the sixth grade science program. However, for most of the concepts students indicated “some” interest as opposed to “definite” interest. (2) There were significant differences among the levels of interest of students taught by different teachers on five topics: Classifying Animals with Backbones; Classifying Animals without Backbones; Elements and Compounds; Sources of Energy; and Atmosphere, Climates of the World, and Natural cycle. (3) There were significant differences in the levels of interest between male and female
students only on two topics; Life Cycles, Heredity, and Living Things, and Sources of Energy. (4) Student achievement and interest was significantly related only on the topics of classifying Animals without Backbones; Properties of Light; Sources of Energy; and Electricity and Magnetism. (5) Teachers perceived all the science items to be of "definite" or greater than "some" interest to the students.

Moore, Patricia Ann (1990) conducted a study on the effect of science inservice programs on the self-efficacy belief of elementary school teachers. This study included three groups of teachers: a treatment group involved in an intensive science inservice program and two control groups. Data from a science efficacy belief instrument and a demographic questionnaire were analyzed using a variety of statistical measures. The results showed that the self-efficacy of the elementary teachers involved in the intensive inservice program was significantly higher than that of the two control groups. In addition, these teachers taught more science and taught using different methods than the other two groups. They were also more active in sharing science information with their colleagues. Teachers agreed that the best inservice programs were relevant to their needs and that more flexible scheduling would increase teacher participation. For the group involved in this study, the science inservice program enhanced the teachers, the curriculum, and the methodology for the improvement of elementary science education.

Finan, Mary Key, Kellye (1990) conducted a study on teacher perception of the elementary science program in Allegany County, Maryland. Significantly less time was reported teaching science and social studies than the other subject areas. Science material reported used more often were the country-supplied curriculum guides and health kits. The two teaching
techniques reported used most often were lecture and discussion. The majority of teachers reported that they used a classroom with no science facilities of materials. Most of the teachers responded that the facilities, equipment, and supplies "Needed Improvement". The majority of the teachers reported a need for assistants in learning new teaching methods, obtaining information about instructional materials and maintaining equipment. The findings supported that gender, grade level, and teacher satisfaction account for variation in time spent teaching science. Gender, grade level, years experience, degree level, and teacher satisfaction explain variation in the use of teaching techniques and the need for assistance. Grade level, years experience, degree level, and teacher satisfaction explain variation in science materials used and the quality of facilities and equipment. Further it is recommended that (1) more time need to be spent in science. (2) More science materials need to be provided. (3) The use of hand-on manipulative needs to be increased. (4) The amount of money spent by Allegany County for science education needs to be increased.


Teachers were interviewed to determine their preparation for utilizing the IALS, involvement of students in the IALS approach, meeting of stated learning goals and satisfaction will the cooperative learning teaching strategy. The major conclusions showed that the teachers were able to effectively utilize the IALS approach, but recommended additional time was provided for teaching the individual lessons. Teachers were able to involve students and meet the established learning goals. Cooperative learning-teaching was not
clearly viewed as favorable or unfavorable. Additionally, the overall study determined that and IALS could be developed and effectively implemented by elementary teachers among diverse groups of fourth grade students.

Nolt, Sally (1991) conducted a Field Analysis of the Integrated Activity Learning Sequence approach to science instructions at the elementary school level. Part 2: Student responses to the IALS approach. Following completion of the IALS all students in the experimental group completed the Student comments pages at the end of the Student Activity Book. Comments were categorized as favorable, neutral, or unfavorable and analyzed to determine student interest in the IALS approach and satisfaction with cooperative learning group instruction. The major conclusions showed that Part 2 of the study determined that students were interested in instruction utilizing the IALS approach and were satisfied with cooperative learning group instruction. No significant differences were found according to gender, ethnic group, academic performance, instructional program, or learning preference. Additionally, the overall study determined that an IALS could be developed and effectively implemented by elementary teachers among diverse groups of fourth grade students.

Jackson, Michael Conoly (1991) evaluated of an instrument for assessing elementary school science program in North Carolina. The purpose of this research was to evaluate the National Science Teachers Association’s Guidelines for Self-Assessment, Elementary School Science for use in assessing elementary school science program in North Carolina. Responses to the modules indicated that teachers and principals rate the majority of the items as being highly described and the statements were clearly stated. Teachers and principals rated the majority of the items as being highly
achieved except for the sections on facilities and support systems. The Science Educator / Science Supervisor group rated the majority of items as being less well achieved. The comments from the teachers during interviews substantiated their ratings of items in the modules. Teachers rated their preparation and classroom effectiveness as highly achieved, but rated items such as facilities and support as not being well achieved. Teachers indicate that science process skills are taught; with “hands-on” activities being the major method of instruction. The ratings of the science educators and science supervisors and the school personnel indicated that the guidelines are generally appropriate and useful for assessing the elementary science programs in North Carolina. Additional research is needed, however, in which elementary schools are assessed using other assessment instruments and the results compared with those from the NSTA guidelines.

Lalitha and Sharacha (1997) conducted a study on the empowerment of teachers to overcome hard spots in Environmental Studies II using activity-based modules at the primary stage. The study aimed at developing competency based, activity based, teaching learning modules for in Environmental Studies II for classes III and to empower the teachers to develop teaching-learning strategies and to use locally available resources. It was found that hard spots in environmental studies II for teachers and students were the same. Teachers were aware of innovative teaching-learning strategy. Teachers were aware of making science joyful. The teachers acquired skill in evaluating the strategies. They were competent in developing teaching-learning strategies. There was significant difference between pre and posttests. Posttest scores indicated the teachers’ mastery over the strategy.
Alka and Krishna Maitra (1997) conducted a study on the attitudes among students, teachers and other professionals towards laboratory and other practical work in science. It was concluded that rural girls of X standard had very high and positive attitude towards science practical. Overall the boys seemed to have more positive attitude than girls towards the practical aspects of science. Grades did not make any significant difference in the attitudes of students. Teachers were quite ambiguous in their responses. They themselves contradict their own responses and offer a number of reasons for not conducting practical or using aids/ demonstration while teaching. Though, all the teachers were familiar with the doctrine of 'learning by doing' they fail to implement in their own pedagogy when asked 'how will you visualize science without practical' the responses were not only distributing but also contradictory to the premise of learning of science.

Bhattacharya (1997) made an attempt to correlate scientific attitude with academic achievement at Higher Secondary Level. It was found that there was significant correlation between the cognitive domain of scientific attitude and academic achievement. There was significant correlation between affective domain of scientific attitude and academic achievement. There was significant correlation between psychomotor domain of scientific attitude and academic achievement.

Lalitha et. al. (2002) studied the attitude of +2 students towards physics laboratory work. It was found that the achievement of +2 students in practical is a definite indicator of their achievement in theory, whereas their attitude towards laboratory work was not considered to be a predictor of their achievement in theory. It was concluded that the achievement of students in theory is independent of their attitude towards laboratory work. Age of the
students has no influence on student’s attitude towards laboratory work and their achievement in theory. Age differences were evident in achievement in practical. Male and female students did not differ in their attitude towards laboratory work and in their achievement in both theory and practical. Similar results were found in respect of schools and parental backgrounds.

DISCUSSION

From the review of Section I of the above studies, it was found that there is strong evidence in favour of Activity-based Approach in teaching school science in respect of Acquisition of Scientific Knowledge, Application of Scientific Knowledge and Development of Scientific Skills (Jha, 1979; Miller, 1990; Lalitha, 1996; Saxena, 1996; Sharda, 1998 and Rama, 2003).

It was reported that guided activity is more effective than self-activity in respect of Concept Formation, Development of Scientific Attitude, Acquisition of Scientific Knowledge and the Training in Scientific Skill (Sharma, 1978). But Self-learning Approach was effective in terms of mean gain in Cognitive Achievement (Hopper, 1982). It was also reported that Self-activity Method when combined with other methods like Audio-visual Method formed an improvement (Dighal, 1985). A study on the effectiveness of self-learning Instructional Materials revealed that Self-learning Instructional Materials are more effective in realizing higher order objectives like applications and skill (Ajitha, 1998). Another study concluded that Integrated Activity Learning Sequence Approach experienced the greatest success in strengthening mathematical skills (May, 1991).

Some of the studies concluded that Experimental Approach or Laboratory Approach was more effective than the Traditional Method (Desai, 1985; Agnihotry, 1987; Mohapatra, 1988; Bishop, 1990 and Goel, 1990). In
the teaching of science, the Experimental Approach is most effective of all other approaches (Desai, 1985). The Process Based Laboratory Experimental Method had the scope to arouse the curiosity among the students (Mohapatra, 1988). It was reported that Individualized Laboratory Method is more effective in the Acquisition of Psychomotor Skills (Goel, 1990).

The review also revealed that Guided- Open-ended Approach of doing experiments is superior to the Traditional Approach in the Development of Skills (Gurumurthy, 1990; Gangoli & Gurumurthy, 1995 and Gangoli, 2000).

In certain other studies it was found that the Programmed Learning Strategy is more effective than Traditional Approach (Basu, 1981; Kalacherry, 1982; Desai, 1985; Desai, 1986 and Agnihotry, 1987).

The review revealed that Multi-media Approach produces higher performance in scientific attitude and achievement (Vardhihi, 1983; Sharma, 1986 and Janakavalli, 1998). In certain other studies it was concluded that Audio-visual Approach is more effective than the Traditional Approach (Muddu, 1978; Dighal, 1985; Desai, 1985; Barve, 1986 and Janakavalli, 1998).

The review also revealed that Environmental Approach shows greater cognitive gain among the students (Joshi, 1981; Deupuria, 1984; Desai, 1985 and O-Saki, 1991).

A few studies reported the usage of The Models of Teaching viz., Concept Attaining Model, Inquiry Model in teaching of Biological Sciences to class VIII students (Sushma, 1987) and Learning Strategy Intervention Model in a sixth grade science class (Carter, 1991).

Other than the above studies the effectiveness of the System Approach in teaching of science (Anjaria, 1984); Correlation, Analysis and
Generalisation Approach in teaching physical science concepts for grade 8 students (Hsu, 1989); Concept Mapping in teaching seventh grade science (Rumer, 1990); Item Calibration Mapping in improving elementary school science (Boone, 1991) and Mastery Learning Strategy in enhancing the cognitive achievement and problem solving skills in introductory chemistry programmes (Maurer, 1991) were also reported.

Of all the studies reviewed, it is found that there is strong evidence in favour of Activity-Based Approach in teaching learning science at upper primary science.

The highlights of section 2 of the review were stated as follows:

1. Practical skills can be developed using learning packages (Adinarayana, 1979 and 1984).
2. Laboratory should be more than extension of lecture class (Ogunniyi, 1983).
3. Process skills should be integrated into the curriculum (Padilla, 1984).
4. The overall proficiency in the process skills steadily increased as students went up from standard to standard (Menon, 1986).
5. Microteaching developed psychomotor skills in biology practical (Dwiredi, 1988).
6. Microcomputers, using a file management programme and structural activities, can be used as a tool to promote student learning of science practical skills (Barge, 1988).
7. Self-instruction materials increased the achievement in science process skills (Barbara, 1989).
8. There is a positive correlation between ability to acquire skills and ability to learn the content (Pandit, 1989).
9. It was possible to teach scientific skills directly (Baker, 1991).

10. It was found that little evidence to gender differences in the performance of skill development (Lock, 1992).

11. Open-ended laboratory experiments facilitated the higher order processing skills. It was also found that weak as well as strong students showed such development (Anita, 1993).

12. The two main reasons for the poor performance in physics practical skills are (a) the type of laboratory extreme used in the course book and (b) the nature of assessment in practical (Srivastava, 1997).

13. There was no significant difference between the rural and urban school students in terms of science laboratory effectiveness (Thaker, 2002).

The highlights of section 3 of the review were stated as follows:

1. Teachers favoured greatly on science activities (Adinarayana, 1984).

2. Many middle school science teachers were poorly prepared to present to their students an accurate view of the nature of science and indicated that a need for an increased emphasis on the training programme for middle school science teachers (Blakely, 1987).

3. Students were generally interested in the science programmes (Abdi, 1988).

4. The science inservice programme enhanced the teachers, the curriculum and the methodology for the improvement of elementary science education (Moore, 1990).

5. The students were interested in utilizing the instructions given and were satisfied with cooperative learning group instruction (Nolt, 1991).

6. Teachers indicated that science process skills taught with hands-on activities were the major method of instruction (Jackson, 1991).
7. Teachers were aware of innovative teaching-learning strategy (Lalitha, 1997).

8. There was significant correlation between the psychomotor domain of scientific attitude and academic achievement (Battacharya, 1997).

9. Male and female students did not differ in their attitude towards laboratory work and their achievement in both theory and practical (Lalitha, 2002).

CONCLUSION

From the above review and discussion it is clear that attempt has been made in different angles about the instructional strategies. Some of the science process skills were developed and tested at different stages. But, however, adequate effort had not been made in relation to practical skills in science at upper primary stage. Hence the present investigation is launched to fill up the gap. The detailed methodology of the investigation is presented in the next chapter.