Chapter Two

Review of Related Literature

2.1 Introduction

William Yeats quotes very aptly, "Education is not the filling of a pail but lighting of a fire". The in service training programmes for secondary school science teachers are held by Gujarat Council of Educational Research and Training (GCERT) and District Education Offices (DEO) since 2011 for continuous and comprehensive evaluation emphasising development of life skills in adolescents through activities for teaching, learning and evaluation. It was stated by Sharma (2006) that "a science teacher of secondary school is supposed to develop process skills which require critical thinking, creative thinking, problem solving and decision making skills or it can be said that, while developing process skills in science, thinking skills also can be developed". Hence the researcher has reviewed studies related to development of life skills for adolescents of secondary school, teaching of science in India. Review of Related Literature has helped to develop conceptual framework and pointed out research strategies and specific procedures that have proved to be productive in designing the methodology and conducting this experimental study.

The purpose of this review of related literature is

- to study the methodology used by the researchers in the field of Life Skill Education
- to study the effectiveness of the LSE programmes used by researchers in developing life skills
- to study the status of teaching science in India and especially in Gujarat
- to study the effectiveness of various strategies used for teaching science in developing life skills along with science process skills, scientific temper and scientific attitude towards environment and other real life problems.

These studies for adolescents have been classified under two main areas further into three kinds each.

Studies related to Development of Life Skills

- Studies on the scope for Development of Life Skills for adolescents
- Studies of different methods for Development of Life Skills for adolescents through a specially designed curriculum of Life Skills

- Studies on Development of Life Skills for adolescents through curriculum of any other subject i.e. through Integrated Approach

Studies on Teaching of Science

- Studies related to status of teaching of Science in India
- Studies related to status of teaching of Science in Gujarat
- Studies on the scope for Development of Life Skills through teaching of Science using different methods
- Studies related to activity based learning strategies of teaching science

The overall review churns up the research gap and relevance for the present study. The main sources for this review are Ph. D. thesis in Hansa Mehta library of the Maharaja Sayajirao University of Baroda, Proceedings of International conference on Life Skill Education at Sri Perumbudur organized by Rajeev Gandhi National Institute for Youth Development, Educational surveys published by MHRD: Government of India, National and International Educational e-journals, ERIC data base, JUSTOR Education, Shodhganga and the knowledge shared by various websites.

2.2 Studies related to Development of Life Skills

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- Studies of different methods for Development of Life Skills for adolescents through a specially designed curriculum of Life Skills
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2.2.1 Studies on the scope for Development of Life Skills for adolescents

Maheshwari & Swarna (2006) conducted the investigation on managing depression for enhanced well being among obese adolescents of Chennai. The objectives of the study were to find out the incidence of depression among obese and non-obese adolescents, to identity the factors that contribute to depression among adolescents, to design/develop strategies to overcome depression from obesity using life skill approach. In phase I, using BMI as an Indicator sample of sixty obese adolescents was selected using purposive sampling technique. In phase II, IPAT depression scale was used to find out the incidence of depression among obese and non-obese adolescents the percentage analysis helped to

know how obese and non-obese adolescent reacted to physical and psychological states of depression. About 81% of obese adolescents, self-criticism about 75% of obese adolescents reported high in low self-evaluation. The important implication suggested at the end is, appropriate strategies of Life Skill Education Programme should be formulated for depressed adolescents to improve their life skills that will help to overcome depression from obesity and cope up positively in life.

Philip (2006) held a descriptive study on information, understandings and attitudes of adolescent students towards gender, sexuality, sexual and reproductive health and rights of adolescents based on life skill education based methodology. The objectives of the study were 1. to probe the information, understandings and attitudes of school going adolescent students towards genders, sexuality, sexual and reproductive health and rights of adolescents 2. to trace the background information for developing a syllabus and curriculum for life skill education for adolescent students. The study was participatory in nature and included both quantitative and qualitative techniques together data from the field using thirty self-made handouts to facilitate the sessions as modules. Six schools were randomly selected from the schools in Trivandrum district of Kerala. One hundred eighty four students participated in the workshop session for different subject. The research conducted by Philip, revealed that there is strong gender discrimination in expectation as boy and girl, in work participation, roles and responsibility sharing, freedom of mobility and knowledge of sexuality adolescents imbibed these from the society and start to propagate it. The investigator found the data in relation to gender discriminations and suggested to develop curriculum of life skill education for adolescent.

Vashistha (2006) carried an empirical exploration of life skills relevant to science and technology. The investigator laid following objective for the study; (1) to identify life skills relevant to science and technology as per the preference of boys and girls of upper primary school; (2) to analyze the preference of upper primary school students for life skills on the basis of achievement in science and technology; (3) to analyze the different components of life skills and study the preference pattern of elementary school students for these components of life skills. The adolescent students of various schools of Ajmer were selected by systematic randomization carried out in three different phases. The

investigator used self-constructed tools like questionnaire to collect data of life skill relevant to elementary level science and technology. The term life skill was conceptualized in order to develop the suitable measuring devices for life skills relevant to science & technology along with their components. Data was collected by building a rapport with the respondents, in only one phase. The data was analyzed using chi-square, which signified that gender discrimination does not exist at all in relation to preference pattern for life skill with respect to science and technology. The chi-square value of level of achievement score of students shows those low achievement groups have the highest preference for communication skill followed by empathy, creative thinking, problem solving, self-awareness, stress management respectively. High achievement group students preferred Problem Solving to be major life skill relevant to science and technology. Students in average achievement group have given the highest preference for self-awareness followed by problem-solving, creative thinking, critical thinking, communication skill, decision-making, stress management, empathy and inter-personal relationship respectively. Hence, the investigator concluded that the achievement of the elementary level students in science and technology has great detrimental effect in determining the preference patterns for life skills. Majority of students preferred problem solving to be the most relevant and interpersonal relationship to be the least relevant to science and technology. Further, the investigator has suggested that schools should impart life skills that are needed for socialization of young people and to prepare them for a productive and prosperous life. Researcher emphasized that in the present context of overloaded school curriculum one of the potent ways to disseminate these life skills is to infuse them across existing subjects.

Mythili (2008) conducted a study on assertiveness and value system among adolescents. The investigator advocated for development of life skill of assertiveness among adolescents thorough level of assertiveness among male and female adolescents, finding the demographic factors involved in assertive behaviour, knowing the value pattern of students in instrumental and terminal values. 25 male and 25 female adolescents from a school of Chennai were chosen with purpose. The tools used by the researcher were Rayhus assertiveness scale and Rokeach study test to know existing status of values. Chi-square analysis was applied to test the significance of demographic factors involved in

assertive behaviour. Students't test was used to find the significant difference between male & female adolescent population in assertive behaviour and instrumental and terminal values. The researcher concluded that birth order, education, family background, physical changes, economic status of their parent's and religious faith have strong impact in being assertive. The researcher further emphasizes that challenges children and adolescents regularly face are innumeracy and literacy skills and so, 164 nations committed to 'education for all' have included "life skills" as a basic learning need for all adolescents.

Paltasingh (2008) analyzed Relationship among Creativity, Intelligence and Achievement Scores of Secondary School Students. The objectives of present study were to study the correlation between i) creativity and intelligence, ii) creativity and science achievement iii) creativity and scholastic achievement, iv) correlation between intelligence and science achievement, v) intelligence and scholastic achievement. The study was co-relational in nature. A total of 180 students of class IX of two Oriya medium secondary schools constituted the sample of the study. Three tools were used to collect the data: Jalota's Group Test of General Mental Ability, Baquer Mehdi's Test of Creative Thinking, and finally the Science Achievement test prepared by the investigator himself. After the collection of data a quantitative analysis was done. Findings of the study were; there is significant and positive correlation between creativity and intelligence, creativity and science achievement, creativity and scholastic achievement scores, intelligence and science achievement and total intelligence and scholastic achievement scores. Paltasingh observed scope to develop life skills through teaching of Science.

Chatrath (2009) conducted a quantitative Research on 400 high school and 350 first year medical students selected by random sampling technique in New Delhi to find 'who is more stressed a high school student or medical student?' The objectives of the study were, to study among high school and first year medical students, the psychological distress and the psychosomatic manifestations of stress and preventing the burden of mental stress among school going adolescents; which is the need of the hours. Self-report questionnaire and GHQ-28 were used to study psychosomatic manifestation of stress. CHIPS-Cohen Hoberman invenentory of physical symptoms was used. The investigator

found that high school students had significantly higher scores for anxiety/insomnia and somatic symptoms when compared to medical students. Both group had low scores for severe depression while studying the physical symptoms. It was found that constant fatigue, low energy levels, chest pain, acidity in stomach, cold/cough, headache, feeling weak and back ache bothered the adolescents. According to Chatrath this result shows dire need to develop life skills in high school students than in medical students; showing scope to develop life skills in high school adolescents.

Devi (2009) conducted a study titled as "A Study of the Relationship between Problem Solving Ability and Academic Achievement of Secondary School Students" which indicates the scope for development of life skill like problem solving to improve academic achievement. Objectives of the study were 1. To investigate the problem solving ability of IX standard students based on sex and type of school. 2. To investigate the mean differences, if any, between the level of problem solving ability of IX standard students with their academic achievement. 3. To investigate the relationship between problem solving ability and academic achievement of IX standard students. Method used was investigation study of correlation type. The sample comprised of 200 IX standard students of which 100 boys and 100 girls were selected randomly from both private and government secondary schools of Davangere city, Karnataka. Findings of the study are, 1. There is no significant difference in problem solving ability of boys and girls. 2. There is a significant difference in problem solving ability of students studying in government and private schools. 3. There is significant difference in academic achievement of students with high, moderate and low problem solving ability. 4. There is a positive relationship between problem solving and academic achievement of class IX students hence there is a scope to develop life skills in secondary school adolescents through teaching of curricular subject.

Gower et al (2013) examined associations between social-emotional intelligence (SEI) and two measures of violence perpetration (relational aggression and physical violence) in a cross-sectional sample of high-risk adolescent girls (N = 253). The researchers evaluated three aspects of SEI: stress management, intrapersonal and interpersonal skills. Results of a multiple linear regression model accounting for participants' age, race/ethnicity and experiences of relational aggression victimization indicated that girls

with better stress management skills were less likely to perpetrate relational aggression. A parallel model for perpetration of physical violence showed a similar pattern of results. Study findings suggest that SEI, and stress management skills in particular, may protect adolescent girls, including those who have been victims of violence from perpetrating relational aggression and physical violence. The researchers further suggest that there is a scope to develop social and emotional skills in adolescent girls through intervention programme which can be effective strategy to reduce perpetration of violence.

2.2.2 Studies on Development of Life Skills through curriculum of "Life Skills"

Life Skill Education programme is a specially designed programme to develop life skills either by Integrated approach i. e. through teaching of any curricular subject or through curriculum of the subject called 'Life Skills'. It can be activity based programme where in the activities are based on the concepts in the curricular subject or activities based on the theory of life skills or activities based on a specific problem like drug addiction or sexual abuse etc. LSE programme can be conducted by Concept Approach i.e. teaching theory of Life Skills or by Activity Approach i.e. involving students in activities that target the indicators of various life skills without informing them about the theory of Life skills UNICEF (2012).

Botvin (1980) observed the effectiveness of life skills training in preventing the onset of cigarette smoking. The effectiveness of a 10-session social psychological approach to the prevention of cigarette smoking was tested on 8th, 9th, and 10th graders in New York. The Program was designed to address both the social and psychological factors promoting the onset of smoking by attempting to: a) increase students ability to cope with direct pressures to smoke, b) decrease their susceptibility to indirect pro-smoking social influences, and c) improve their ability to cope with anxiety. The program was conducted by allied health professionals and utilized group discussion, modeling and behaviour rehearsal. Results indicate significant differences between the experimental and control groups in terms of the proportion of new "experimental smokers", Furthermore, there were significantly greater post-test changes for the experimental group on several of the knowledge and psychological measures, suggesting that the decrease in the onset of smoking behaviour among the experimental subjects did occur for the hypothesized

reasons. The Life Skill Education programme was based on specially designed Life Skill curriculum for prevention of cigarette smoking.

Botvin and Baker et al (1984) conducted a study on substance abuse prevention. The prevention strategy attempted reduce intrapersonal pressure to smoke, drink excessively, or use of marijuana by fostering the development of general life skills as well as teaching students tactics for resisting direct interpersonal pressure to use these substances. Result indicated that the prevention program had a significant impact on cigarette smoking, excessive drinking and marijuana use when implemented by peer leaders. Furthermore, significant changes were also evident with respect to selected cognitive, attitudinal and personality predisposing variables in a direction consistent with non-substance use. The Life Skill Education programme was based on specially designed Life Skill curriculum to prevent drug abuse.

Bharath & Kumar (2002) aimed to assess the impact of the Life Skill Education program by assessing the difference between experimental group and control group by testing their life skills after the intervention program. A total of 605 students were taken as the sample group consisting of adolescent girls and boys of 14 to 16 years studying in 8th, 9th or 10th standard in the two schools of Bangalore rural and Udupi. A total of 423 students were assessed as controls. Out of the 1000 odd teachers who were trained as Life Skill educators, 100 were selected randomly and their feedback on the perceived changes in their students who were in the Life Skill Education program was compiled. The student indicators were prepared by the authors as a part of the resource material. Rosenberg Scale of Self-Esteem, Preadolescent Adjustment Scale, Generalized Self-Efficacy Scale, Strengths and Difficulties Questionnaire – Self-Report Version, Class Room Indicators were used as tools for data collection. The trained teachers were the Life Skill educators and followed the pre designed Life Skill Education program. The classes were interactive and participative. The teachers whose feedback was compiled observed positive changes in the classroom behaviour, interaction among students and self esteem of students due to intervention of Life Skill Education program. The Life Skill Education programme was based on the specially designed Life Skill curriculum to develop self efficacy.

Prasad & Nagpal (2002) examined the effect on advocacy and capacity building through life skills education programme, the peer educators approach, for adolescents. The objectives of study were (1) to design a school based program for mental health and life skill education called "Expressions India", (2) to sensitize the school going adolescents about relevant psychological issues (3) to promote life skills and prevent the difficulties associated with behavioral and learning problems (4) to create awareness, responsibility and empowerment amongst adolescents, their parents and teachers. The sample consisted of 120 schools of New Delhi, 6000 teachers as master trainers and 200 adolescents as peer educators of same age. Using the structured questionnaires the data was collected about the issues of students and concerns of parents and teachers. Lectures and training workshops were conducted for parents, teachers, peer educators and school doctor. The topics like common childhood and adolescent problems related to development, behaviour, emotions; life skills, family communication relationships, basic counseling skills were thoroughly discussed, using informative material on substance abuse, HIV/AIDS, anger and stress management, coping with failures etc. The study concluded that the role of peer educators was significant in maintenance of adolescent education and school mental health program. The peer educators shared their background, values and life experiences with schoolmates. This in turn developed health related life skills, in adolescents. The Life Skill Education programme was based on specially designed Life Skill curriculum to prevent HIV/ AIDS.

Sharma (2003) had published a paper on measuring life skills of adolescents in a secondary school through specially designed scale to study the existing status of life skills in adolescents. The objective of this study was to develop a scale to measure life skills and to assess the levels of life skills in adolescents of a secondary school at Kathmandu. The investigator concluded that most of the teachers were not aware of the concept of life skills. Maternal education was significantly associated with higher life skill levels in adolescents. Connectedness and family support were other important factors influencing the level of life skills in the adolescents.

Zollinger & Commings (2003) studied evaluations of school-based tobacco prevention and control programs that yielded mixed results. This study assessed the impact of the Life Skills Training Curriculum on Marion County, middle school students' knowledge,

attitude, and ability to make good lifestyle decisions. From 1997 to 2000, students in grades six to eight in the study schools received the training through Life Skills curriculum. Survey data were used to compare tobacco use behaviour, attitudes and knowledge of those exposed with those not exposed to the program. Of the students surveyed, 12.5% were currently smoking. There were significantly fewer current smokers, and more students exposed to the program indicated they intended to stay smoke-free. Fewer of those participating in the program "hung out" with smokers and more said they should easily refuse a cigarette if offered one. Students completing the Life Skills Teaching Curriculum were more knowledgeable about the health effects of smoking. Program effects were different for male and female students as well as for White and Black students. The Life Skill Education programme was based on specially designed Life Skill curriculum to prevent use of tobacco.

Gamble (2006) in his article on teaching life skills for Student Success has written that Chicago Public Schools (CPS) recognized that their graduates were still struggling to find employment. They also concluded that those graduates who found employment were having difficulty in retaining their jobs. Chicago educators hired the company 'All Students Can Learn' to write the curriculum that addresses employability skills for junior high school students through university students and adults entering the workforce. Chicago Public School then piloted this curriculum with great Success. This article describes teachers and students responses toward this curriculum specially designed to develop employability skills.

Ahmed (2008) held a study on knowledge of sexual abuse, self-concept and assertiveness among girl children. The objectives of the study were i) to measure the knowledge of sexual abuse and its relationship with self concept and assertiveness among girl children; ii) to develop content for a prevention program on child sexual abuse. In order to develop the components to be included for a prevention program a study was conducted on the sample to assess the knowledge of child sexual abuse and its relationship with two life skills, namely, self-concept and assertiveness. Data was collected using children's knowledge of abuse questionnaire by Tutty; the self-concept scale by piers and Harris, children's assertiveness inventory by Ollander. Using correlation to assess the relationship between the variables, the investigator showed that the life skill education

programme and the life skills developed by the intervention of programme reduced the incidence of child sexual abuse and they mastered the skill to resist inappropriate touching or the skill to take action if at all abused. The Life Skill Education programme was based on specially designed Life Skill curriculum to prevent sexual abuse.

Galgali (2008) studied 'Adolescent Life Skills Education Program- the Bangalore Experience' with the following objectives; 1) to determine the readiness of school management of implementing a structured life skill program; 2) to discuss the topics and methodology adopted for life skill training; 3) to discuss the immediate impact of a life skill programme on students, teachers and parents. Ten schools and colleges in Bangalore, which were ready to implement life skill program, were approached by a team of pediatricians trained in adolescent health and life skills in 2006, 2007, 2008 for implementation of life skill program. 362 adolescents were targeted for Life Skill Education program after training principals and teachers. The life skill classes were designed to target the high-risk behaviours of improper nutrition, decreased physical activity, poor safety measures, unsafe sexual behaviours, substance abuse, injuries and suicide. The Investigator concluded that; all schools are not willing to launch a life skill program; the program needs universal implementation and wide spread publicity; innovative and creative participatory and experiential learning methods should be adopted; the immediate impact of the program is excellent and its long-term impact needs further evaluation.

Kenneth (2008) conducted the investigation to study the "Effect of life skill training on the academic stress of Tenth Standard Students" of a particular school of Chennai, where the sample was purposive. The factors contributing to academic stress within an adolescent population of class ten students were identified using the academic stress questionnaire. Life skill training was imparted accordingly. After the pre test-post test experimental research, a significant decrease in the stress level of adolescents was found after the treatment. The investigator concluded that school is a major contributor to students' stress. Since adolescence is considered as a stage of 'stress and strome', proper management of stress in adolescents is highly essential for success in adulthood. The research has proved that life skill training decreases the stress level in adolescent. The

programme was designed on the basis of Life Skill curriculum specially designed to manage stress.

Mehrotra & Kumar (2008) conducted a research to observe the "Basic Impact Indicators for Adolescent Well Being through Life Skills Education", for a purposive sample of peer educators of twenty five schools in a segment of National Capital Region area of New Delhi. The objectives of the study were 1) to design the life skill program to build capacity of peer educators for responsible sexual behaviour, understanding of stress, coping with substance abuse; 2) to identify and train master trainers for implementation of program; 3) to conduct workshops by trained facilitators; 4) to give feedback of the program while conducting the workshop; 5) to measure the success of the program. The tools used to collect data were interviews, questionnaire, feedback forms, and longitudinal assessment sheets. The participatory methods like role plays, case studies, brain storming, interschool literary festival, group discussions, situational analysis, games, collage making and quiz are employed to help adolescents and young people to gain knowledge, make positive healthy decision, examine attitudes, develop skills and avoid risks. Before this pilot intervention was conducted, master trainers were trained. The investigator concludes that the measured impact of the program showed increased attendance in school, proactive participation of adolescents in school activities, enhanced positive family and school partnership and positive health observations by school counselors. The Life Skill Education programme was based on specially designed Life Skill curriculum to prevent substance abuse, sexual abuse and stress management.

Rajan (2008) carried the research for one thousand adolescent girls, two hundred each from different types of schools of Delhi. The objective of the study was to design a school mental health life skill programme for girls. The data was collected in three phases using questionnaire and interview. The researcher concluded that a properly conceptualized and organized school mental health program equipped adolescent girls with suitable life skills and abilities needed for good mental health. The Life Skill Education programme was designed on the basis of the specifically designed Life Skill curriculum for mental health.

Rao & Kumar (2008) carried a "Study on Effectiveness of life skills Education on Adolescents", of quasi-experimental design on 152 students of class XI of a grant-in-aid

higher secondary co-education school at Perambur, Chennai. The objectives of the study were; 1) to do screening and form an experimental and control group, 2) to study the demographic profile of the students, family details and socio-economic background; 3) to impart life skills education inputs to the experimental group; 4) to study the outcomes of the life skills education inputs on the experimental group; 5) to compare the impact of life skills education between the experimental and control group; 6) to suggest strategies for making life skills education as sustainable practice in the school. Before the implementation of life skills program, screening of 152 students was done with Questionnaire and Monney's Problem checklist. The screening scores were treated as the pre test scores for the sample. The outcomes of the life skills education were measured & compared. Comparison of impact of life skills education between the experimental and control group showed positive impact of the intervention and made the investigator to insist the effectiveness to the school management, teachers, parents and policy makers. The Life Skill Education program was designed on the basis of specially designed Life Skill Curriculum.

Azad & Adhikary (2009) conducted a qualitative research "To address the HIV and AIDS issues and empowering the out of School Vulnerable Adolescents through Life skill Education." The objectives of the study were, to empower out of school adolescents through Life Skill Education; to select & identify organizations who will support the project; to develop Life Skill Education material e.g. posters, manual for master trainers; to train the Peer Educators, to monitor the project; to conduct Life Skill Education program. The sample of 20,000 out of school adolescents was selected by stratified sampling technique in New Delhi, 326 master trainers and 2409 peer educators were selected for Life Skill Education program. Data was collected by using tools like interview, feedback sheets etc. The study took place in phases like collection of data, training of master trainers, training peer educators and actual Life Skill Education for out of school adolescents. Interviews of parents, NGO-heads, adolescents involved were taken at the end. The investigator concludes by stating findings like, i) initiation of Life Skill Education program brought tremendous impact among adolescents, which increases their knowledge on growing up issues, HIV and Aids, reduced myths and misconception ii) it enhanced adolescent's self-confidence and provided a platform for the adolescent

girls to talk about the sensitive issue, iii) it mobilized the parents to enable the environment for Life Skill Education to prevent Aids. The Life Skill Education program was based on the specially designed Life Skill syllabus to educate the adolescents about HIV/AIDS.

Komanduri (2009) studied the "Impact of Life Skills Education in Promoting Self Perception in children with Conduct Problems. The objectives of the study were to study the impact of life skills education in prompting self-perception in two groups of boys with conduct problems and to evaluate the effectiveness of life skill education in promoting self-perception. From the adolescents of rural and urban setting of Tirupati twelve boys each with conduct problems were selected for the single subject research design. Self-Perception Scale Test (SPST) was administered before the intervention of life skill program. The life skill program was conducted in sessions. SPST was conducted after the sessions. The comparison of scores of Self Perception scale before and after Life Skill Education indicated significant improvement in self-perception of the boys of rural and urban setting who had conduct problems. The consensus that a small group for skills training tends to be more efficacious than individual training sessions was proved by this experimental study. The most important conclusion was without life skill intervention, emotional and behavioral problems in adolescents might result in escalation of academic problems, antisocial behaviour and eventual drop out in the later years. The Life Skill Education programme was based on specially designed curriculum to develop self perception in the students with conduct problem.

Lineo K. (2009), of Lesotho had conducted a study on Life Skills of adolescents. The introduction of Life skills education at both basic and tertiary education was meant among other things to improve all aspects of the quality education, ensuring equitable access to appropriate learning and facilitating Education for All (EFA) and Millennium Development Goals (MDG) initiatives. The purpose was to explore the main components of life skills programmes in place at Lesotho education system to address development problems such as poverty reduction, preventing spread of HIV/AIDS and alcohol and drug abuse. The study examined how the programmes were implemented and evaluated at Primary schools, Secondary schools and institutions of higher learning. Qualitative data was collected through document review and analysis; interviews of policy-makers in

the Ministry of Education and Training, Deans of the Faculty of Education in the institutions of higher learning, principals, education officers and curriculum developers. The findings highlight a number of issues and potentials emanating from assessment and evaluation, quality and teacher capacity in the delivery of the programmes. The Life Skill Education programme was based on specially designed curriculum to prevent drug or alcohol abuse and HIV/ AIDS.

Nagpal & Joshi (2009) conducted research for adolescents of 93 students of three junior colleges of South Mumbai. It was a purposive sample with the objectives like to analyze the family history and life style (diet, exercise, sedentary time) birth weight and the BMI and BP to detect risk of Metabolic Syndrome Body Mass Index, Blood Pressure and waist circumference measurement were used to select the sample. The Sample was trained in life skill workshop and the result showed the positive impact of Life Skill Education programme based on specially designed Life Skill curriculum to fight obesity.

Srinivasan & Padmavathi (2009) conducted an experimental research on Life Skills Education for convict children in convict home to prevent drug/alcohol abuse, unsafe sexual behaviour HIV/Aids and increased risk of violence. Pre test questionnaire was given to the adolescents, the purposive sample of convict home of Sri Perumbudur. Life skill education program was intervened to prevent drug abuse, unsafe sexual behaviour, HIV/Aids and increased risk of violence. Post-test questionnaire was used to measure the impact of Life Skill Education Analysis of pre test & post test score by t-test has shown significant improvement in the knowledge and skills to prevent drug abuse, unsafe sexual behaviour HIV/Aids and increase risk of violence through Life Skill Education programme specially designed for convicts.

Khera & Khosla (2012) analyzed the relationship between self concept and core life skills for randomly selected 500 adolescents studying in secondary classes of Sarvodaya schools situated in south Delhi under gone for Life Skill Education. The Major findings of the study is a positive co-relation between Core Affective Life Skill and Self Concept of adolescents which means those who have these essential skills are better confident in all. The Life Skill Education Programme was based on specially designed Life Skill curriculum to develop self concept.

Pujar et al. (2012) conducted a study to see impact of Life Skill Education Program on adolescent girls of class 8 and 9 of Dharwad district of the state of Karnataka with sample size of 328 which was randomly selected. The intervention program to develop life skills consisted of guest lectures, brain storming, working in small groups and role play to discuss and practice life skills like creative thinking, critical thinking and skill of empathy, problem solving and coping with stress. After training adolescent girls were instructed to practice in real life situations. After the intervention, a gap of one month later the post test assessment was done to know the impact of intervention on life skill development of girls. Students't test was used for comparison between pretest and posttest scores that showed rise in posttest scores. The study concludes that the intervention on life skill education is helpful for the rural adolescent girls to take Positive Action and improve their critical thinking, creative thinking, skill of empathy, coping skills of stress and problem solving ability. Life skills are the building blocks of one behavior and need to be learnt well to lead a healthy, meaningful and productive life. Attempts should be made to understand the adolescent's problems and guide them in acquisition of life skills. The intervention on life skill development is a good support system for adolescents at the community level.

Martin & Nelson (2013) conducted a survey in U.K. and U.S.A. to study the 'Effectiveness of School-Based Life-Skills and Alcohol Education Programmes' on decision making skills. On the basis of curriculum for alcohol prevention, the Life Skill Education programme was designed for secondary school adolescents by 'Drink Aware'. Little positive effect was found on the adolescents hence suggested developing Life skills through teaching of every school subject with involvement of their parents.

Parvathy & Pillai (2014) conducted a study to know 'Impact of Life Skills Education on Adolescents in Rural School' in Karunagapally district of Kerala for class IX students, with a sample size of 57 with control group, experimental group and pretest-posttest experimental design. The major objective of the study is to analyse the knowledge of life skills among adolescents and the impact of life skills education training on their knowledge level. Life skills training module prepared for the study by the researchers was administered to the experimental group. The data was collected through questionnaire developed and administered by the researcher. The tools used for the same

include 1) Socio demographic sheet which describes the socio economic status of the respondent and 2) Life Skills knowledge level analytic questionnaire specially prepared by the researcher for the study which included questions covering ten skills. There was positive impact of life skill education training on the skills like self awareness, empathy, critical thinking, creative thinking, decision making, problem solving, effective communication skill and skill of inter-personal relation, coping with emotions and coping with stress. The study had some limitations like it is conducted in a limited number of samples. The tool used; the questionnaire is phase validated and needs standardization and scale significance was missing in several spaces. The major suggestions for future are that the study needs to be extended more into larger number of samples and contextualization and modification of the module based on need and nature of the intervention groups can add on to the efficiency. The scope of using variety of methods for transmitting the skills also needs to be taken into account.

2.2.3 Studies on development of Life Skills by Integrated Approach

Meghani (1999) conducted a Study of the effectiveness of teaching learning strategy for developing critical thinking in students of Standard XI using Psychology subject as content. The Objectives of the study were i) to evolve a strategy for teaching- learning critical thinking in students of Std. XI, using the subject Psychology as content, to develop a tool for measuring critical thinking in students of Std. XI, to find the effectiveness of the evolved strategy for teaching- learning critical thinking. The Hypothesis of the study was: the evolved strategy for teaching- learning aimed to develop critical thinking will lead to increase in the mean scores on the post test measuring critical thinking. The sample of the study comprised of English medium students of Std. XI, who had opted for Art Stream and had Psychology as one of their subjects in the academic year 1997 in Navrachana Higher Secondary School affiliated to Central Board. Tools and Techniques used were restructured into lesson plans using techniques and methods aimed at enhancing critical thinking in students. PMI technique i.e. Plus, Minus and Interesting technique, OPV Other People's Point of View technique, and CAF Consider All Factors technique are some of the techniques used. Methods used for infusing critical thinking are case study and Socratic Questioning. A self made tool for measuring critical thinking in students was used to collect data before and after the

intervention programme. In order to find out the effectiveness of the evolved strategy for teaching critical thinking, qualitative and quantitative analysis was carried. For quantitative analysis 'single group t test' was employed. Findings of the study showed that the evolved strategy for teaching learning critical thinking had been effective in developing critical thinking in students with regard to ability to think independently through logical reasoning and justification, ability to evaluate arguments/beliefs/opinion using PMI technique, ability to compare and contrast analogies using CAF technique, ability to think dialectically and reflectively, ability to apply knowledge in a new situation, show improvement in questioning skill and critical reading skills and imbibe affective dimensions of critical thinking like intellectual autonomy, intellectual empathy, intellectual courage and intellectual humility. This study tried to develop the Life Skills through teaching of the subject Psychology.

Hanumanthaiah (2000) conducted a study titled "An Investigation of Effectiveness of Curricular Creativity Inputs in Physics at the Secondary School Level" with objectives to prepare lesson plan in Physics of class X with curricular creative inputs, to teach Physics for class X over a period of time on the lines of these lesson plans, to study the effectiveness of such lessons on students of class X On subject terms of mental abilities, sex, socio-economic studies, to inculcate the creative attitude towards life. A purposive sample was chosen for the investigation. Class X adolescents of Vijaya High School, Jayanagar in Bangalore were selected. The size of the sample was 71consisting 45 boys and 26 girls of same class. They varied in their mental abilities and socio-economic background. Tools and Techniques used were Creativity Test by Baqer Mehdi (1975), RSSB Test of Mental Ability by Sathya Murthy (1964), SES Scale by Kuppaswamy, Reaction Questionnaires of lesson plan for experts and Reaction Questionnaire to students constructed by the investigator were used for the study. The data was analyzed through t-test. Findings of the study were all the boys and girls taken together have responded positively to the Curriculum Creative Inputs. Their creative ability has increased considerably through Life Skill Education Programme integrated with Physics.

George (2006) studied 'Enhancing life skills among middle school students through interventional programs for school students of Madurai', Tamilnadu, where the sample of 134, 7^{th} class students belonging to 'early adolescence' was selected by cluster sampling.

The objectives of the study were to explore the presence and enhancement of creative thinking as a life skill among the middle school students, to measure the major components of creative thinking, namely fluency, flexibility, originality and elaboration and to measure academic performance as a related variable of creative thinking. The academic tests were conducted to measure achievements and the creative thinking test made by Murthy in 2005 was used to assess the enhancement of creative thinking through an intervention. In the experimental design of the research, an experimental group & a control group were selected and a pre test, post test was used. The intervention included role pay, brainstorming and other interactive group exercises, for a period of 30 working days, one hour per day. The comparative analysis of the pre test, post test differences in creative thinking and academic performance of the control group and experimental group, clearly revealed an enhancement in creative thinking and academic performance because of the intervention program of life skills. The regression analysis indicated a significant positive impact of creative thinking on academic performance. The researcher concluded the study with the remark that the life skill activities provided within the institutional context on a routine basis were well received, internalized and the outcome noticeably expressed. This implies that development of life skills can take place well through integrated approach i.e. through teaching of school curricular subjects.

Patel (2006) conducted a qualitative study titled 'Developing a sustainable Life Skill Education Program in Bhavnagar, Gujarat. The sample consisted of the children between three years to fourteen years of non school going children of the slums of Bhavnagar to the students of private schools. The objectives of this study were to study the effectiveness of Life Skill Program and to design the modules for sustainable LSE program. It was concluded that life skill education is beneficial in targeting negative behaviours in children, community involvement is necessary to implement the LSE program, the topics of Life Skills cannot be taught directly rather the life skills need to be nurtured over a long period through the teaching of various subjects.

Kumar & Veermani (2008) studied Life Skills Education among tribal children. The study aimed to study the effect of life skill education on the children of "Malyali tribe in Kalvayam Hills of Tamilnadu, a purposive sample". The data was collected by using tools like interview schedule, focus group discussion and case study. For imparting life

skills special lessons & activities were designed. The investigator concluded that teaching life skills form an integral part of curriculum at many schools of 'Malyali' tribe at Kalvayam hills in Tamilnadu. The researcher further says that the aim behind introducing life skills in schools is to capture the true essence of adolescence. Lessons in life skills help in holistic development of children. Schools have integrated life skills development programme with the school curricular subjects.

Singh (2008) conducted a case study of National Institute of Open Schooling (NIOS), Noida working in the field Life skills for enhancing excellence in education and lifelong learning. The data was collected by studying records, questionnaires and interview of persons working in the institute for adolescents. The study reveals that NIOS caters to the educational aspirations of the most vulnerable and crucial group of out of school young people, through printed self-study material and a limited number of contact classes for concept clarification. The target group belongs to urban slums, rural areas, school dropouts, and first generation learners or physically, mentally or educationally challenged who have no access to authentic information. The approach for effective life skill transaction has been through experiential learning. Life skill education is not taught as a separate subject but integrated in existing subjects. NIOS has adopted the curricular approach of seamless integration in every subject to ensure effective internalization of life skills.

Mark (2012) conducted a study with Integrated approach titled "The Role and Development of Life Skills in Young Sports Participants" in U.K. The experimental design of pre test-post test, with a sample of 50 adolescents who have Physical Education as one of their academic subjects was chosen by the researcher. Seven point Likert scale was used as the tool after the implementation of Life Skill Education Programme that had activities related to sports. Data was analysed using ANOVA and finding mean Standard Deviation for pre intervention and post intervention. The findings of the study state that the current study aimed to deliver and evaluate a life skills development programme. More specifically, the researcher examined whether participants of the life skills programme applied mental skills and techniques in sports and in school with greater frequency than those in the control group. Secondly the researcher investigated whether participants reported a higher quality motivation and wellbeing than those not in the

programme. With respect to the application of mental skills in school and sports there is some evidence to support the benefits of the development programme. Despite the lack of significant results, there was a trend towards greater application for school goal setting, sport self-talk and sport attention control in the experimental and control groups over the period of the programme. Goal setting was a central component of the development program.

2.2.4 Major Observations of the studies related to development of Life Skills

- Initial eight studies suggest scope for development of life skills in adolescents.
- Twenty two studies show development of life skills through specially designed life skill curriculum that are problem specific.
- Later seven studies show development of life skills through Integrated Approach i.e. through teaching of school curricular subjects. Most of the researchers have used experimental design with quantitative methods for data analysis.
- Vashistha (2006), Lineo (2009) and Martin & Nelson (2013) have used qualitative methods to collect and analyze the data.
- Philips (2006) has used qualitative and quantitative methods for data analysis.
- Lineo (2009), Martin (2013) and Zollinger et al (2013) have used survey method to collect data.
- Botvin et al (1980), Botvin & Baker et al (1984), Bharat and Kumar (2002), Prasad (2002), Zollinger et al (2003), Gamble (2006), Patel (2006), Ahmed, Azad, Galgali and Mehrotra in (2008), Nagpal (2009) and have tried to develop problem specific i.e. content specific life skills for prevention of drug abuse or alcohol or prevention from AIDS through studies with experimental design. These researchers have designed a curriculum and strategy to develop life skill to address a particular problem existing with the adolescents and tried to enhance the quality of physical health of adolescents.
- Sharma (2003) conducted a survey to design a scale to measure the level of life skills in adolescents. Kenneth (2008), Mehrotra (2008), Komanduri (2009), Khera (2012) evaluated the effectiveness of LSE program to improve mental health of adolescents through content specific LSE programme. The studies conducted for Mental Health have focused on developing self perception, self awareness and stress management. Pujar et al. (2012) conducted a study to see impact of separate LSE Program on

adolescent girls of class 8 and 9 to develop creative thinking, critical thinking and skill of empathy, problem solving and coping with stress. Parvathy & Pillai (2014) conducted experimental study to improve 10 life skills given by WHO through LSE programme.

- Meghani (1999) developed the strategy to develop critical thinking skill by LSE programme through teaching of Psychology. Further Patel (2006), George (2006), Kumar & Veermani (2008) and Singh (2008) recommend development of Life Skills through teaching of all the school curricular subjects. While creative thinking skill is developed by Hanumanthaiah (2000) through teaching of Physics and by Mark (2012) through Physical education.
- Rao (2008), Gower et al (2013) and Martin et al (2013) insist on developing life skill education as sustainable practice, hence suggested to develop life skills through teaching of school subjects with involvement of their parents.

2.2.5 Trends observed in studies related to development of life skills

Doctoral Studies on development of life skills in the period of 1980 to 2014 are conducted for adolescents of secondary school. Initially the studies were conducted to develop content specific life skills through life skill curriculum for particular health related problems like drug prevention or substance abuse or AIDS prevention. Later in 1997 when WHO defined Life Skills as skills needed by the people to take informed decision, solve problem, think creatively and critically, communicate effectively, build healthy relationships, empathize and cope with others and manage their lives in a healthy and productive manner. WHO classified the life skills into five main areas as thinking, social, negotiation, non-judgmental and empathy across the cultures for mental health. In 2000 Dakar Framework of Action by UNESCO committed to 'Education for All' had set one of its six objectives as improving all aspects of the quality of education and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills. At this initiative of UNESCO through Education For All, doctoral studies on development of life skills to develop various components of life skills started to improve the quality in education. The investigator of present study has observed following trends in each decade.

1980-1990: Botvin (1980), Botvin & Baker (1984) undertook the study of 'Preventing cigarette smoking through life skills training' and 'Prevention of substance abuse through life skills training' quantitative study with experimental & control group for content specific life skills through specially designed LSE curriculum and programme for adolescents. Thus the common practice of developing life skills with the objective of prevention of substance abuse is seen in the researchers. The studies are experimental in nature using quantitative methods for data analysis with randomly selected sample of adolescents.

1990-2000: This review has only one study in this decade in India conducted by Meghani (1999) who developed critical thinking skills with quasi experimental design through teaching of Psychology to purposively selected sample of adolescents. The researcher used integrated approach to develop life skills and measured these with self developed tool, using qualitative and quantitative methods for data analysis.

2000-2010: This decade saw significant rise in the studies on Life Skill Education. Twenty four studies conducted on development of life skills in adolescents are reviewed. Hanumanthaiah in (2000), Bharath & Kumar and Prasad in (2002), Sharma and Zollinger et al in (2003) Gamble, Patel, Philip and Vasishtha in (2006) George in (2006), Ahmed, Galgali, Kenneth, Maheshwari, Maithili, Mehrotra, Paltasingh, Rajan, Rao in (2008), Azad, Devi, Komanduri, Lineo, Nagpal in (2009) examined the effect of Life Skill Education Programme on the adolescents. The researchers of this decade advocated development of life skills through specially designed Life Skill Education Programme for physical as well as mental health. Most of the studies have collected data using standardized tools like Rosenberg scale of Self-Esteem, Pre adolescent Adjustment Scale, Generalized Self-Efficacy Scale, Self Report versions, Class Room Indicators, Structured questionnaires, Questionnaire by Tutty, Self-concept Scale by Piers and Harris, Children's assertiveness Inventory by Ollander, Self constructed but standardized tools, Mooney's Problem Checklist and Self Perception Scale Test where data is quantitative and analyzed using t-test for purposive sample.

2010-2020: It is observed by the investigator that the number of researches in development of life skills is on rise. Khera in India and Mark in U.K. (2012), Martin et al in U.K. and U.S. (2013) confirm improvement in the quality of life of adolescents with

implementation of Life Skill Education Programme. The researchers support life skill education through integrated approach i.e. designing of life skill education programme on the basis of the curricular subject to develop generic life skills. In this decade the trend of studies on life skill education changed from problem specific to integrated approach. The studies were of experimental nature using quantitative methods for data analysis. Khera (2012) and Martin et al (2013) have used Random Sampling technique while Mark experimented on the purposively selected sample.

2.2.6 Research Gaps identified from studies related to development of life skills

The life skill education in formal schools began in nineteen eighties when main emphasis of researchers was on improvement in the quality of physical health of adolescents through life skill education. It seems that the relation of mind with the body was overlooked by the researchers in this decade.

- Main focus of researches reviewed is not on development of thinking skills that would make the adolescent think critically, creatively to recognise and address the problem before her/him and take the right decision.
- Very few researchers have attempted to develop thinking skills that are generic in nature.
- Later from 1999 the life skills developed which actually are generic in nature was attempted by the researchers all over the world, but development of only one component of thinking skill was tried by the researchers.
- Investigator of present study has not come across any study that has attempted to develop all the four components of thinking skills only.
- The researcher has not come across any study conducted for secondary school adolescents that has tried to develop life skills through Integrated Approach woven with subject curriculum and formative evaluation pattern.

2.3 Studies related to Teaching of Science

The investigator of present study had a question that pondered on development of life skills through teaching of the subject science to adolescents of secondary school. With this objective in mind the researcher undertook study of sixteen doctoral researches to understand the present status of teaching science since independence of India. The studies

related to status of teaching science are further divided into two parts: studies across other states in India and studies across Gujarat.

- Studies related to status of teaching of Science in India
- Studies related to status of teaching of Science in Gujarat
- Studies on the scope for Development of Life Skills through teaching of Science using different methods
- Studies related to activity based learning strategies of teaching science

2.3.1 Studies related to Status of teaching of science in India

Veerappa (1958) conducted a study to examine the position of science education in India and assessed the developed trends on the basis of observation in the USA, UK and the feasibility of introducing these trends in Indian institutions was also investigated. The researcher examined the trends in science education from primary through the degree course level. Researcher found that due to lack of proper laboratories, well equipped science teachers and effective teaching methods science education in India was not on a proper footing. Researcher found that teaching science through herbaria plans, the lecture demonstration method, and essay type questions in examinations were the common trends. Researcher has suggested that teaching science through the integrated or concept approach has scope in Indian situation.

Muddu (1978) conducted a study entitled 'A study of prevalent status of instructional procedures in biology in high schools'. The objectives of the study were to evaluate the facilities provided to teachers, such as laboratories, audio visual aids, to find out the type of instruction adopted in teaching biology in accordance with the concepts envisaged in the syllabi, and to find out the extent to which the instructional procedures met the demands of biology syllabi in the process of reorganizing the scheme of secondary education. The study was designed as a quantitative empirical study. The sample consisted of teachers of 120 high schools teaching biology in class VIII, IX and X of the twin cities of Hyderabad and Secunderabad. The variables involved in the investigation were the present status of instructional procedures followed by teachers in biology teaching, the adequacy of classroom instruction to effect behavioral changes in students and the adequacy of the laboratories, reading materials, extracurricular activities in secondary schools. A questionnaire was prepared and administered to the selected

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

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

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

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

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

Mehna (1986) conducted a study entitled "An investigation into some factors affecting academic achievement in science of standard IX students of greater Bombay" with a view to find out the predictors of achievements in science as a whole with relation to certain

variables. Major research findings of the study were, six variables, viz. verbal intelligence, motivation for learning, general science, scientific knowledge and aptitude, numerical ability, liking for teachers of science and interest in medicine were significant predictors of achievement of class IX students in general science. The research findings imply that pupils' performance in science subject can be improved if teachers succeed in generating a feeling of liking for them among pupils, if teachers develop aptitude for science among children by providing scientific information, if teachers can motivate children to learn science subject. This needs adequate information and training for teachers of science in making science teaching interesting and in training them in the techniques of arousing pupils' motivation for learning science.

Mohapatra (1989) conducted a study on "Four dimensions of the teaching-learning of science: Characteristics and implications." Major objective of the study was to identify the role of the teacher and the learner in the teaching learning process in developing and modifying scientific concepts. Whole study was based on the review of related literature regarding the origin of scientific concept formation in the minds of children and related it to the teaching-learning situations. The major finding of the study was the science teacher had an important role in helping the child to develop proper concepts about objects and events by utilizing children's personal experiences with the rational thinking process.

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

Kansakar (1996) did an Investigation into the understanding of Science and Scientific Temper: A Cross Cultural Study. The objectives of study were to develop and validate instrument on understanding of science, to develop and validate instrument on scientific temper, to study the effect of type of school, class, level, geographical location, sex on

level of understanding of science among students. The sample comprised of 1315 Students of classes X & XI from India and Nepal. The sample was selected through Random Sampling Technique. The major finding of study was students from Nepal were found to possess significantly higher understanding of science and higher level of scientific temper than students of India.

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

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

Karthikeyan & Mohideen (2005) conducted a research titled "A Study of Correlation between the Availability and Utilization of Physics Laboratory Facilities in Higher Secondary Schools and Attitude of Higher Secondary Students towards Physics Practical". Objectives of the study were (i) To find out the correlation between the availability and utilization of physics laboratory facilities in higher secondary schools and attitude of higher secondary students towards physics practical; (ii) to find out whether there is any significant difference in the attitude of higher secondary students towards physics practical with respect to different variables such as sex, locality, language of

instruction and Groups; (iii) to find out whether there is any significant difference in the attitude of higher secondary students towards physics practical with respect to the school variables such as types of management and nature of schools (Boys, girls and coeducational); (iv) to find out whether there is any significant difference in the attitude of higher secondary students towards physics practical with respect to the family variables; and (v) to find out whether there is any significant difference in the availability and utilization of physics laboratory facilities among the higher secondary schools in Thoothukudi Educational District with respect to the variables: types of management and nature of schools. The sample consisted of 420 student selected randomly from 9 higher secondary schools in Thoothukudi Educational District. Tools used included Attitude scale and a questionnaire. The statistical techniques like Rank Difference Correlation Coefficient, Chi-Square test, and ANOVA were used to analyze the data. Findings of the study were (1) it is found that there is a positive correlation between the availability and utilization of physics laboratory facilities and students attitude towards physics practical. (2) The attitude of girls, MPCB group students and rural students at higher secondary levels was found to be more positive than boys, PCBZ group students and urban students respectively.

(3) The attitude of the higher secondary students in girls' schools and the government schools are more positive than boys and co-education schools and aided and self-finance schools respectively. (4) Mother plays a vital role in developing students' attitude towards practical. (5) It is mainly found that the availability and utilization of physics laboratory facilities are more in girls' schools.

2.3.2 Studies Related to Status of Teaching of Science Particularly in Gujarat

Rajput et al (1978) carried out a survey of science laboratories in the western region. The objective of the survey was to study the role of laboratories in the basic education of science as perceived by science teachers. It intended to analyze the main objectives of laboratory work in the opinion of science teachers, the extent to which the objectives were realized, the area of the laboratory , the number of experimental tables in the laboratory, the total time allotted for laboratory work in each subject, the problem faced in conducting the laboratory classes, the procedure adopted for making purchases for the laboratory, the total grant available for the laboratory, the additional grant needed for the

laboratory and the assistance in the conduct of laboratory work by trained laboratory attendants and helpers. The study was conducted on ninety four science teachers of whom, thirty five were from Madhya Pradesh (M.P.), twenty seven from Gujarat, twenty two from Maharashtra and ten from Goa, who attended the correspondence cum contact programme at the Regional College of Education, Bhopal. A questionnaire was developed to collect data. The main findings of the survey were the objectives of the laboratory work outlined by the teachers were to verify facts taught in theory classes, to develop habit of doing independent work among the students, to create interest in science, to prepare students for higher studies, to develop skills of handling the apparatus/equipments, to observe and critically think about the results, to develop the habit of reasoning, to avoid memorizing the subject, to create interest for research, to have clear understanding of the concepts of the respective subjects and to find limitations and drawbacks in the theory portion and to develop habit of doing systematic work. The major unwritten goal of laboratory work was however to prepare students for practical examination held externally. In Madhya Pradesh sixty eight percent schools did not have any water supply in the laboratories, ninety one percent schools had no gas supply, twenty eight percent did not have electric fittings, seventy seven percent did not have any botanical garden and eighty nine percent schools did not have any workshop for undertaking minor repairs. In Maharashtra the percentage of schools having water supply was forty five, gas thirty two, electricity eighty two, botanical gardens twenty three and workshops forty five while corresponding percentages in Gujarat were forty four, eighteen, almost nil and twenty two respectively. As many as half the schools included in the sample won prizes and certificates for distinctive work in science. In M. P. fifteen percent schools did not have any experimental tables and in Gujarat and Maharashtra the corresponding percentages were eight and five respectively. Practical work not attempted in class IX in about fifty five percent schools in M. P. and for Maharashtra and Gujarat the corresponding figure was twenty per cent. The main problems faced by the teachers were lack of free time for them to arrange for practical work, laboratory assistant being busy elsewhere, the poor quality of equipment and chemicals supplied by firms offering lowest quotations and disciplinary problems of students.

Menon (1986) conducted the Study of a System of Science Education in the Perspective of the Process of Science Inquiry. The major objectives of the study were to arrive at the norms of development of the process skill of scientific inquiry among students of secondary and higher secondary classes of the English medium schools which followed the curriculum system framed by the Gujarat Secondary and Higher Secondary Education Board, to study the overall impact of the curriculum system on the development of the process skills of scientific inquiry, to examine the science textbooks for standards VIII to XII for their suitability to develop skills of scientific inquiry, and to examine the instruction and valuation practices in relation to scientific inquiry. In order to develop the norms of development of the process skills of scientific inquiry, a multi-cross-sectional survey was conducted among a sample of 1448 students of standards VIII to XII belonging to the English medium schools in the city of Baroda. Data were collected with the help of the Test of the Process of Scientific Inquiry (TOPSI) which was constructed and validated by the investigator. The information generated through this survey was contrasted with that generated in the first survey. The obtained data were subjected to content analysis. A sample of forty four lessons given by science teachers of the English medium schools following the curricula under study were observed using the System of Observation of Cognitive Processes in Science Instruction (SOCOPSI). In addition to this a sample of practical lessons in the laboratory were also observed and 220 questions asked in the classroom tests were content analyzed. The major findings of the study were the overall proficiency in the process skills steadily increased as students went up from standard to standard, there was a sudden transition in the overall development of process skills between standards X and XI (around the age of sixteen years), the skill of identifying variables had been developed by the time students reached standard VIII, the skill of interpreting observational data was developed around fifteen years of age, the skill of controlling the variables did not develop among the students in the system at seventeen years of age. Children of the schools affiliated to the CBSE were found better in the development of the process skills. Textbooks were the only curricular material through which the curriculum guidelines percolated up to practicing schools and questions mostly tested the product aspects and not the process aspects.

Patel (1997) conducted an investigation titled, " A Study of Scientific Attitude and Its Correlates Among secondary School Students of Baroda". The objectives of the study were i) to construct and standardise an instrument to measure scientific attitude of secondary school students, ii) to measure the scientific attitude of secondary school students of Baroda, iii) to study the nature of distribution of scientific attitude scores of secondary school students of Baroda, iv) to study the relation between scientific attitude score with socio-economic status, achievement in science and general achievement of students, v) to compare the scientific attitude among the students with high,average and low achievements. The sample consisted of 292 rural and 304 urban students of class X studying science curriculum offered by the Gujarat State Board of SecondaryEducation during the academic year 1995-96. The tools used to collect data were official documents, records, scientific attitude scale and scale to measure socio-economic status. The findings of the study show that the students of different socio economic status differ significantly with respect to scientific attitude. Scientific attitude of high achievers was more than the Scientific attitude of average and low achievers. Scientific Attitude of Urban girls was maximum and that of rural boys was minimum.

Umasree (1999) conducted a study entitled science curriculum and its transaction: an exploratory study in secondary schools of Vadodara. The objectives of study were: to study the objectives of science curriculum at the secondary schools in Vadodara, to study the transaction of curriculum in science in the classroom situations in schools at Vadodara, to gather the teachers' opinion about the different aspects of science curriculum through classroom observation, questionnaire and interviews, to compare the intended and transacted curriculum. The sample for actual classroom observation consisted of sixteen secondary schools in Vadodara city covering fifty teachers and 240 classroom sessions in science for eighth, ninth and tenth standards. The tools consisted of classroom observations, and semi-structured interviews and questionnaires. The data analysis was done through content analysis. The findings of study were 1) lecture method was the most convenient to use as large chunks of information could be conveyed in less amount of time 2) main objective of education is success in examination that predominates the thinking of teachers, students and parents 3) Lack of time to complete the textbook content is the main reason behind absence of using teaching aids 4)

assessment of science curriculum indicates the existence of two curricula: official and operational (that transacted by teacher in classroom) 5) wide gap between intended curriculum of science and transacted curriculum. The researcher suggested reframing of science syllabus keeping in view the time factor, improvement in textbook syllabus with respect to scientific, technological and societal factors, orientation of teachers about objectives of teaching science, training of teachers for new instructional strategies, examination in 'practical's at secondary level, inclusion of questions based on application of science concepts and inclusion of projects in the science textbook.

2.3.3 Observations of the Studies related to Teaching of Science

The observations of above researches show that, before independence (1947) and two decades after independence appeared alien and imposed from foreign world. The reviews studied from 1958 till 1999 further depict the following features of status of science teaching in India and particularly in Gujarat.

- In nineteen fifties and sixties science teaching in India was not on proper footing considering subject science as a part of social science. The objectives of teaching of science curriculum were not defined clearly and teachers were not aware about the nature of science hence were not able to teach science as a process and product. Science laboratories, equipments for teaching science, teaching aids were not available.
- In seventies it was observed that presence of vital factors affecting quality of science teaching were; lack of qualified teachers to teach science, lack of adequately equipped laboratory for secondary students, lack of funds from government, overcrowded classrooms, inadequate teaching tools like demonstration tables, bulletin boards, film strips, projectors, microscopes and lack of laboratory apparatus. Schools in rural area did not have adequate water supply, laboratories, absence of laboratory assistants, properly furnished classrooms and enough number of qualified teachers to teach science, Muddu (1978), Swaranamma (1978).
- In 1982 Sharma noted change in the pattern of education to 10 + 2 + 3 and witnessed revision of curriculum, textbook, methods of teaching science, teacher education programme from 1947 to 1977. The investigator emphasized that education of the subject science in secondary school has changed from concept approach to

environmental approach that gave rise to modern science curricula. It had largely expanded by seventies but the methods of teaching science have remained unchanged.

- Till 1983 status of teaching of science was not improved as a result the benefits of modern science failed to reach masses. There were ideological and social constraints on the development of science in India Barman (1983).
- Lack of teachers' training to use laboratory and science clubs were not formed in the secondary schools to develop aptitude to learn science amongst class IX students, Desai (1986), Mehna (1986).
- Absence of science teacher's role in developing concepts about the objects and events by using personal experiences of children and making them use rational thinking process Mohapatra (1989).
- Positive relation exists between attitude to science and achievement score Kar (1990).
- Students with higher scientific creativity, intelligence and problem solving ability have higher understanding of science processes as compared to middle and low level students and quantitative achievement on conceptual understanding for class IX students Kwatra and Sharma (2000).
- Positive correlation exists between the availability and utilization of physics laboratory facilities and students' attitude towards physics practical, girls have more positive attitude than boys of Thoothukudi educational district of higher secondary Karthikeyan and Mohideen (2005).
- In Gujarat Rajput et al (1978), Menon (1986), Patel (1997) observed that, curriculum of science textbooks of Gujarat State Board of Education has less scope compared to the science textbooks of Central Board of education to develop science process skills, the questions asked in the examination were focused on knowledge alone i.e. science as product while process aspect of science inquiry is hardly evaluated in examination, while teaching science in secondary schools the process skills are hardly developed in the school,
- Scientific attitude and socio-economic status decide achievement scores of students of class X of secondary schools of Vadodara and hence it is necessary to conduct study on development and measurement of scientific attitude after intervention of the specially designed educational programme aimed to develop scientific attitude.

- Umasree (1999) observed that, the sole objective of teaching science in secondary class remained as passing exams, wide gap between science curriculum decided by NCF and actually transacted curriculum, lack of time to teachers to complete the syllabus and absence of use of teaching aids, Lecture method preferred by all science teachers over any other method as it could help to transact large chunks of information.

2.3.4 Research Trends and Gap Related to Teaching of Science in India

The researches on the status of teaching science in India in the period of 1983-1990 show change in every aspect of teaching science in secondary schools in India. Aspects like objectives of teaching Science, curriculum of science at every level of education, methods of teaching science, examination pattern, science teachers' training and facilities provided by government to secondary schools, supervision and inspection practices and emphasis on the use of Laboratory for science experiments had undergone a change (NCERT, 2001). The review indicates that after independence of India the trend of studies on teaching of science moved from basic needs of teaching science like laboratory work, teaching aids in secondary classroom to questioning of fundamental objectives of teaching science, knowledge based curriculum to skill and value based curriculum, transaction of concepts of science in the form of chunks of information to the application of scientific concepts in daily life.

2.3.4.1 Trend of Researches in each decade from 1947 to 2013

1947-1960: Survey method is used to know status of teaching science in India with randomly selected sample and tools like observation schedules.

1961-1970: Investigator did not come across any study on status of teaching science in India during this decade.

1971-1980: Survey method is used to know status of teaching of science with randomly selected sample and self constructed tools like questionnaire. Three studies of this nature were conducted in 1978 by Muddu, Rajput et al and Swaranamma.

1981-1990: In this decade the trend of researchers is to conduct literature review to observe origin and development of modern science in pre-independent India or use survey method to get data from very large samples of the population using

questionnaires, observation diaries and interview as their main tools. The sample is selected by random sampling technique. The objectives of studies in this decade were to know the status of teaching science with different perspective of studying effect of teacher's workload on teaching science, teacher's qualification and understanding of concepts, to find the relation between achievement score in science and students' liking for a science teacher and to study the impact of development of process skills on scientific inquiry using specially designed tools like Test of The Process of Scientific Inquiry (TOPSI) and System of Observation of Cognitive Processes in Science Instruction (SOCOPSI) and questionnaire.

1991-2000: In this decade the objectives of the studies were, to study relationship between attitude and achievement in general science of class IX students, investigate into the understanding of Science and Scientific Temper Cross Culturally, understanding of Science Process in Relation to Scientific Creativity, Intelligence and Problem Solving Ability of Middle School Students, to study interrelationship between quantitative achievement and conceptual understanding of the students learning science and to study interrelationship between quantitative achievement and conceptual understanding of the students learning science. Most of the studies in this period are comparative in nature that proved importance of teaching science as a process. The samples were drawn using stratified random sampling method. The tools like questionnaire, tests and interview were structured and standardized by the investigators.

2001-2010: In this decade most of the investigators in the area of teaching of Science conducted studies on effectiveness of new strategies to teach science in the class of adolescents not on the status of teaching science in India. The researcher could come across only one study related to the study of status of teaching science. The objective of the study is to study correlation between the Availability and Utilization of Physics Laboratory Facilities in Higher Secondary Schools and Attitude of Higher Secondary Students towards Physics Practical. Tools used included Attitude scale and a questionnaire. The statistical techniques like Rank Difference Correlation Coefficient, Chi-Square test, and ANOVA were used to analyze the data.

2.3.4.2 Research gaps Studies related to Teaching of Science

- Status of teaching science is not studied separately as the status in private schools, government schools, grant-in-aid schools and international schools.
- The comparative study of status of science teaching in various types of school in terms of science syllabus, laboratory facilities at secondary level, teacher's competency, fee structure, funding, student-teacher ratio, school policy, execution of government policies and accountability are missing.
- Status of teaching science in terms of activity based approach used in private, government or aided schools that involves students individually is not compared with activity based approach for students as a member of team.
- Comparative study on the status of teaching science in private and government aided schools to develop life skills is not found.

2.4 Studies on teaching of Science by different strategies

Kamalakanthan (1968) conducted an experimental study of teaching physics by traditional and problem solving method. The study attempted to find out which of the two specific methods, traditional (conventional) or problem solving, provided for students' gain in and retention of knowledge and abilities. The sample consisted of thirty two students of class X. A test on the unit on heat was prepared. After consultation with the subject teachers and experts in the field, items comprising the pre test, numbering sixty were finalized and were administered to all thirty two students at the same time, under exactly similar conditions. On the basis of the scores obtained the students were divided into two groups, comprising sixteen students in each group. One group was designated as control group while the other was designated experimental group. The control group was taught by the traditional method. The experimental group was taught by the problem solving method. The two groups were taught for a period of eight days, the unit on electricity and magnetism by the traditional and problem solving methods, respectively, at the rate of an hour for each group. The gain in or retention of knowledge and abilities was measured by noting the score points in the three group tests- base test, post test and delayed retest of identical nature given at the start, at the close and after the lapse of some time. Mean, standard deviation and T test were employed to analyse the data. The findings of the study were: the differences in respect of both growth and retention were

not at all statistically significant, the difference in the percentage of growth between the control and the experimental groups together was not statistically significant (t=0.78), neither of the methods was significantly superior to the other, the difference in the percentage of retention was not statistically significant for both the groups, however from the point of view of objectives and the end products of science teaching, the problem solving method had positive favorable points as compared to the traditional method of teaching.

Muddu (1978) carried out study of the effectiveness of the use of motion pictures as aids in the teaching of biological sciences as compared to the usual methods. The objective of the study was films provide the elements for vicarious visual experiences, the use of effective and appropriate films results in more learning in less time and better retention of what is learned, films help in increasing factual knowledge, teaching skills, building attitudes, changing motivation, retention of knowledge, films are the most powerful, prolific, popular, pointed and polished of all the media that penetrate into the conceptualistic skeleton of the human mind. This was an experimental study comprising pre-test/post-test, experimental group and control group design. The sample of the study consisted of sixty students of class VIII of the age group twelve to fourteen years. The sample students (thirty students to each group) were assigned to the experimental and control group randomly. The mean achievement gain of both groups was compared. The findings of the study were there was a significant improvement in the post-test performance of students in both the groups over the pre-test, there was significant improvement in post-test performance over pre-test performance in higher ranges of scores particularly in the case of the experimental group, There was a definite improvement in the pass percentage in case of the experimental group, the sound pictures helped to a great extent the above average students to comprehend the subject matter in biology, the use of films in teaching of biological sciences helped in more learning in lesser time and better retention of what was learnt, instructional films stimulated the scientific interest of the students, instructional films had immense potentialities in teaching and provided the elements for vicarious visual experiences which in turn made the lessons more vital and further made the language used in lessons more meaningful.

Jha (1979) conducted an experimental comparison of different methods of teaching high school biology. The study was designed to test experimentally the relative effectiveness of various methods of teaching biology. The experimental study was conducted on a sample of sixty students in class X in Bankipur government girls' high school, Patna. These students were regular students and they were selected out of a total number of 100 students in the class. Again the sixty students were divided into three groups randomly. The first group was control group, second demonstration group and third activity group. The investigator taught all the groups after administering pre test. Only one group was taught in a day. To avoid fatigue every group was taught in the first period. Post test was administered at the end of the experiment. ANCOVA was employed to analyze the results. The difference was further examined by paired t test. The main finding of the study was that there was strong evidence in favor of activity based approach in teaching school science in respect of acquisition of knowledge, application of the scientific knowledge and development of scientific skill.

Exemmal (1980) carried out a study on construction of certain models for teaching school botany using environmental and ethnic resources and testing the efficacy of such models. The major objectives of the study were to construct models for teaching botany using environmental and ethnic resources, to test the efficacy of the teaching models by comparing the achievement in botany of the treatment groups, to examine the effect of environmental approach on the attitude of pupils towards teaching and learning and to compare the effectiveness of environmental approach and formal approach in realizing certain select educational outcomes. The tools employed for the study were teaching models in botany, a rating scale on teaching models, an achievement test in botany, a scale for measuring the attitude of pupils towards science teaching and learning, a judgment schedule for teachers and pupils and verbal and group test of intelligence, a science interest inventory and a general data sheet. Six topics from the botany syllabus of standard IX were selected for the construction of teaching models and tested experimentally using parallel group design by comparing the immediate post teaching and the extent of forgetting scores of the total sample and the subsample of the environmental approach group and the formal approach group. The effect of the environmental teaching and learning was studied by comparing the pre and post attitude

scores of both the groups. The experimental study was limited to eight schools. The rating scale was administered to 300 teachers and 100 experts. The major findings of the study were the environmental approach was significantly superior to the formal approach in terms of immediate post teaching and delayed memory scores, significant difference existed between rural and urban students in their immediate post teaching achievement when the groups were exposed to the environmental teaching, pupils belonging to low SES groups were significantly superior to those belonging to high SES groups in their achievement when taught through environmental approach, pupils belonging to rural areas were significantly superior to urban students in their achievement when taught through environmental approach.

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

Kumar (1981) carried out an experimental study of the relative effectiveness of three methods of instruction exposition method, programmed learning method and multimedia method in science education. The main objectives of the study were to find out the relative effectiveness of the three methods of instruction, to study the relative retention in learning through the three methods. A 3x2 factorial design was employed. The biology students of classes IX and X of two inter colleges formed the sample of the study. In all 180 students were divided into three groups of sixty each. The findings of the investigation were the multimedia was more effective than the programmed learning method or expository method, the programmed learning method was more effective than the expository method, retention in learning by the multimedia method was higher than the other two, retention in learning by the programmed learning group and the expository group was equal, there was no interaction between three methods of instruction and the levels of intelligence. Strategies three and two produced significantly higher mean scores than one and no significant difference between strategy three and strategy two.

Shah (1981) conducted a study entitled "An experimental investigation of the effects of selected teaching strategies on the development of creative thinking and achievement in science." Researcher has used four different strategies to identify the relative effectiveness. The used strategies were 1.Lecture 2.Lecture + discussion 3.Lecture + discussion + practical and 4. Lecture + discussion + practical + A.V.Aids. Samples have been selected purposively from one school of Petlad (Kheda district) keeping in mind certain criteria. From the selected school, researcher has made four equivalent groups of twenty four students from grade VIII. Four teachers from one purposively selected B.Ed. College and four units from standard VIII science textbook following Gujarat Secondary Education Board syllabus were selected for the study. The study reveals that the difference existed between the selected strategies for their effectiveness in developing creative thinking and achievement in science of eight class pupils significantly, the strategy four was more effective in developing creative thinking and its components as compared to all other strategies, the results highlighted the importance of having the maximum use of audio visual aids in the classroom teaching for enhancement of creative thinking, it was found that the Strategy four produced significantly high mean scores for achievement of pupils than all other strategies.

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

Hopper (1982) conducted an experimental study in the use of modular approach for teaching biology in standard XI. The main objectives were to design and develop instructional modules on selected unit in morphology, physiology and ecology, to find

out relative effectiveness of three modular approaches involving self learning, peer group learning and peer group learning with teacher intervention. The sample consisted of students of standard XI of three higher secondary schools of Madras. The sample consisted of fifty three, fifty and fifty three students. The major findings of the study were all the three structured modular approached of teaching were effective in terms of mean gain in cognitive achievement. However, the self learning approach was more effective than the other two approaches. There was no relationship between intelligence and mean gain in achievement through modular instruction.

Rabindranath (1982) developed a multimedia instructional strategy for teaching science (biology) at class VIII. The main objectives of the study were to develop a duly validated multimedia instructional strategy for teaching the course in biology at standard VIII, to study the relationship between students' achievement and intelligence, to study the feasibility of the strategy in terms of cost and time and to develop alternative instructional components for teaching few concepts and their relative effectiveness. The sample was selected randomly that consisted of 2 control groups and two experimental groups. The tools used for data collection were Madhukar Patel's Intelligence Test and Achievement test. The tools used for data analysis were Pearson's Product Moment coefficient of correlation, ANOVA and T test. The major findings were the instructional strategy was effective to the extent that seventy percent of the experimental group students obtained sixty percent and above in all the unit tests and comprehensive test, the experimental group students performed better than the control group on the comprehensive test and also on the annual examination conducted by the school authorities. Development of scientific attitude was significantly higher for the experimental group, about seventy percent students expressed favorable reaction to all the components except towards team teaching, there was a positive and significant correlation between intelligence and achievement through the strategy, the strategy was quite feasible in terms of time as it required only ten additional periods spread over the whole year for completion of the course.

Shinde (1982) conducted a study of non-formal science activities in secondary schools of Maharashtra state with special reference to their impact on scientific attitude and achievements in science. Major objective was to study the involvement of secondary

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

Vardhini (1983) developed a multimedia instructional strategy for teaching science (physics and chemistry) at secondary level and studied relationship between achievement using the strategy and intelligence and scientific attitude. Objective of the study was to develop a validated multimedia instructional strategy for teaching science in standard VIII and study the relationship between achievement using the strategy and intelligence and scientific attitude. It also intended to develop alternative instructional inputs and study their effectiveness. The inputs of the strategy were introduction, lecture, discussion, guided discovery, audio-visual and biographical accounts, summaries, glossary, diagrams, exercises and assignments, criterion tests. The instruments used in the study were criterion test and comprehensive tests prepared by the investigator, scientific attitude scale prepared by the investigator, Madhukar Patel's Intelligence Test, a reaction scale prepared by the investigator and the examinations conducted by the school. Descriptive statistical techniques and the t test were used for analysis and hypothesis testing. The strategy was found valid against the criterion of scientific attitude and almost all the units indicated average/high level of performance on total test, the strategy was found valid amongst criterion of scientific attitude in that significantly higher performance was noted for the group in the post test over the pre-test, Visual projections with teacher explanation and those with taped commentary were equally effective in terms of achievement, the strategy was found feasible when seen in terms of its reproducibility and the cost management by individual schools.

Deopuria (1984) conducted a comparative study of teaching science through Environmental and Traditional Approach in schools of Madhya Pradesh. Researcher selected the students of V, VIII, IX and X grades and compared their achievement in

science in these two different approaches regarding certain variables. The sample of teachers and students was selected randomly. Self designed three tools to measure achievement score, attitude towards environmental approach for teachers and attitude of class ten students towards environment were standardized and used. Statistical techniques like Mean, standard Deviation and T test were used for testing of the hypothesis. Major findings of the study were, the environmental attitude inventory showed significant positive gains in attitude towards the environment for the entire experimental group of students, the environmental approach showed greater cognitive gain in knowledge, understanding and application of science concepts related to environmental education but it was not effective in the teaching factual recall type concepts at middle and secondary school levels. Researcher has suggested that, the teachers can use the environmental approach for improving the teaching learning processes by involving students in activities which create awareness in them through programmed learning, second through slides with discussion approach the third through experimental approach and fourth through the traditional approach.

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

Dighal (1985) conducted study entitled improved method of teaching biological sciences in schools of Tripura and West Bengal. The objectives of the study were to explore how to make life science teaching lively, realistic and interesting to the students, to attempt scientifically the improvement of the present methods, to remove drudgery in the

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

Barve (1986) conducted study on preparation field and testing of filmstrips for the teaching of Science a Course in Standard IX, and a study of their comparative effectiveness in the teaching-learning process as compared to the traditional practice. The objectives of the study were to prepare filmstrips on selected topics from the science course of standard IX, to teach the selected units of the science course of standard IX by using these filmstrips, to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of the achievement of the learner, to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of achievement of the learner considering sex and level of achievement as parameters, and to compare the effectiveness of teaching with the help of filmstrips in terms of achievement of the learner considering age, liking and availability of gadgets at home as parameters. The researcher developed ten filmstrips based on units of science from the syllabus. In order to study the effectiveness of the filmstrips, the researcher used untreated control group design with pre-test post- test. The students for the experiment were chosen by the incidental sampling method. Pre-achievement and post-tests were administered to both the groups. The test scores were analyzed by using ANOVA. The major findings of the study were filmstrip was more effective than the traditional method for teaching the facts, principles and concepts in

science, filmstrip and the traditional methods were equally effective for teaching abstract concepts in science, filmstrip was an effective teaching aid for all levels of learners, i.e. low, medium and high achievers, filmstrip was more effective for the learners between thirteen and sixteen years of age than for learners between seventeen and twenty one years of age, filmstrip was a more effective method of teaching science for both sexes, i.e. males and females.

Khalwania (1986) conducted a study on effectiveness of concept based science curriculum in developing cognitive structures and acquisition of process skills among high school students. Major objectives of the study were to develop the concept based science curriculum in developing cognitive structures and acquisition of process skills among high school students, to study its efficiency as compared to a conventional curriculum to teach a few important science concepts, to study the effect of socioeconomic status of the learner on the development of cognitive structure. Researcher has taken 160 samples for his study and divided them in two groups of eighty each. This was the randomized group pre-test/post-test design study and found that the concept based curriculum was more effective than the conventional curriculum in terms of acquisition of process skills. The investigator used six standardized tools for data collection that measure Self Concept of Ability, Intelligence, Socio Economic Status, Content Comprehension, Logical Operation and Process Skills. The data was analyzed with 2 x 2 x 2 x 2 factorial design of ANOVA. Students having high socio-economic status do not differ significantly with that of students with low socio economic status. Both the group did equal in process skills. Curriculum types do not interact significantly with levels of intelligence, levels of self-concepts and levels of socio-economic status.

Joshi (1987) conducted a study on "Evolvement of an instructional strategy for teaching elements of science to class IX students of M.P. state." The major objectives of the study were to develop an Instructional Strategy (IS) and study its effectiveness in terms of students' performance on criterion related tests and students reactions towards various components of the instructional strategy as a whole. The sample for the field study comprised 109 students studying in class IX. The design of the study was single group, only post-test type, intelligence was controlled statistically. Data were analyzed through ANOVA followed by t-test, chi-square technique and percentiles. It was an experimental

study. The major findings were, the developed strategy was found to be effective than the traditional teaching in terms of achievement of the students towards different components of the IS and the IS as a whole, the developed IS was found significantly superior to the traditional method in terms of the development of higher mental ability in science, adjusted with respect to their IQ.

Kalacherry (1987) conducted study entitled preparation and experimental tryout of Programmed Instructional Material in the syllabus of chemistry prescribed for class VIII in Maharashtra state. The major objectives of the study were to prepare programmed lessons on the prescribed topics of the chemistry syllabus, to try out the programmed instructional material, to find out the error rate and time factor, to finalize the programmed material for actual use and to determine effectiveness of the programmed instructional material. The sample was 200 students of class VIII of four schools in natural settings. The major findings of the study were about eighty three percent of the students were able to respond correctly to eighty three percent of the frames, though ninety on ninety standards could not be reached the attainment was considered satisfactory. It was found that a few students who scored usually below fifty percent in the traditional system scored above eighty five percent through the use of Programmed material.

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

Kelkar (1998) conducted a Study of Effectiveness of Methodology "Exploring the Mind" for Teaching Science to the Students of Standard VIII. The objectives of the study were to find out different methodologies used for teaching science in different schools, to analyze the effectiveness of these methodologies in the learning of science subject, to find out concepts which are not clearly understood by the students by application of

traditional methodologies, to analyze the reasons which inhibit understanding of the concepts, to evaluate the effectiveness of the methodology "Exploring the mind". The study was experimental. Pre test-post test control group design was used. Sample consisted of 588 students studying in standard VIII selected randomly from seven schools out of twenty five private co-educational English medium schools from Pune Municipal Corporation. After pre test, the selected three topics: metals and non-metals, pressure and microbes were taught to experimental group through "Exploring the Mind" methodology and to control group through traditional method by their teacher. Treatment was continued for two weeks with thirty five minutes school period. The investigator constructed questionnaire and achievement test. T-test was used for data analysis. The findings of the study were there is significant difference between the mean of experimental group and control group of all schools. The mean of experimental group is greater than mean of control group, when methodology "Exploring the Mind" is applied to boys & girls in developed or developing schools, the level of achievement is the same for all irrespective of sex factor or infrastructure of the school.

Remadevi (1998) conducted study entitled "Application of Information Processing Models in Teaching Chemistry at the Secondary and Higher Secondary Levels". The objectives of this study were to find out whether Information Processing Models (IPM) in the teaching of chemistry in comparison with the Conventional Method (CM) of teaching are effective or not in the Secondary and Higher Secondary Schools of Kerala. To prepare learning materials based on IPM in chemistry for the Secondary and Higher Secondary classes as revealed through the achievement of pupils, to compare IPM and CM in teaching chemistry for the secondary and higher secondary classes as revealed through the achievement of pupils. To compare the effectiveness of IPM and CM in teaching chemistry for the secondary and higher secondary classes as revealed through the achievement of pupils with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement, High Intelligence categories, Low Intelligence Categories, categories of high achievers on scientific attitude scale and categories of low achievers from Secondary and Higher Secondary on scientific attitude scale, to compare the effectiveness of IPM and CM in developing scientific attitudinal change in pupils, to test whether there is any significant difference in the scientific

attitude scores when IPM is used and when CM is used. The sample consisted of two divisions each of classes VIII, IX, X, XI and XII from Secondary and Higher Secondary School Karappuzha and Government Higher Secondary School Kalavoor of Kottayam District. The one division was considered to be experimental group to be taught through IPM, while the second was through CM. The Lesson transcripts based on IPM and CM for each of the unit; Scientific Attitude Scale and Verbal Group test of Intelligence by N.P.Pillai et al. were used for collecting the data. The statistical techniques used for the analysis of the data were ANCOVA followed by t-test. The major findings of the study were the pupils taught through the IPM were found to have significantly higher achievement than those taught through CM in the test as a whole. The pupils taught through IPM were found to have significantly higher achievement than those taught through CM with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement and application level of cognitive achievement at 0.01level of significance. The pupils belong to high intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to low intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to the categories of high achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils belonging to the categories of low achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM. The pupils taught through IPM were found to have significantly higher scores on scientific attitude scale than those taught through CM. There was significant difference in the scores on scientific attitude scale when CM was used.

Khirwadkar (1999) conducted a study titled 'Developing a computer software for learning Chemistry at Standard IX' with objectives, to develop CAI package in subject of Chemistry for standard XI Science Students studying GSTB syllabus, to study the effectiveness of the developed software in terms of instructional time and achievement of students, to study the effect of software package on students' achievement in relation to students' intelligence level, motivation level, and attitude towards the package and to study the attitude of the students and teachers regarding the effectiveness of the CAI

package with respect to contents, presentation, examples, illustrations, graphs and figures, evaluation items, utility of software and instructions given in the instructional manual. The sample selected purposively, for the study was one of the English medium schools of Baroda City for implementing the developed software. One section of Standard XI Science was taken and thirty students were selected randomly as sample for the experimental group and rest of the students of the section constituted the control group. A pre-test post-test experimental and control group design was employed. The tools used for data collection were pre test, post test, unstructured interview schedule, structured interview schedule, attitude scale, Junior Index of Motivation Scale and Madhukar Patel's Intelligence Test. The software developed by the investigator was used as treatment tool. The data were analyzed through ANOVA, ANCOVA and content analysis. The developed software package was found to be effective in terms of academic achievement of the students. The students and teachers were found to have favorable opinion towards the software package. Interaction effect of IQ, motivation and opinion of students on their academic achievement was found.

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

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

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

Vijay Kumari (2002) studied the effect of different methods of teaching Science on the achievement, basic science process skills and scientific attitude of pupils with different achievement levels. The objectives of study were to study the effect of methods, levels of pre-acts and their interaction on achievement of knowledge, understanding and application objectives separately by taking intelligence as covariate, to compare variation in interaction patterns due to change in prior achievement levels of pupils with respect to Teacher Demonstration Method (TDM), Guided Discovery (GD) and Cooperative Learning Method (GDLM & CLM) of teaching science, to explain the relationship between significant differences in achievement, improvement of scientific attitude and Basic Science Process Skills (BSPS) in terms of differences in teaching process. The study was experimental in nature. 3X2 factorial design was used. The findings of study were: The TDM was significantly more effective than CLM with respect to the criterion of achievement scores on knowledge objective but CLM was as effective as GD and TD methods. TDM and CLM were equally effective with respect to knowledge objective,

The TDM was significantly more effective than guided DM and CLM while TDM were equally effective on the understanding and application objective respectively, on total achievement in science the TDM was significantly more effective than both GDM and CLM, GDM was significantly more effective with respect to improvement of scores on science attitude of low achievers than high achievers.

Sidhu & Singh (2005) studied "Comparative Study of Concept Attainment Model, Advance Organiser Model and Conventional Method in Teaching of Physics in Relation to Intelligence and Achievement Motivation of Class IX Students". The Objectives of the study were, (i) To study the effect of Bruner's concept Attainment Model on scholastic achievement as compared to conventional method of teaching in Physics in relation to intelligence and achievement motivation; (ii) to study the effect of Ausubel's Advance Organiser Model on scholastic achievement as compared to conventional method of teaching in physics in relation to intelligence and achievement motivation; and (iii) to study the relative effectiveness of Bruner's Concept Attainment Model and Ausubel's Advance Organiser Model on scholastic achievement in Physics in relation to intelligence and achievement motivation. The sample consisted of 240 students of Class IX, enrolled in Government Senior Secondary School, Kanganwal; Government High School, Jhuner, and Government Senior Secondary School, Sandaur (District Sangrur, Punjab) divided into three groups (n=80 each), two experimental groups and one control group. Pre-test, Post-test control group quasi-experimental design was employed. The statistical technique of three way analysis of variance (3×2×2) was used on gain scores for finding out the main effect and interaction effect of teaching techniques, intelligence and achievement motivation on scholastic achievement in physics of Class IX students. The experiment was conducted in three stages pre-test treatment and post-test in all the three groups. Meenakshi's Socio-economic Status Scale, Jalota's Verbal Group test of General Mental Ability, Achievement Motivation test of Pratibha Deo and Asha Mohan, Lesson plans and a criterion test in physics were used for the study. Finding of the study was no significant effect between various teaching techniques, intelligence and achievement motivation on scholastic achievement of students for learning of concepts in physics.

Suresh & Rajeshwari (2005) conducted a study titled, "Influence of Simulated Experiments on the Knowledge and Attitudes of Higher Secondary Students towards Bio-

technology and Genetic Engineering". Objectives of the study were,(i) To find out the significant difference of knowledge in bio-technology and genetic engineering between the students in the experimental group and the students in the control group; (ii) to find out the significant difference of knowledge and attitude towards the said subject among sex and different types of schools; and (iii) to investigate the relative retention of learning and change in their attitude towards bio-technology and genetic engineering after the experiment. Methodology used for the study consisted of a pre-test and post test design to investigate the influence of simulated experiments of bio-technology and genetic engineering. The sample for the study was selected from higher secondary biology group students belonging to State Board Schools in Chennai. The total number of subjects selected for the study was 270. Tools for the study were Knowledge test to Measure Knowledge in Bio-technology and Genetic Engineering constructed by the investigator and Attitude Scale towards Bio-technology and Genetic Engineering was adopted from Roger Lockand Colin Miles's Scale (1993). Findings of the study are (1) the higher secondary school students have a poor knowledge and attitude towards bio-technology and genetic engineering. (2) Boys, girls and mixed students differ significantly in their knowledge and attitude. (3) There is a significant difference in knowledge and attitude towards bio-technology and genetic engineering between the experimental group and control group and there is a significant difference in students' relative retention of learning in bio-technology and genetic engineering between experimental and control group. (4) There is a significant change in their attitude towards bio-technology and genetic engineering after learning bio-technology and genetic engineering through both simulated experiments and traditional method of teaching.

Amin (2011) developed and implemented an activity based science teaching programme for pre service student teachers who will be teaching science to adolescents of secondary and higher secondary school. The researcher studied effectiveness of the developed programmes in terms of content knowledge of science and technology, experimental ability, understanding about nature of science, teaching qualities enhanced as science teachers, understanding about science teaching. The sample consisted of 40 student teachers selected purposively who would be teaching science to adolescents in future. The design used was single group pre test - post test. The researcher found that the

developed activity based science teaching programme was effective in terms of developing clarity on science concepts, enhancing experimental skills, enhancing the understanding about the nature of science, improving qualities as a teacher in general and science teacher in particular. It was also found that there was enhancement in understanding of the benefits of scientific activities among the pre service student teachers.

2.4.1 Observations of the studies on teaching of science

- Except Amin (2011) all the above studies are conducted for adolescents of secondary school. Amin (2011) conducted a study for student teachers who would be teaching the adolescents of secondary school in future.
- The studies related to teaching of science by various methods have shown comparison between use of traditional methods and Innovative methods.
- New strategies or methods used by various researchers can be listed as
  - problem solving method of teaching science by Kamalakanthan (1968),
  - use of motion pictures as aid to teach biology by Muddu (1978),
  - use of activity based approach to teach biology to develop scientific knowledge its application and scientific process skill by Jha (1979),
  - use of ethnic and environmental approach to teach botany by Exemmal (1980),
  - use of multimedia programmed material to teach physics by Basu (1981),
  - use of science kits and self instructional audio tutorial system by Sivadasan (1981),
  - use of three methods: exposition method, programmed learning method and multimedia method by Kumar (1981),
  - use of four different methods on creative thinking skill like lecture method, lecture + discussion method, lecture + discussion + practical method and lecture + discussion + practical method + A.V. aids method and their comparison on creative thinking skill and achievement score by Shah (1981),
  - use and comparison of modular approach, peer-group learning, self learning and peer group learning with teacher intervention by Hopper (1982),
  - use of multimedia instructional strategy by Ravindranath (1982),
  - use of non formal science activities by Shinde (1982),

- use of multimedia instructional strategy for teaching physics and chemistry by Vardhini (1983),
- use of programmed learning environmental approach over traditional approach by Deopuria (1984),
- comparison between use of programmed learning material, slides and laboratory experiments over traditional lecture method for selected contents of science syllabus by Desai (1985),
- the possibility to make life science teaching lively, realistic and interesting to students using science club method, audio-visual method, self activity method, local excursions, science exhibitions, film shows on life sciences and orientation programmes for life science teachers was explored by Dighal (1985),
- use of teaching science course by film strips over traditional method by Barve (1986),
- use of concept based curriculum over conventional curriculum to develop scientific process skills by Khalwania (1986),
- use of new instructional method over traditional method by Joshi (1987),
- use of programmed instructional material to teach chemistry over traditional method by Kalacherry (1987),
- use of self learning process based material to develop science process skills by Grewal (1988),
- use of thought provoking problems in teaching science by Vaidya (1991),
- use of exploring the mind method over traditional method by Kelkar (1998),
- use of information processing model in teaching chemistry by Remadevi (1998),
- use of Computer Assisted Learning material to teach chemistry by Khirwadkar (1999),
- use of mastery learning programme over conventional method by Thaker (2001),
- use of Inquiry training model by Upadhyaya (2001),
- use of Teacher Demonstration Method, Guided Discovery Method, Cooperative Learning Method over traditional method by Vijay Kumari (2002),
- use of instructional programme in environmental studies for acquisition of process skills by Sidhu and Singh (2005),

- use of simulated experiments on bio technology and genetic engineering by Suresh and Rajarajeswari (2005),
- use of activity based science teaching programme for pre service student teachers to enhance experimental skills and develop clarity of science concepts by Amin (2011).

- Almost all studies indicate the superiority of innovative methods compared to the traditional methods. The review of the related literature on science teaching makes it clear that various researchers indicate the following points to ponder by the teacher of Science in Secondary school.

- The traditional lecture method used in classrooms even today is not suitable to achieve the objectives of teaching science.
- There is a kind of disinterest amongst teachers in trying out new methods.
- There is a lack of time, infrastructure and motivation to attempt new strategies of teaching science.
- Teachers mistake the goals of science curriculum for the objectives of transacting the syllabus.

2.4.2 Trends observed in the area of teaching science with different strategies

1961-1970: Very few studies are conducted in this decade trying new strategies to teach science to secondary students in India. The study conducted is a comparative study testing effectiveness of traditional and problem solving methods in the knowledge gain of adolescents for a very short period of eight days with pre test and post test experimental design, using quantitative method for data analysis.

1971-1980: The studies conducted in this decade are of pre test and post test, experimental designs with experimental and control group selected randomly from the population. Teaching science through films, environmental and ethnic resources, demonstrations and activities was tried and tested for its effectiveness on application of scientific knowledge and development of scientific skills.

1981-1990: In this period use of technology is seen while trying out of new strategies. Investigators have used multimedia programmed instruction, audio tutorial system, use of science kits using guided discovery approach, modular approach involving self learning, peer group learning with and without teacher intervention, use of non formal science activities, multimedia instructional strategy, programmed learning approach, teaching

through filmstrips and self learning 'process based method' to learn science. The researchers have selected the sample randomly and pre test post test experimental design is used by them with ANOVA and paired T test for data analysis.

1991-2000: The researchers are found to use new methods to teach science in which development of higher order thinking is tried. Methods named as 'Exploring the Mind', Information Processing Model and Computer Assisted Instructional package are tried for randomly selected or purposively selected samples. Almost all researchers have used pre test post test, experimental design with control group and experimental group and self constructed tool like achievement test. The data analysis is done by using T test, ANOVA, ANCOVA and content analysis.

2001-2010: In this decade the researchers used new methods like Mastery Learning Programme, Inquiry Training Model, Teacher Demonstration Method, Guided Discovery Method and Cooperative Learning Method, Bruner's Concept Attainment Model, Ausubel's Advance Organiser Model and Simulated Experiment Method to teach science. The Sample for experiment is chosen by random sampling technique. The studies are of pre test - post test, experimental design. For data collection tools like intelligence tests, science creativity tests, theory building capacity test , Rodger Lockand Colin Miles's Scale such tools, other than previously used tools were used. The techniques used for data analysis are Rank Difference Correlation Coefficient, Chi-Square test and ANOVA.

After 2011: The investigator has come across a study that used activity based programme for teaching science. The study has single group pre test and post test experimental design with purposive sample. The tools used were self designed tests. The techniques used for data analysis were ANOVA and ANCOVA.

2.4.3 Research gap observed in reviewed researches on teaching science

The investigator did not come across studies that,

- Focus on development of life skills through teaching of science.
- Methods of teaching or evaluation through activities like role play, storey telling and use of drama for particular scientific concepts, seminars are not tried in the natural setting of secondary school classroom and their effect in terms of life skills is not measured.

- Effect of activities like power point presentations by students on the given content of science, surveys, project presentation in teams, drama written and performed by students for given theme of science is not observed and measured in terms of life skills.
- Most of the investigators have measured the effect of new methods of teaching science in terms of achievement score i. e. considering nature of science as a product but very few have measured the effect of new strategy of teaching science in terms of life skills.

Hence the investigator concludes that it is desirable to teach science in secondary school by designing the activity based programme for the adolescents that gives scope to develop life skills which can make the adolescents happy and ready to face challenges in daily life while achieving the objectives of learning science.

2.5 Implications of the review of related literature for present study

2.5.1 Implications of related literature on development of Life Skills through Teaching of Science

The review of studies related to Development of Life Skills imply the following,

- The review implies that development of life skills in schools is of utmost importance to make the learner responsible and productive human being.
- The researches in the field of Life Skill Education in the late nineties imply that existence of thinking skills like critical thinking, creative thinking, problem solving and decision making in adolescents controls their behaviour indicating good mental health that leads to good physical health.
- The review of related literature suggests that secondary school teachers should conduct life skill education programme to develop generic life skills through teaching of curricular subjects entwined with the current evaluation pattern.
- When institutions of primary & secondary learning integrate life skills education with the curriculum, the outcome need not merely be enhancement of academic competence, but creation of individuals capable of meeting the demands of life.
- According to the researchers mentioned above, adolescents being in the late childhood stage, at the threshold of formal operational thinking, it is probable that the input for the enhancement of thinking skills is well absorbed by them.

- The investigators in the area of Life Skill Education for secondary school adolescents suggest that educational institutes need to provide cognitively stimulating activities if at all we need to make our children not just data gatherers but data initiators.

2.5.2 Implications of studies related to Status of Teaching Science with different strategies

Status of teaching science in Grant-in-aid schools is different than teaching of science in fully government or private schools. It is different with respect to the facilities and funds available, the teacher student ratio, the time and classes allotted to the subject teacher, the educational background of the wards of the students, management and parent support, the syllabus of the subjects, work load and responsibilities allotted to the teachers.

- To develop life skills through teaching of curricular subjects in the natural setting of the school the factors affecting the quality of teaching the subjects should be studied before designing the Life skill Education Program for the secondary school students.
- The development of life skills through teaching of the curricular subject science is possible by activity based learning method or project based learning or inquiry approach or problem based learning method that is designed on the basis of curricular subject.
- The studies related to teaching of science with different strategies indicate that new and innovative methods to teach science can develop science process skills that have direct relation with thinking skills. While developing science process skills among the adolescents through teaching of science there is a scope to develop their life skills like critical thinking, creative thinking, problem solving and decision making skills.
- The studies mentioned above reveal the relation between thinking skills and scientific attitude.
- Life Skill Education Program can be designed to teach science based on Inquiry based approach

2.6 Conclusion

Review of related literature in the area of Life Skill Development and Teaching Science helps to conclude that the life skill activities provided within the institutional context on a routine basis can be well received, internalized and the outcome can be noticeably

expressed. Adolescents being in the late childhood stage, at the threshold of formal operational thinking, it is probable that the inputs for the enhancement of thinking skills can be well absorbed and appropriated by them. The investigators in the area of science education and life skills suggest that educational institutes need to provide cognitively stimulating activities if at all we need to make our children not just data gatherers but data initiators. When institutions of middle school / secondary learning integrate life skills education with the curriculum, the outcome need not merely be enhancement of academic competence, but creation of individuals capable of meeting the demands of life. Simply delivering the content in the classroom of adolescents who are full of energy is as good as pouring cold water over the hot coal. The chalk and talk method alone does not transform young adolescents into leaders. It is the need of the hour that teachers of secondary school teach the subjects in such a way that the learners can face any challenge that comes their way to live happily, be productive and responsible citizens and become not just data gatherers but data initiators. In this context National Curriculum Framework, (2005) has suggested reforms in science teaching. Avoid too much emphasis on drill and rote learning. Instead, give weightage on observation, design, analysis, argumentation and process skills in general. Science process skills are special skills that simplify learning science, activate students, develop students' sense of responsibility in their own learning, increase the permanency of learning, as well as teach them the research methods. NCERT (2001) has given specific objectives for teaching the students of secondary stage class (IX, X) as to understand the basic concepts, principles, and laws of science, to apply those principles in finding solutions to the problems related to agriculture, energy, health, nutrition etc. It also states the objectives as to develop problem solving and decision making skills, to acquire process skills, which form a part of the attitude for developing a scientific temper, to develop manipulative skills which are required to deal day-to-day life challenges. To develop above mentioned skills, Gujarat State Board of Education in 2010 suggested student centered activity based approach to teach curricular subjects and designed its textbooks accordingly. In the present study the researcher has designed activity based LSE programme based on the curriculum of science and got it validated by the experts. The review of related literature has given direction to decide the methodology to conduct the present study.