CHAPTER II

REVIEW OF RELATED LITERATURE

2.1 Theoretical Overview

2.1.1 Introduction

2.1.2 Scholastic Backwardness

2.1.3 Science Process Skills

2.1.4 Scientific Creativity

2.2 Abstract of Related Studies

2.2.1 Introduction

2.2.2 Studies related to Scholastic Backwardness

2.2.3 Studies related to Science Process Skills

2.2.4 Studies related to Scientific Creativity

2.3 Summary
2.1 THEORETICAL OVERVIEW

2.1.1 Introduction

Society expects much from its schools, both in terms of general education and vocational training. The school plays a pivotal role in human resource development. The task of the teachers in schools is a challenging one. Teaching is one of the toughest jobs there because teacher has to do many things. He must be a good leader, an effective speaker, a quick diagnostician, a tactful diplomat and a firm but fair disciplinarian. Effective teaching is intelligent application of psychological principles to solve the practical problems encountered in teaching learning process. Teaching slow learners is an arduous task. Their ability to deal with abstract and symbolic materials, that is, language, number and concepts is very limited and their reasoning in practical situation is inferior to that of average students. These pupil differ slightly from normal students in learning ability. They are also unable to deal with relatively complex games and school assignments. They need much external stimulation and encouragement to do simple type of work. These students who are known to be slow to ‘catch on’ are called slow learners or backward learners.

2.1.2 Scholastic Backwardness

Backward learners constitute an appreciable fraction of our population. The term ‘backward’ or slow learner is reserved for those children
who are unable to cope with the work normally expected of their age group. Kirk (1972) took ‘the rate of learning’ as the basis for identifying slow learners. According to him, the slow learners, gifted and the average children can be classified according to their ‘rate of learning’. He also strictly refused to equate slow learners with mentally retarded because the former is capable of achieving a moderate degree of academic success even though at a slower rate than the average child. As an adult, a slow learner usually becomes self-supporting, independent and socially adjusted; but in the early stage adapts himself to regular class programme which fit in with his slower learning ability.

Hence there is a great need for special educational measures for the backward learners to ensure maximum progress they are capable of. We have to give them special attention on humanitarian grounds so that they can overcome the unhappiness and personal inadequacy that are the concomitants of severe educational and social failures. Other utilitarian reasons also justify the need for special attention to slow learners in the school. First, the country needs the fullest development of the human resources, not only in those capable of development of higher skills but also in those capable of routine tasks which are equally essential for the maintenance of the social organisation. Secondly, the cost of mental ill health and delinquency which can result from educational failure may be greater in the long run than the cost of developing adequate means of special educational treatment in childhood.
**Characteristics of Backward Learners**

Backward learners have limited cognitive capacity. They fail to cope with learning situations and to reason abstractly. Rational thinking becomes practically impossible. They have the capacity to succeed in rote learning. These children show interest in learning where relationships are clearly demonstrated. With regard to retentive memories they require more practice and revision in comparison with normal children.

One of the pertinent characteristic of backward learners is poor memory. It occurs due to lack of concentration.

Classroom situations include distraction and lack of concentration of slow learners. This typical behaviour is also associated with poor motivation. Again different studies also report that when the learning materials are presented through concrete situations, the backward learners’ concentration and attention do not differ significantly from that of a normal child.

Inability to express ideas through language is another significant characteristic of a slow learner. A slow learner also lacks imagination and foresight. He faces difficulty to foresee consequences in the future.

**Causes of Educational Backwardness**

The causes of the educational backwardness are school absence, ill health, unfavourable school and home conditions and emotional barriers to learning, poverty etc. Some important ones are discussed below.
• **Poverty**

In a developing country like India, poverty is considered to be the primary cause of slow learning. Poverty affects children in two ways (1) by impairing children’s health and (2) by reducing their learning capacity. Again it brings rare opportunities to acquire general knowledge through enriched experience. In other words, a child from a sophisticated family has a variety of avenues to explore and get plenty of materials to meet his requirements. He gets educational toys and books which are conducive to acquire general knowledge to improve his educational background. On the contrary, a child from an impoverished family does not get enough opportunities to live a full life.

• **Intelligence of family members**

Another potent factor of learning is the level of intelligence of parents as well as family members. It is true that educated and intelligent parents can provide educational experiences and materials to their children according to their own intellectual level. But if the parents are not intelligent, they cannot take positive steps towards the upliftment of their children. The economic conditions of the family also play a major role to permit the parents to spent a little amount of money on their children regularly.

• **Emotional factors**

Emotional factors contribute a lot towards the slow learning of children. Psychologist confirmed this through their research analysis. When a
child comes to the school, he brings his emotional world with him. It is a well known fact that tensions and conflicts exercise a negative effect on learning of the child. So the tensions at the home, the relationships between the siblings and parents themselves can have an adverse effect on the child.

- **Personal factors**

  Besides all these above factors, there are some personal factors which are more or less responsible for slow learning. Personal factors include long illness or long absence from school and lack of confidence in self. It was found that children who lack self-confidence are usually slow learners.

2.1.3 **Science process skills**

  We are living in the age of rapid changes and science is playing a dominant role in bringing about these changes. Science has enabled man to probe into the vast spaces beyond the sky. At present science dominates every field of our activities. Thus a science teacher’s goal should be to help students develop not only their scientific knowledge but also the knowledge of science. In fact communicating the nature of science is now widely recognized as one of the general goals of science education. The special emphasis on the learning processes rather than on the product is a distinctive feature of modern science. Therefore the new science programme for middle school students all over the world lay a significant emphasis on the understanding of the process of science and process skills. Process skills are fundamental to science, allowing every one to conduct investigations and reach conclusions.
The term process skills means cognitive processes which describe various forms of interaction with content- observation, interpretation, inference, predicting, communicating etc, thus a set of transferable abilities that reflect in the behaviour of individuals is called process skills.

**Science- A Process Approach (SAPA)**

Science-A Process Approach is designed to present instruction in science by American Association for the Advancement of Science during 1962-68, which is intellectually stimulating and scientifically authentic. There are a number of ways of conceiving the meaning of ‘process’ as amplified in ‘Science-A Process Approach’. First, the emphasis in process implies a corresponding de-emphasis in “content”. The children are not asked to learn and remember particular facts or principles, but they are expected to learn such things as how to infer internal mechanisms in plants, how to make and verify hypothesis and how to perform experiments. A second meaning of process centers on the idea that what is taught to children should resemble what scientists do – “the processes” that they carry out in their own scientific activities. Scientists observe, classify, measure, infer, making hypothesis and perform experiments. The third and perhaps the most important meaning of process introduce the consideration of human intellectual development. From this point of view, processes are in a broad sense “ways of processing information”. Such processing grows more complex as the individual develop this from early childhood onwards.

Some distinctive features of this programme are
a. Instructional materials are contained in booklets written for and used by the teacher. Accompanying kits of materials are designed for use by teachers and children. Except for certain data sheets in the later grades there are no printed materials addressed to the pupils.

b. The exercises are ordered in sequences of instruction to provide a developmental progression of increasing competence in the process of science. The topics covered in the exercises have been taken from various fields of science including mathematics.

c. Each exercise is designed to achieve some clearly stated objectives. These are phrased in terms of pupil’s behaviour that can be observed as outcomes of learning upon completion of the exercises.

d. Methods of evaluating pupil’s achievements and progress are an integral part of the instrumental programme. The exercises reflect the objectives of the exercises and provide means of assessing outcome.

e. SAPA is planned for use of all kinds of children including the gifted and under privileged in the age level 10-13. There is sufficient material to challenge the most capable and integrated children. Similarly the under privileged children find their science experience exciting and rewarding.

f. Science-A process Approach (SAPA) defined process skills as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists. SAPA grouped process skills into two types. They are Basic skills and Integrated Skills.
A. Basic Process skills

There are eight basic science process skills. They are

- Observing
- Classifying
- Using number relations
- Measuring
- Using time and space relations
- Communicating
- Predicting
- Inferring

B. Integrated Process Skills

- Defining operationally
- Formulating hypothesis
- Interpreting data
- Controlling variables
- Experimenting

It is important that the above mentioned skills and integrated processes do not operate in isolation. Experimenting for example, involves coordination among all the proceeding basic skills and integrated processes.

A brief description of the expected sequence of development in both basic and integrated process categories is as follows.
a. Observing

Beginning with identifying objects and object properties, this sequence proceeds to the identification of changes in various physical systems, the making of controlled observation and the ordering of a series of observation. This process involves using the five senses to obtain information about objects and events. Observation provides both a basis for new inferences and hypothesis and a tool for testing existing inferences and hypothesis. Scientists develop explanations using observations (evidences) and what they already know about the world (scientific knowledge). Observation helps us to identify observable properties of objects including weight, size, shape, colour, temperature and the ability to react with other substances.

b. Classifying

Development brings with simple classifications of various physical and biological systems and processes through multistage classifications and their coding and tabulation. Classifying process involves imposing order on connections of objects or events. Examples are metals or non-metals acids or bases etc. This process also involves using classification schemes to identify objects or events to show similarities, differences and interrelationships.

c. Using number relations

This sequence begins with identifying sets and their members and progress trough ordering, counting, adding, multiplying, dividing, finding average using decimals, and powers of ten.
**d. Measuring**

Beginning with the identification and ordering of lengths, development in this skill proceeds with the demonstration of rules of measurement of length, area, volume, weight, temperature, force, speed and number of derived measures applicable to specific physical and biological systems.

This process begins with measuring instruments properly, carrying out calculations with measurements; select appropriate instruments for measurement, using standard units of measures, using mathematical operations to find indirect measurements etc.

**e. Using time and space relations**

This sequence begins with the identification of shapes, movements and direction. It continues with the learning of rules applicable to straight and curved paths, direction of an angle, changes in position and determination of linear and angular speeds.

**f. Communicating**

Development in this category begins with description of simple phenomena and proceeds through describing a variety of physical objects and systems and changes in them for observed results of experiments. Some scientists work in teams, where some like to do it alone, but modern day science requires extensive communication between scientists. They use various forms of communicating like the oral, written words, graphs, maps, mathematical equations and different kinds of visual demonstrations.
Students should be able to undertake oral written and pictorial communications.

g. Predicting

Prediction is using knowledge to identify and explain observation or changes in advance. For this process, the developmental sequence process from interpretation and extrapolation of the data to the formulation for testing predictions.

h. Inferring

This process involves explaining observations. Scientists cultivate the ability to make carefully thought out inferences to explain an observation or set of observations. They then decide what new observations would support the inference. They make new observations to see whether each of the inferences in an acceptable explanation of the new and old observations.

B Integrated Process Skills

a. Defining operationally

Beginning with the distinction between definitions which are operational and those which are not, this developmental sequence proceeds to the point where the child constructs operational definitions in problems that are new to him.
b. Formulating hypotheses

At the start of this sequence, the child distinguishes hypotheses from inferences, observations and predictions. Development is continued to be a stage of constructing hypotheses and demonstrating tests of hypotheses. This process involves looking for cause that explain observations and then generalizing these explanations.

A hypothesis is a generalization that includes all objects or events of the same class. Hypotheses can be formulated based on inferences as well as observations. Hypotheses are accepted or modified or rejected if further observation does not support it.

c. Interpreting data

This sequence begins with descriptions of data, inferences based upon them and progress to constructing equations to represent data, relating data to statements of hypotheses and making generalizations supported by the experimental findings. Interpreting data process consist of three different areas ie. to produce inference, prednisone and hypotheses and developing skills in the use of statistical measures.

d. Controlling variables

The developmental sequence for this integrated process begins with the identification of manipulated and responding variables (independent and dependent) in a description of demonstration of an experiment. Development proceeds to the level at which the students, being given a problem, inference
or hypotheses actually conducts an experiment, identifying the variables, and describing and controlling new variables. This process involves understanding of how variables influence each other. The most definite results of an investigation are obtained when variables can be identified and carefully controlled.

Best results can be obtained by (a) changing one variable in a systematic way and watching for corresponding changes in another variable. And (b) by holding constant all other variables while manipulating one variable and observing the response of another.

**e. Experimenting**

This is the most important skill to be developed in students and it is an integrated process. It is developed through a continuation of the sequence for controlling variables, interpretation of observations of scientific experiments, stating a problem, constructing hypothesis and carrying out experiential procedures. This process encompasses most of the other processes.

**The relationship between Scientific Creativity and Scientific Process Skills**

Scientific research requires creativity in the sense of creating original solutions and new understanding. Problem solving in science requires a student to explore her own repertoire, to imagine a variety of routes to a solution. This is the justification for considering scientific creativity as worthy
of attention in the education of students who will either become scientist or who need an understanding of society.

Solving problems in science is a process in which investigative activities aim at giving opportunities to students to solve a problem using their skill and their conceptual framework. (Gott and Duggan, 1995). By doing these, students use their skills of applying the scientific process. These skills can be grouped within five major categories.

1. Identification of the problem
2. Designing the experiment by deciding the variables
3. Making measurements, observation and finding the evidence and defining them.
4. Presentation of the data using tables and graphs
5. Evaluation of the process of criticizing the validity and reliability of the data and drawing conclusions.

The creativity component of the investigative work could be measured by checking the students’ skill of producing a problem and deciding the variables, planning experiments, trying different methods etc. It is believed that finding out students’ scientific process skill will also show how much students have the scientific creativity components.

2.1.4 Creativity

Everyone is a unique creation, but does not possess the same creative ability as his peers. Some are endowed with creative talents and contribute
to advancement in the fields of art, literature, science, business teaching and other spheres of human activity and are responsible for propounding new ideas and bringing about social and cultural changes. Mahatma Gandhi, Abraham Lincoln, Homi Bhabha, Newton, Shakespeare were some of the creative individuals who left their mark in their chosen fields. Though they were undoubtedly gifted with creative abilities, the role of environment in terms of education, training and opportunities in their development cannot be ignored.

Good education, proper care and provision of opportunities for creative expression inspire, stimulate and sharpen the creative mind and it is in this sphere, that parents, society and teachers make a significant contribution. They are required to help the children in nourishing and utilizing their creative abilities to the utmost. The educational process, therefore should be aimed at developing creative abilities among children. This can be achieved by acquainting the teachers and parents with the real meaning of the creative process and the ways and means of developing and nurturing creativity.

The terms ‘creativity’ or ‘creative process’ have been defined in many ways. According to Levin (1978), creativity is the ability to discover new solutions to problems or to produce new ideas, inventions or works of art. It is a special way of thinking, a way of viewing the world and interacting with it in a manner different from that of the general population. According to Stein (1974) Creativity is a process which results in novel work that is
accepted as tenable to useful or satisfying to a group of people at some point of time.

There seems, however, to be considerable lack of agreement among these scholars regarding the true nature and concept of creativity – its process as well as its product. Some of them consider it to be purely a function of the mind, a component of the cognitive behaviour while Ausbel and others maintain it to be an attribute of the person as a whole involving his total behavior and functioning of his whole personality. The definitions have considered creativity both as a process and a product, the thought as well as its result, but the central, essential condition of novelty or newness in the creation has not been overlooked by any one. By incorporating all these viewpoints, creativity can be described as the capacity or ability of an individual to create, discover, or produce a new or novel idea or object, including the rearrangement or reshaping of what is already known to him which proves to be a unique personal experience.

**Nature and Characteristics of Creativity**

Creativity as a unique and novel personal experience may said to possess the following characteristics:

- Creativity is universal
- Creativity is innate as well as acquired
- Creativity produces something new or novel
- Creativity is adventurous and open thinking
• Creativity is a means as well as end in itself
• Creativity carries ego involvement
• Creativity has a wide scope
• Creativity and intelligence do not necessarily go hand in hand
• Creativity rests more on divergent thinking than on convergent thinking
• Creativity and school achievement are not correlated
• Creativity and anxiety often go together

Various theories have been put forward for explaining the mechanism of creativity. The theory considering Creativity as a god-given gift and the theory of insanity advocating positive correlation between insanity and creativity have been rejected as being either inborn or an environmentally acquired characteristics are not accepted and exclusive of each other.

While Taylor’s level of theory of creativity is known to distinguish the existence of creativity at five levels in an ascending hierarchy, the hemisphere theory of creativity considers creative acts as a function of the interaction between the brain’s hemispheres. A good explanation of creativity has been propounded by the psychoanalytical theory of creativity which defines creativity as a means and a product of one’s emotional purgative, a medium for sublimation and catharsis.

2.2 ABSTRACT OF RELATED STUDIES

The review of related studies is important as any other component of the research process. It involves systematic identification, location and
analysis of documents containing the information related to the research problem. The literature review has several important purposes that it will worth the time and effort. The major purpose of reviewing the literature is to determine what has already been done that relates to our topic. An effective research is based upon past knowledge. The review of literature helps to eliminate the duplication of what has been done and provide useful hypothesis and helpful suggestions for significant investigation.

The survey of related studies implies locating, studying, and evaluating reports of relevant researches, published articles, going through related portions of Encyclopaedias and research abstracts, pertinent pages out of comprehensive books on the subject and going through related manuscripts if any. For any worthwhile study in any field of knowledge the research worker needs and adequate familiarity with the work which has already been done in the area of his choice. He needs to acquire up to date information about what has been thought and done in the particular area. He has to build upon the accumulated and recorded knowledge of the past

Here the investigator has made an attempt to survey the articles related to the topic under study. The related studies reviewed in this context are presented below under the following heads.

2.2.1 Studies related to Scholastic Backwardness

2.2.2 Studies Related to Science Process Skills

2.2.3 Studies Related to Scientific Creativity
2. 2.1 Studies Related to Scholastic Backwardness

Nair, Paul and Mohan (2003) conducted a study to find out the factors affecting scholastic performance of adolescents belonging to various groups and the determinants for poor scholastic performance. 1892 adolescents of 13 to 19 years age group belonging to different category of schools were interviewed and assessed by a team consisting of paediatricians, psychologists and PG students using teenage screening questionnaire and study habit relating scale. Daily study pattern, family environment, educational status of parents, personal distraction and attitude towards studies were observed as factors affecting scholastic performance.

On multivariate analysis the predictor variables for poor scholastic performance were lower studying in daily lessons, poor concentration in studies, lower education status of father and unhappy family. It was concluded that it is feasible to identify determinants of scholastic performance and plan intervention strategies at school level.

A study conducted by Kapur, Shenoy and Kapur (1996) on scholastic backwardness among 5-8 years old school going children. 1535 children were screened by their class teachers of which 1023 were found to have scholastic backwardness. No gender differences were noticed. The rates of specified difficulties such as reading, writing and arithmetic were found to be 4.69%, 5.15% and 15.96% respectively. About 26% of scholastically backward children were also found to have psychological disturbances. In addition they most often came from families which could not afford basic amenities,
had fathers with alcoholic dependence, inconsistent disciplining and poor parental disorders. They also had more frequent school changes tuition and fewer hobbies compared to the scholastically superior children.

The objective of the study conducted by Krishnakumar, Geetha and Palat (2006) was to evaluate the effectiveness of an individualised educational programme for children with scholastic backwardness.

Among the children attending a child guidance clinic for scholastic backwardness, 12 of them who were diagnosed as slow learners based on current level of academic functioning and IQ and 6 children having mild mental retardation were given individualised education for a period of two months. Independent assessors evaluated the academic functioning at the beginning of the training and at the end. The results showed that the children had significant improvement in their academic functioning and self esteem after the training.

Rao and Rajaguru (1995) studied, “Effectiveness of Video assisted instruction on the achievement of slow learners”. The major objectives of the study were: 1. To investigate the effectiveness of video assisted instructions on the achievement of slow learners in learning science concepts. 2. To make a comparative study of the achievement of slow learners in terms of the following variables: Sex differences, socio-economical difference, management of school, parents’ educational status and family size of slow learners. 3. To study, the relationship between achievements of slow learners and their intellectual capacity.
After analysis, the study gave the following conclusions.

1. The slow learners of control and experimental groups were alike in immediate retention. But female slow learners of video assisted instruction group performed better in immediate retention than conventional learning group.

2. The socio-economic status had impact on immediate return of slow learners in learning science concepts through video assisted instruction.

3. The slow learners of govt. schools and private schools were alike in intelligence test.

4. The socio-economic status and parent’s educational status had least impact on intelligence of control and experimental group slow learners.

Reddy and Ramar (1997) conducted the study, “Effectiveness of Multimedia Based Modular Approach in Teaching English to Slow Learners to develop multimedia based modules for Std. VIII English subject and to measure the effectiveness of multimedia based modular approach with special reference to slow learners. The following are the conclusions.

1. There was no significant difference between the pre test and post test mean scores of the control groups.
2. There was significant difference between the post-test means scores of control group slow learners taught through traditional lecture method and the experimental group slow learners through multimedia based modular approach.

Reddy and Ramar (1996) undertook an experimental study to assess the Relative effectiveness of Video Instruction in Teaching Science and Social Science to slow learners. The main findings of the study were: 1. There was significant difference between pretest and post test mean scores of experimental group slow learners when the subjects were taught through video instruction. Further their achievement was higher in the post test than in the pretest. Moreover the rate of progress made by the experimental group slow learners signified the relative effectiveness of video instruction in teaching two different subjects i.e. science and social science. 2. There was significant difference between the post test scores of the control group slow learners taught through traditional lecture method and the experimental group slow learners taught through video instruction. Further the achievement of experimental group slow learners was higher than the achievement of control group slow learners. Moreover, an analysis of rate of progress made by the control group slow learners and the experiential group slow learners brought to light the effectiveness of video instruction.

Reddy and Ramar (1995) conducted a study on the Effectiveness of Computer Assisted Instruction in Teaching Science to slow learners. The main objective of this experimental study was to develop CAI software for
science subject of St. VIII and assess its effectiveness with special reference to slow learners.

The study arrived at the following results. There was significant difference between the post test mean scores of control group slow learners taught through traditional lecture method and the experimental group slow learners taught through CAI. Further the achievement of experimental group slow learners was higher than the achievement of control group slow learners. Moreover the rte of progress made by the experimental group slow learners was higher than that of the control group slow learners.

Reddy and Ramar (1997) conducted an experimental study to measure the effectiveness of modular approach with special reference to slow learners and also to assess how far modular approach enables the slow learners to cope with normal students. The study revealed the following conclusions.

1. There was significant difference between the pretest and the post test mean scores of experimental group slow learners when social science subject was taught through modular approach. Further their achievement was higher in the post test than in the pre test.

2. There was significant difference between the post-test mean scores of control group slow learners taught through traditional lecture method and the experimental group slow learners taught through modular approach. For the achievement of experimental group slow learners was higher than the achievement of control groups slow learners.
3. There was significant difference between the post-test mean scores of control group slow learners and the normal group students. Further the achievement of normal group students was higher than the achievement of experimental group students.

Reddy and Ramar (1997) conducted a study, “Effectiveness of Multimedia Instructional Strategy in Teaching Science to Slow Learners”. The experimental study was undertaken with two objectives in view:

1. To develop multimedia package for VIII standard science subject

2. To measure the effectiveness of multimedia instructional strategy with special reference to slow learners. Two matched group of slow learners were constituted for the purpose of this experiment and a normal group comprising average and above average students was also formed in order to assess how far multimedia instructional strategy enabled the slow learners to cope with normal students. The control group and the normal group were taught though traditional lecture method while the experimental group was taught through multimedia instructional strategy. The obtained result showed that the multimedia instructional strategy was more effective than the traditional lecture method in teaching science and it enabled the slow learners to cope with normal students to a considerable extent.

Shankar and Mangayarkarasi (2012) conducted a study, “Remedial Strategies for Reducing Learning difficulties of Tenth Standard Slow Learners”
in Analytical Geometry” revealed the maximum efficiency of remedial strategies in teaching analytical geometry to reduce learning difficulties. Moreover the slow learners in analytical geometry showed improvement in learning.

### 2.2.2 Studies Related to Science Process Skills

Aktamis and Ergin (2008) has conducted a study on “The effect of scientific process skills on students’ scientific creativity, scientific attitude and academic achievement.” The aim of this study was to investigate the effect of teaching scientific process skills to students to promote their scientific creativity, attitude towards science and achievement in science. As a result of the research, it was determined that the scientific process skills education increased the students’ achievements and scientific creativities, however, no meaningful progress was made on their attitude towards science when compared to the teacher centred methods.

Hancer and Yilmaz (2007) had published an article on “The Effect of the characteristics of adolescence on the science process skills of the child.” The study has been carried out in order to revise the interest levels of the adolescents who study at the secondary schools. In this study science process skill test was used to assess the science process skill of the students. The data gained form this study was analysed using t-test. Consequently it has been discovered that the sciences process skills of the adolescents do not differ according to their scores and ages but according to their socio-cultural conditions.
Lumbantobing (2006) has conducted a “Comparative study on process skills in the elementary science curriculum and text books between Indonesia and Japan.” This study was carried out to investigate how the Indonesian and Japanese science curricula and test book set the process skills. The curricula were analysed on the basis of basic process skills and integrated process skills involved in their hand-on activity section. Research findings indicated that: The objective of Indonesian curriculum 1994 does not set the substance of process skills. The objective of Japanese curriculum 1994 sets the substance of process skills. Indonesian text books primarily emphasize basic skills in all grades’ levels. Japanese text book emphasize basic skills in the third grade and integrated skills in the fourth, fifth and sixth grades.

Temiz, Taser and Tan (2006) had developed a validated multiple format test for assessing science process skills. The purpose of this study was to develop a multiple format instrument, in order to measure the development of 12 science process skills. For this purpose, a questionnaire with fifteen constructed response type items and one hands-on task was developed. In its final form, it was administered to a total of eighty 9th grade students in four different high schools in Turkey. The test administration time was set at 90 minutes. The reliability of the instrument was also established and found to be high (r=0.88) Initial results suggested that the procedures followed in this study could provide guidance for researchers working on the development of test and activities. The results appeared to imply that a
multiple format instrument that included both a hands on task and paper pencil items could be successfully developed and used.

Monhardt and Monhardt (2007) published an article about “Creating content of the learning and science process skills through picture books.” This article provides suggestions on ways in which science process skills can be taught in a meaningful content through children’s literature.

Culler, Collina and Emjadalka (2005) had presented a paper in Learning Conference 2005 on “Problem solving process skills as predictors for arriving at correct answers to subtraction problems with English Language learners”. The purpose of the study was to examine the relationship between each of the five problem solving process skills and arriving at the correct final answer to a subtraction problem. The problem solving process skills include explaining the problem, estimating the final answer, representing the problem, solving the representation and explaining the answer. Results of the study indicated that the only process skill significantly related to arriving at the correct final answer to a subtraction problem was process three (representing the problem) and process four (solving the representation.)

Saat (2004) had conducted a study on “The acquisition of Integrated Science process skills in a web-based learning environment”. This quantitative case study examined the process of acquisition of integrated science process skills, particularly the skill of controlling variables, in a web based learning environment among grade five children. Data were gathered primarily from children’s conversations and teacher revealed that the children
acquired the skill in three phases: from the phase of recognition to the phase of familiarisation and finally to the phase of automation. Nevertheless the acquisition of the skill only involved the acquisition of certain sub skills of controlling variables. This progression could be influenced by the web based instructional material that provided declarative knowledge, concrete visualisation and opportunities for practice.

Galyam and Grange (2003) had conducted a study on “Teaching thinking skills in Science to learners with special needs.” The aim of this study was to teach specific skills and processes that are known to be representative of problem solving activity in science to learners with special needs, using selected instrumental enrichment tools when needed. Major findings show that even complex concepts such as controlling variables, formulating hypothesis were understood by most of the learners, ie. The programme might prove to be successful in enabling learners with special needs to science.

Hartikainen and Sorumunen (2003) had conducted a study on “Seventh Grade Pupils scientific process skills in biology context.” The aim of this study was to investigate seventh grade pupils’ scientific process skills, their ideas about learning and studying science and views about science and scientific investigation. One of the major findings of this study was the quality of the pupils’ procedural thinking concerning the scientific investigation is quite modest.
Onwuequbuzie (2000) had presented a paper at the Annual meeting of the Mid-South Educational Research Association about “Science process Skills and Achievement in research methodology courses.” The purpose of this study was to investigate the relationship between student competency in science process skills and their conceptual knowledge of research concepts, methodologies and applications. Participants were 124 graduate students enrolled in several selection of a required introductory level course in research methodology. Science process skills were measured via the Test of Integrated process skills- 2 and performance in the research methods class was assessed through mid term and final examinations. Findings revealed that the students who demonstrated the highest competency in process skills also tended to exhibit levels of performance in the research methods course that both the midterm and final examination stages. The relationships were moderate to large.

Lazarowitz and Huppert (1993) conducted an experimental study on “Science process skills of tenth grade biology students in a Computer Assisted Learning (CAL) setting.” The goal of this study was to investigate the impact of CAL integrated with class room laboratory instruction versus class room laboratory work alone on students’ achievement and mastery of science process skills. The results indicate that the experimental group performed significantly better on three science process skills a) graph communication b) interpreting data and c) controlling variables. The integration of CAL in to the existing Biology curriculum is discussed in the light of its potential to help
students master science process skills and improve their academic achievement.

Strawitz (1993) published an article on the study of effects of review on science process skill acquisition. This study was designed to examine how programmed materials could be implemented to promote a higher level of process skills proficiency. A secondary purpose was to compare these effects with those of student receiving non-programmed instruction in the process skills. A major finding of the study was that the student learn more effectively from programmed instruction than from teacher-directed instruction.

Mason (1992) made an attempt to study the effect of acquisition of integrated science process skills. This study describe the effect of a constructivist institutional procedure designed to teach seventh graders to use a scientific experimentation approach to learning traditional Euclidean geometry. Particularly this study was designed to compare pre and post test scores to measure students’ acquisition of integrated science process skills. The result of this study indicates that science process skills acquisition was enhanced through the instructional processes that were used to teach geometry to seventh graders, and that cognitive styles appeared not to play a major role in their acquisition of these skills.

Scharmann (1989) published an article on “Developmental influences of science process skill instruction.” The aim of the study was to examine the purported influence and developmental nature of science process emphasised during a given semester of study, as well as over extended
curricular sequences, each sequence being representative of three recognized pre-service elementary science teacher preparatory programme. Data were collected from 135 elementary pre-service teachers enrolled in science teaching method courses at the end point of one of the three sequences: Introductory process instruction with three subsequent semesters of integrated science content and teaching methods, process instruction with separate subsequent content and teaching methods, and only science content with subsequent teaching methods. Results indicated that a one semester process skills course was influential in developing a basis for science content acquisition and in fostering an understanding of the nature of science. Result also indicates that expected additional gains were significant in science content acquisition through matriculation in an extended curricular sequence.

Hsuing (1988) conducted a study on the relationship among integrated science process skill achievement, logical thinking abilities and academic science achievement. 635, tenth grade students were classified in to three levels. The results showed that there was a significant but moderate correlation between integrated science process skills and logical thinking abilities.

1. There were significant gender differences in science process skill achievement logical thinking abilities, and academic science achievements, males out performed females.
2. Neither test of integrated process skill nor group assessment of logical thinking was effective predictors of individual academic science achievement.

Tanuputra (1988) conducted an investigation of the extent to which science process skills were present in the lower secondary science curriculum. The findings from the interview of teachers showed that some teachers seemed to know which methods are appropriate to promote student active learning. Some teachers expressed their wish to include questions or statements in the worksheets which encourages students to think and a small number of teachers suggest opportunities for students to devise investigations.

Singham (1987) conducted an investigation of the science process skills in the intended and implemented PSP (process skill program) in Singapore. The findings showed that the teachers perceive the objectives of PSP at a glance on activity oriented project. The findings indicated that there is no significant variation in the experience of process skills by pupils across class/age levels. (P4, P4 and P6). Hence the notion of a hierarchy existing with the higher class/age levels using more of the integrated skills as PSP states was not substantiated in this study. The study showed that the Singapore children are capable of using the process skills, more importantly, that they can be analytical, critical and able to communicate their ideas when the opportunity is provided for them.
Padilla and Padilla (1986) had presented a paper on “Thinking in Science: The Science process skills” designed to support the premise that many important clues to the solution of the problem of teaching thinking skills in science contained in the science process skill literature. This paper synthesizes research related to the teaching of science process skills. Studies which evaluate the effect of the science curricula are described. Specific attention is given to studies which focus on single process skills, comprehensive process skill outcomes and on formal operational studies which focus on the ability to conduct experiments. The role of computers in teaching process skills is also examined. The reviewed research suggests that thinking in science can be taught and learned by elementary middle and secondary students. Implications for instructions are noted and specific suggestions for teachers were offered. These include (1) matching the teaching tasks and expectations to the level of the learner (2) working with familiar materials (3) teaching efficient problem solving strategy.

Padilla and Okey (1986) investigated different patterns and amounts of instruction on planning experiments with sixth and eighth grade students. Results showed that both sixth and eighth grade students can learn to use certain integrated process skills, growth was apparent in identifying variable and stating hypothesis.

Helseth (1984) conducted a study to find out the relationship among process skills, instruction, achievement, formal operational thinking ability, academic aptitude, perceived locus of control and achievement motivation for
non science majors enrolled in a college biology course. The findings revealed that the instructional strategy emphasising integrated science process skills was not effective in promoting significantly higher biology achievement and formal operational thinking ability. Students’ integrated science process skill achievement, mathematical aptitude and formal operational thinking ability were consistently related to biology achievement at the end of the course.

Mohammed (1983) conducted a study to determine the effects of Science Process Skills instruction on in-service secondary school teachers. It was found that teaching of science process skill objectives and process activities of trained teachers were significantly better than the untrained teachers.

Cox (1983) investigated the development of selected science process skills required in elective science classes. The result indicated that the tenth grade students have significantly higher adjusted science process competency post test score than did ninth grade students in required science classes. Science process skill knowledge was retained through the high school years. Student who had selected one or more years of science had significantly higher adjusted science process competency post test scores than those students who had not selected science.

Franser (1981) explored into the relationship between socio-economic status and proficiency in inquiry skills. The SES was measured in terms of
parental occupation. The main correlation between SES and inquiry skill performance was found to be statistically significant.

Manoj and Devanathan (2011) conducted a study on the effectiveness of Problem based learning strategies on science process skills in relation with scientific attitude. The researcher aimed at documentary and explaining associations, if any between the effects of intervention of problem based learning strategy in enhancing process skills in biological science and scientific attitude and to find out the relationship between the variables.

The major findings of the study are

1) Problem based learning strategies significantly enhance process skills in biological science

2) Process skill in biological science and scientific attitude are positively correlated.

3) Problem based learning has bearing on improving scientific attitude of students at secondary level.

Aruna and Sumi (2011) investigated the “Effectiveness of process Approach in Science on Attitude towards Science and process skills in Science”.

The main objective of the study was to find out the effectiveness of process approach in science on process skills in science and attitude towards science of Std. IX pupils. The major findings of the study were:
There is significant difference in the mean achievement scores of experimental group and control group for the two variables, attitude towards science and process skills in science. At the initial stage, there was no significant difference in the mean scores of pretest of non verbal intelligence class room environment, socio economic status and achievement in science. From the findings it is evident that the process approach in science is superior to the constructivist model of teaching for increasing attitude towards science and process skills in science.

Geevarghese (2007) conducted a study on school related variables and process outcomes in Mathematics at the secondary school stage. The aim of this study was to analyse the attainment of process skill in mathematics of secondary school students in the whole sample and subsamples classified on the basis of school related variables. Major findings of this study were the attainment of process skills in mathematics of secondary school pupils was not satisfactory, with basic process skills of 58% and integrated 30%. Process skill outcomes are very much related to learning environment and teacher effectiveness. The attainment of process skills of pupils doing both textual exercises and extra textual exercises are better than of those who are doing solely textual exercises.

John (2007) aims to find out the acquisition of the selected science process skills among the students of standard nine of Ernakulam District with special reference to gender, locale and type of management. Boys of standard nine possess higher acquisition of selected science process skills
than girls. Also the students of aided schools possess higher acquisition of selected science process skills than girls. Also the students of aided schools possess higher acquisition of selected science process skills than those of government schools. Students of rural schools possess higher acquisition of selected science process skills than those of town schools. There is significant relationship between scores on the selected science process skills and creativity of students of standard nine of Ernakulam District. It can be interpreted as the student’s science process skills are more creative.

Aruna and Usha (2006) investigated on “Influence of Cognitive Style, Intelligence and Classroom climate on process outcomes in Science”. This study was conducted on a representative sample of 1000 pupils of Std. IX of secondary schools of Kerala. The sample was selected by giving due representation to sex, locality of students and management category of students. The data were collected using Group Embedded Figures Test (GEFT), Standard Progressive Matrices Test (SPMT), Scale of classroom climate and Test of process outcomes in science. The study revealed that

1. Sex and Management have some significant effect on process outcomes in science of secondary school pupils

2. Locale has no contribution in the development of process outcomes in science.

3. In process outcomes in science, girls are found to be superior to boys.
4. Private school pupils score higher in process outcomes in science than government school pupils.

Satyaprakash and Patnaik (2005) developed and standardised a process skill test and standardised a process skill test in Biology for Class VIII. The objectives of the study were

1. To develop a process skill test in Biology

2. To standardise the process skill test in Biology

Aruna (2004) conducted a study “Process outcomes in Science and classroom climate”. The data for the study was collected from 400 students of Std. IX of Kozhikode district of Kerala State.

The correlational analysis revealed that the relationship between process outcomes in science and classroom climate is positive and significant for the total sample and subsamples based on sex, locale and management except rural sample.

Nancy (2002) had conducted a study on “The relationship of different dimensions of study habit with process outcome in biology of IX Standard students.” The study was intended to investigate the relationship between process outcomes in biology and each of the selected dimensions of study habit and to predict process outcome in terms of the independent variables which are correlated with process outcome. Further, it aimed to find out the ability of the independent variables to discriminate the high, average and low process achievers in terms of the mean scores of study habit. The study
obtained significant correlation between process outcome and most of the
dimensions of study habit.

Joseph (1998) identified cognitive, affective and environmental
variables related to process outcomes in physics. It was concluded that
process outcomes in physics could be predicted by employing four
independent variables, viz intelligence, attitude towards science learning,
science learning interest and socio-economic status. These predictors were
found to be highly correlated to process outcomes in physics.

Germann (1994) found that academic ability, biology knowledge and
language preference had significant direct effects on science process skills
and achievement. There were significant mediated effects by cognitive
development, parent’s education and attitude towards science in schools. The
variables of cognitive development and academic ability had the greatest total
effects on science process skills.

Sebastian (1993) conducted a survey of selected enquiry skills among
standard nine students of Mangalore city corporation which revealed that
boys and girls are equally good in process skills, but the skill of observation
seems to be higher among boys. Science club membership and other science
facilities seem to be significantly related to the acquisition of science enquiry
skills.

Suresh (1991) tried to identify the sociological cognitive and
environmental variables related to process outcomes in biology. It was
concluded from the study that process outcomes in biology could be predicted by employing four independent variables viz. Intelligence and science learning approach, parental education and parental income. These predictors were found to be positively and significantly related to science process outcome.

Ampili (1991) in her study assessed separately the possible relationship of process outcomes in science to science interest, scientific attitudes, and attitude towards academic work of total sample and relevant subsamples. She found a positive and significant relationship between process outcomes and science interest, scientific attitude and attitude towards academic work.

Singh and Black (1991) conducted a study to find out the effects of task contexts on pupils’ performance in science process skills. The study revealed that there exists an apparent interaction between process skills and contexts. Pupils’ achievement on the interpretation skills was significantly high in everyday contexts than in scientific contexts, whereas in application skills it was significantly higher in scientific context.

Lobo (1990) found that the teacher students who possess science process skills were able to improve pupils’ achievement through their modified behavior. It was also found that as a result of process skills teaching, teachers tend to be more heuristic, problem solving oriented and speculative in contrast with those who are not given this training.

Paulose (1987) examined the influence of certain personality variables, gender, residence on process outcomes in physics of university entrants. The
study found that the F-value corresponding to the main effects of personality variables were significant in the case of four out of the nine variables. Gender and residence of the subjects were also found to have a significant influence on process outcomes. Males were seen to be superior to females in their process achievements.

2.2.3 Studies Related to Scientific Creativity

Sukla and Sharma (1987) administered a scientific creativity scale in 330 urban, rural and refugee students in the middle school to test for fluency, flexibility and originality. The results indicated that the lowest scores came from tribal pupils and rural pupils scored higher in fluency than the refugees.

Yawalker (1985) investigated into the development of some personality correlates of Scientific creativity. The study was aimed at investigating the efficiency of two creative teaching techniques, viz. bionics and morphological correlates analysis conducive to develop some personality correlates of scientific creativity. The personality variables under study were self-reliance, dominance, emotional stability and super ego strength.

Misra (1986) conducted a study on effect of home and school environment on scientific creativity. The major findings showed that boys do not differ significantly from girls with respect to inquisitiveness which is an aspect of scientific creativity. However, girls excel boys in three aspects viz. fluency, flexibility and originality. All the significant relations among the
variables seemed to be tied with verbal intelligence, non-verbal intelligence and socioeconomic status.

Sansanwal and Deepika (1997) found that

1. Male and female students did not differ significantly in scientific creativity.

2. Interaction between standard and gender did not have any significant influence on scientific creativity.

3. Scientific creativity scores of students belonging to high and low levels of intelligence did not differ significantly.

Anilkumar (1992) conducted a study on the relationship between creativity in science and certain demographic variables of secondary school pupils. The study showed that there exists a significant relationship between each of the components of creativity in science and total creativity in science with each of the demographic variables, namely gender, locale and socioeconomic status.

Devi (1992) studied the relationship of pupils between attitude towards science and creativity of secondary school pupils and arrived at the following conclusions: The positive correlation obtained for the total sample and sub samples with attitude towards science and creativity in science and each of its components correlated was significant at 0.01 level. This study concluded that attitude towards science has certain role in the development of creativity in science among pupils.
Asmali (1994) conducted a study on the relationship between Science achievement, science interest, scientific attitude, process outcomes in science and scientific creativity of secondary school pupils and found that there was a significant relationship among the variables viz. science achievement, science interest, scientific attitude, process outcomes in science and each component of scientific creativity and each of the experimental variables can discriminate significantly between the high average, and low creative pairs in the dimensions of scientific creativity.

Craine (1994) conducted a study on the relationship between student learning styles and creativity and performance in introducing college chemistry. The study was designed to examine the relationship between the four independent variable such as sensing, feeling, sensitive thinking, intuitive thinking, incentive feeling and the dependent variables of performance. Based on his study, the major finding was the relationship exerts between student leaning styles, creativity and performance.

Parkhurst and Bruce (1994) conducted a study on developing creative thinking based on the three stages of creativity, ie. Analysis, comparison and synthesis on the 7th and 8th grade students. The subjects were pretested with Torrence tests of creative thinking, verbal and figural forms A and with Torrence Tests of Creative Thinking – verbal and figural forms B and analysis of results did not indicate significant differences between control and experimental groups.
Maha (1994) investigated the relationship between teachers’ expressed attitudes towards creativity and their actual instructional behaviours in the classroom. A sample of 30 teachers was selected for the study. The findings indicated that there was a negative relationship between attitude and instructional behaviour. The analysis of variance indicated that the demographic variables such as teachers’ age, educational background, and teaching experience have no relationship with attitude and instructional behaviours and there have no influence in creativity.

Tafari and Marie (1994) in their effects of creativity on teacher-student interactions sought to determine the effects of teachers creative abilities on their interaction with children. The Torrance test of creative thinking (figural form A) was employed to assess the creative abilities of 46 teachers and their students. Results indicated that no significant relationship existed between teachers’ creativity with respect to teachers’ expectations of students creative aptitude. Significant relationship exists between teachers’ creativity and amount of response opportunities, questions answers and terminal feedback they provided to students. Also significant differences existed between group means based on gender and creative abilities of students.

Haneeshia (2001) conducted a comparative study of scientific creativity of pupils in DPEP and non DPEP schools in the state of Kerala. The study found that the two groups differ significantly with respect to fluency, flexibility, originality and total creativity.

The study found out that the variables Intelligence, Scientific Creativity and Home Environment clearly discriminated the High, Average and Low Achievement groups. So these variables have significant association with achievement in Science.

Resmi (2011) conducted a study on the self-concept, Achievement motivation and Scientific Creativity of Secondary school students. The study revealed that there is no significant relationship between self concept and scientific creativity of secondary school students with regard to gender, locality of institution and SES.

2.3 Summary

The investigator conducted an exhaustive review of the work done in the areas related to Scholastic Backwardness of upper primary students, studies related to Science Process Skills and Scientific Creativity. An attempt was made to include some relevant theoretical literature as well as abstracts of available studies on relevant variables. It has been seen that a large number of studies were conducted in the science process skills of normal achievers. But no such studies were there in scholastically backward students. Moreover, the research works done in scholastically backward students and scientific creativity are very few.