CHAPTER III

REVIEW OF RELATED LITERATURE
A methodological review of past literature is a crucial endeavor for any academic research (Webster & Watson, 2002). A literature search is the process of querying quality scholarly literature databases in order to gather applicable research manuscripts related to the phenomenon under investigation. Review of related literature is an essential part of any research project, as it implies locating, studying and evaluating reports of researches relevant to the topic under investigation. It provides the researcher with an insight into the methods, techniques and approaches adopted by other researchers leading to clarity of his chosen problem area, significant improvement of his research design and avoiding the risk of duplication.

The present study being stated as *Relation of achievement in science and certain context variables with comprehensive science process measures at the secondary school level*, the review of related literature is primarily concerned with the area of ‘Science Education’. The purpose of the review is twofold: to characterize the nature of the research carried out in the relevant area and to present a distillation of the findings. For convenience, the review has been categorized under the following titles.

(a) Studies relating to science learning outcomes
(b) Studies relating to context variables
(c) Studies relating to science instruction
(a) **Studies relating to science learning outcomes**

The studies under this category include studies relating to the following areas.

- Curriculum and **Science Process Skills (SPS)**
- **SPS and Achievement in Science/ Academic abilities**
- Approaches and tools to assess SPS
- The science learner and SPS/ Achievement in Science

**Gauchet (2011)** utilized both quantitative and qualitative methods in investigating how a novel science curriculum, geared towards the 21\textsuperscript{st} century student, affected skills and attitude towards science for tenth grade students. Statistical tests revealed no significant differences between students who received the novel curriculum versus those who received a traditional curriculum. Both groups showed significant improvements in all skill areas. The findings suggest that the task of creating a meaningful and relevant curriculum based on the necessary skills of the century is not an easy task. Qualitative findings suggest integrated design and student technology are promising.

**Akinbobola & Afolabi (2010)** analyzed the science process skills in West African senior secondary school certificate physics practical examinations in Nigeria for a period of 10 years (1998-2007). Ex-post facto design was adopted for the study. The 5 prominent science process skills identified out of the 15 used in the study were: manipulating (17\%), calculating (14\%), recording (14\%), observing (12\%) and communicating (11\%). The results showed high percentage rate of basic (lower order) science process skills (63\%) as compared to the integrated (higher order) science process skills (37\%). The results also indicated that the number of basic process skills was significantly higher than the integrated process skills in the West African senior secondary school certificate physics practical examinations in Nigeria.
Oloruntegbe (2010) in his paper *Approaches to the Assessment of Science Process Skills: A Reconceptualist View and Option*, explains that to measure science-learning outcomes at skills level, assessment must be modified and restructured not only in form and context, but in vocabularies and nomenclatures. Thus, there emerged different forms, like alternative, authentic and performance assessments, which are labeled the most suitable for assessing science process skills demonstrated and developed by students during science activities. He took a critical look at these various forms and found them not being strong and therefore advocates on-the-spot assessment of skills as compliments and supplements to those others.

Bunce et al (2010) developed a nationwide *student-achievement and process-skills instrument* that was tested for both reliability and validity. The instrument was subsequently used in a nationwide study to investigate differences in student learning for both Process-Oriented Guided Inquiry Learning (POGIL) and non-POGIL general chemistry students.

Burak (2009) made an investigation into the relationship between Science Process Skills with efficient laboratory use and science achievement in Chemistry education. He found a positively significant and linear relationship between science process skills taught in laboratory applications and efficient laboratory use of the students; between their efficient laboratory use and their achievement in the course; and between their science process skills and achievement in the course.

Jayalekshmi (2007) compared the performance of students of state schools and CBSE schools with respect to their process skills in Science. She found that there is significant difference between the performance of students of state and CBSE schools with regard to process skills in science. The scores obtained by students of CBSE schools were significantly higher when compared to those of state schools, with respect to their process skills in science. The group following CBSE
scheme was found superior to the state scheme, even though they do not follow an activity oriented curriculum.

**Kazeni (2005)** developed an instrument valid and reliable enough to measure integrated science process skills competence, effectively and objectively in secondary schools. The science process skills tested for were; identifying and controlling variables, stating hypotheses, designing investigations, graphing and interpreting data, and operational definitions. The paper and pencil group-testing format was used in this study, which consisted of thirty multiple-choice test items. The reliability coefficient of the tool was 0.81.

**Kazeni (2005)** measured the integrated science process skills competence of grades 9, 10 and 11 learners from the Capricorn district of the Limpopo province of South Africa using a paper and pencil group-testing format which consisted of thirty multiple-choice test items. The results showed that there was no significant difference between the performance of white and black learners, and between boys and girls.

**Turpin and Bob (2004)** investigated the effect of an integrated, activity-based science curriculum, on science achievement, science process skills, and attitudes towards science. The research involved seventh grade students using the Integrated Science (IS) curriculum as the experimental group and seventh grade students using a traditional science curriculum as the control group. The results showed that that the seventh graders involved in the IS activity based science program had a significantly higher score in the areas of science achievement and science process skills when compared to students using a traditional science program. IS students had significantly higher scores on the specific science process skills of Identifying Experimental Questions, Identifying Variables, Designing Investigations, and Interpreting Data.
Geevarughese (2003) analysed the influence of certain school related variables and intelligence on process outcomes in Mathematics at the secondary school stage. She found that the attainment of process skills in Mathematics of secondary school pupils was not satisfactory, while there exists a significant relationship between Mathematics process outcomes and each of the independent variables – intelligence and school related variables.

Kumari (2002) studied the effect of intelligence, adjustment and anxiety on process outcomes in science of secondary school children. A test constructed in science process was used to measure process outcomes. Intelligence (verbal, non-verbal and total) spatial ability, general anxiety and examination anxiety had a positive correlation with process outcomes. Negative correlation was obtained between personal adjustment and process outcomes in science.

In the meta analysis of 122 studies on cooperative learning, Marzono, Pickering, and Pollock (2001) found that students using cooperative learning strategies had improved achievement.

Joseph and Suresh (2001) in their study tested the ability of the select affective variables – attitude towards science learning and science learning interest - to discriminate among three levels of process achievement in physics and the extent of relationship of these variables with process outcomes in physics. It was found that the select affective variables could discriminate significantly among high, average and low process achievement and that they bore positive significant correlation with process outcomes in physics.

Sheeba (1999) conducted an investigation to assess the acquisition of science process skills and their relationship with achievement in science of seventh grade students of Thiruvananthapuram, Kerala. She found that the seventh grade students have a better acquisition of concrete science process skills than the
abstract science process skills and that there is a significant positive relationship between acquisition of science process skills and achievement in science.

**Harlen (1999)** emphasized the need to include science process skills in the assessment of learning in Science and that without the inclusion of science process skills in science assessment, there will be a mismatch between what students need from Science, and what is taught and assessed. Several researchers developed instruments to measure the process skills that are associated with inquiry and investigative abilities, as defined by Science – A Process Approach (SAPA), and the Science Curriculum Improvement Study (SCIS) (*Dillashaw and Okey, 1980*). There were efforts to develop science process skills tests for both primary and secondary school learners. The literature on the development of science process skills tests for the different levels of education, show some shortcomings that prompted subsequent researchers to develop more tests in an attempt to address the identified shortcomings.

**Ostlund (1998)** pointed out that the development of scientific processes simultaneously develops reading processes. **Harlen (1999)** reiterated this notion by stating that science processes have a key role to play in the development of skills of communication, critical thinking, problem solving, and the ability to use and evaluate evidence. Competence in science process skills enables learners to learn with understanding.

**Deepthi (1998)** conducted a study to find out the relationship between scientific attitude and process outcomes in science of higher secondary students. The study revealed that scientific attitude has greater influence on the process outcomes in sciences. Scientific attitudes and process outcomes in science of higher secondary school students are positively and significantly correlated with each other.
Colley (1997) suggested that there were effects of gender in the acquisition of science process in a project-based science curriculum. Females achieve higher in science process skills than males. As they reach high school, males achieve higher in science process.

Kunjawinski et al (1997) examined how students’ science process skills may be accurately and deliberately evaluated. They found that the awareness of the importance of process skills in science education has increased, but practical methods of assessing student performance have received minimal attention. They concluded that students who used specially developed process skill activities performed better than control group.

Rajan (1996) conducted a study on the basic process skills of standard VI students of Kasaragod Taluk. The process skills considered were observation, inference, classification, measurement, space/time relationship and prediction. It was found that there was no significant difference in the basic process skills between boys and girls. The basic process skills were not equally distributed among the pupils. A significant relationship was seen between the scores of the basic science process skill test and science achievement of students.

Asmali (1994) studied the relationship between science achievement, science interest, scientific aptitude, process outcomes in science and scientific creativity of secondary school pupils. The study revealed that there is considerable relationship between process outcomes in science and scientific creativity. Among the four variables used in the study, the three variables viz. science achievement, science interest and process outcomes in science discriminated significantly between the HC-AC pair. Science achievement, scientific attitude and process outcomes in science discriminated significantly between the HC-LC pair.
Lay, Khoo and Jenny (1993) made an attempt to gauge the acquisition of integrated science process skills, logical thinking abilities and science achievement among rural secondary students in the Interior Division of Sabah, Malaysia; and to determine whether there is a significant difference in the acquisition of integrated science process skills, logical thinking abilities, and science achievement between male and female rural secondary students. They found the existence of moderate, positive and significant correlation between integrated science process skills, logical thinking abilities and science achievement among rural secondary students in the Interior Division of Sabah, Malaysia. Also they observed differences in the acquisition of integrated science process skills and science achievement between male and female rural secondary students. Generally, female students performed better than their counterparts in the acquisition of integrated science process skills and science achievement.

Onwu and Mozube (1992) developed and validated a science process skills test for secondary science students in the Nigerian setting. This test, based on the format and objectives of the TIPS, was a valid test with a high reliability (0.84).

Shymansky et al (1990), in a meta analysis of 81 activity-oriented science programs, found a significant improvement in science achievement by students involved in science inquiry.

Research has highlighted the relevance of science process skills development on academic ability. Simon and Zimmerman (1990) found that teaching science process skills enhances oral and communication skills of students. These researchers agree with Bredderma’s (1983) findings in his study of the effect of activity based elementary science on student outcomes, that the process approach programmes of the sixties and seventies, such as the Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS) and Science-A Process Approach (SAPA), were more effective in raising students’ performance and attitudes than the traditional based programmes.
Bhargava (1986) made an attempt to study the process of ‘measuring’ which the pupils are required to develop for acquiring scientific knowledge at the school stage. The relationship between the scores on the process of measuring and other variables such as pupil’s residence, sex, age, intelligence, SES and achievement in physics was also determined. It is found that the relationship between the performance on the process of ‘measuring’ and intelligence and achievement in physics are positively and significantly correlated.

Daume (1981) compared the relationship of science content achievement and science process achievement to the variables of reading achievement, attitude towards science and sex in two junior high school programs: ISCS and traditional. Results indicated that students in ISCS and traditional science did not differ significantly on science content achievement, science process achievement attitude towards science when the variables of reading achievement, and sex were held constant. When the variables of reading and mathematics achievement were controlled, significant differences were found in favour of males in the traditional science program or science content achievement, attitude towards science and science process achievement, but not for males in the ISCS program.

The close relationship between science process skills and higher order thinking skills is acknowledged by several researchers. Padilla et al (1981) in their study of “The Relationship between Science Process Skills and Formal Thinking Abilities,” found that, formal thinking and process skills abilities are highly inter-related. Furthermore, Baird and Borick (1985), in their study entitled “Validity Considerations for the Study of Formal Reasoning and Integrated Science Process Skills”, concluded that, Formal Reasoning and Integrated Science Process Skills competence share more variance than expected, and that they may not comprise distinctly different traits.
Dillashaw and Okey (1980) developed the more comprehensive Test of Integrated science Process Skills (TIPS), which included most of the integrated science process skills, such as identifying and controlling variables, stating hypotheses, designing experiments, graphing and interpreting data, and operational definitions. The test was meant for use with middle grade and secondary school students. The test had a high reliability (0.89), and was also non-curriculum specific.

Tannenbaum (1971) developed an instrument to assess the acquisition of science processes entitled ‘Test of Science Processes’ (TOSP) for use at middle and secondary school levels (grades seven, eight and nine). This test assessed skills of observing, comparing, classifying, quantifying, measuring, experimenting, predicting and inferring. It consisted of 96 multiple-choice questions.

Woodburn et al (1967) were among the pioneers of the development of science process skills tests for secondary school students. They developed a test to assess secondary school learners’ competence in methods and procedures of science. Research evidence shows that, of the science curriculum projects for secondary schools, only the Biological Science Curriculum Study (BSCS) had a test specifically designed to measure process skills competence. This test, referred to as the Biology Readiness Scale (BRS), was intended to provide a valid and reliable instrument to assess inquiry skills for improved ability grouping in the Biological Sciences Curriculum Study.

Summary:

An analysis of the above studies relating to science learning outcomes, indicate that acquisition of science process skills is vital to the learner to attain the expected learning outcomes in science. A process – oriented, activity based curriculum, incorporating innovative instructional and assessment techniques is the need for the hour, which can contribute positively towards the expected science learning outcomes.
(b) **Studies relating to contextual variables**

The studies under this category include studies relating to the following areas.

- Science instruction and science learning outcomes
- Motivation and science learning outcomes
- Family and science learning outcomes

**Bryan, Glynn and Kittleson (2011)** examined the motivation of students in the age group of 14-16 years to learn science in their introductory science courses. The students’ intrinsic motivation, self-efficacy, self-determination and achievement were related. Consistent with social cognitive theory, self-efficacy was the motivation factor most related to achievement. The findings suggest that science teachers should use social modeling and collaborative learning activities to foster students’ motivation, achievement and interest in science careers.

**Chir (2011)** in his study demonstrates that science instruction focused on complex topics can succeed by combining visualizations with generative activities to encourage knowledge integration. Students are more successful at monitoring their progress and remedying gaps in knowledge when required to distinguish among alternative explanations.

**Remziye et al (2011)** conducted a study to determine Turkish elementary school students’ level of success on science process skills and science attitudes and if there were statistically significant differences in their success degree and science attitudes depending to their grade level and teaching method. Results of the study showed that use of inquiry based teaching methods significantly enhances students’ science process skills and attitudes.

**Nurhan et al (2010)** aimed to determine the science process skill achievement level of primary school seventh grade students in a Science and Technology lesson and relations among academic background of the parents,
monthly income of the parents, having a computer, having own room and students’ science process skill levels. It was found that students’ science process skill levels were in middle level. As a result, primary school seventh grade students’ science process skill levels did display differences according to parents’ academic background, their monthly income, having a computer, having own room. But, it was found that the science process skills of the students do not change in terms of gender.

**Jonathon (2009)** analysed the relationship between parental involvement in the education of middle-school students and the student’s satisfaction with school. This research found that a relationship exists between parental involvement in the education of the middle-school students and the student’s satisfaction with school. Additionally, a statistically significant direct relationship between the residence of a student and satisfaction with school-related activities was also observed.

**Kemal et al (2009)** investigated the effect of problem based learning and motivational styles on students’ academic success and attitudes towards Biology course. The results showed that the problem based learning method didn’t affect students’ academic success and attitudes towards biology course. However the students who had achiever motivational style, a kind of motivational style, were more successful than the others who had social motivational style. The students’ motivational styles didn’t affect their attitudes towards biology course.

**Tsurusaki and Katelin (2009)** explored how making connections between school science and student’s everyday lives can lead to higher quality science education. They discussed how the object of the activity and the participation framework and the interaction between the two aspects provided opportunities for the students and teacher to make connections between student’s funds of knowledge and school science and merge them to create hybrid spaces.
Milner (2008) conducted a study to determine if there is a differential effect of two different learning environments determined by constructivist classroom contextual factors on elementary science student’s motivation and learning strategies. Paired sample t-tests determined that student motivation and learning strategies were higher in the life laboratory than in the regular classroom.

Tran (2008) sought to understand the connection between students’ out-of-school experiences and their learning in science. This study addressed the following questions: (a) What effects does contextualized information have on student achievement and engagement in science? (b) To what extent do students use their out-of-school activities to construct their knowledge and understanding about science? (c) To what extent do science teachers use students’ skills and knowledge acquired in out-of-school settings to inform their instructional practices? The results of the study include the following: (a) Controlling for student and classroom factors, student’s ability to transfer science learning across contexts is associated with positive learning outcomes such as achievement interest, career in science, self-efficacy, perseverance and effort. Science teachers who have limited information about students’ out-of-school experiences thus rarely integrate these experiences into their instructional practices.

Felita (2006) examined the effects of hands-on-science instruction on the science achievement of middle school students. The study was concerned with the influence of hands-on science instruction versus that of traditional science instruction on the science test scores of middle school students. Findings of the study revealed that a statistically significant difference existed in the science performance of middle school students exposed to hands-on science instruction. These students had significantly higher scores than the science performance of middle school students exposed to traditional instruction. But, a statistically significant difference did not exist between the science scores of male and female middle school students.
Fraser and Rambuda (2004) did a factor analysis on the description of teachers’ understanding and opinions regarding the application and utilisation of the science processes skills during the teaching of Geography. The research revealed that according to the perception of Geography teachers, a very clear distinction can be drawn between the basic science process skills and the more advanced integrated science process skills. The investigation confirmed that Geography learners are exposed to a limited number of science processes during the teaching of Geography and that these skills are mostly confined to the basic processes.

Turpin & Cage (2004) found in their study that activity-based methods had some effects on achievement in SPS but they did not find any changes in attitudes towards science courses, and they concluded that teacher behaviors are more influential on attitudes.

Murphy and Beggs (2003) found that children liked doing experiments best in science. The reasons given included that doing experiments was fun, that they found out things and that they were learning whilst enjoying themselves.

The study conducted by Mason (2002) revealed that the science process skill acquisition was enhanced through instructional processes that were used to teach geometry to seventh graders and that intelligence appeared not to play a major role in their acquisition of process skills.

Campbell (2001) and Ponchaud (2001) found that, when asked about what they liked best in science, children most frequently replied “doing experiments” and “finding out new things”.

Sheeba (2000) conducted a study to find out the relationship between different dimensions of study habit and process outcome in biology for the whole sample and the relevant sub samples based on sex of the student, locality of the school and management category of the school. She found that marked or
substantial correlation existed between study habit and process outcome in biology of ninth standard students. The result indicated that the extent of correlation between study habit (total) and process outcome in biology was higher in girls than in boys, in rural students than in urban, private school students than in government school students.

Dawson (2000) designed a study to test the hypotheses that there is a significant positive correlation between science process skills and correct understanding in photosynthesis, and that students who received explicit instruction in science process skills in a laboratory experience designed to promote conceptual change would have fewer misconceptions than students who did not. Results indicated that there was a significant positive correlation between science process skills and understanding of photosynthesis. The science process skill of hypothesizing showed the strongest correlation while that of prediction had the weakest. The author found no significant effect on understanding of the concepts of photosynthesis due to either explicit instruction in science processes skills or to performing an inquiry based, laboratory, designed to point out these misconception.

Brichen (2000) cited the importance of small group practical work and using ICT in promoting positive attitudes to science.

Nair (1999) compared over and under achievers in science with their achievement motivation. He found that achievement motivation of over achievers and under achievers was not significant. Nair (1999) also found that achievement motivation of pre-degree students studying in the regular stream was higher when compared with students studying in the correspondence stream.
Jayanthi (1999) studied the relationship between achievement motivation and achievement in natural science among the secondary school pupils of Palakkad Educational District. She found that achievement in Natural Science was positively related to achievement motivation for the total sample and related sub samples.

Seethamony (1997) and Mathews (1980) have shown that democratic attitude of parents have a positive relationship with academic achievement of children.

Ahuja (1995) made a study to determine whether the use of co-operative learning instructional strategy would influence the academic achievement, attitude towards science class and process skills of middle school science students. Findings of the study indicated that the use of a co-operative learning instructional strategy resulted in greater academic achievement and better attitudes towards science class of the students. The process skills were not influenced by instructional strategy.

Ebenezer and Zoller (1993) interviewed 72 randomly selected students that had been involved in an activity-based program. They found that classroom teacher behavior variables had more influence on student attitude than curriculum variables.

Veina (1991) studied achievement motivation and achievement in the school of Mexican and Anglo-American eighth grade students and found that there was no significant difference in the relationship between achievement motivation scores and the grade point averages and no significant difference in the relationship of boys and girls.

Gillen (1990) investigated the effect of teacher’s acquisition of science process skills, teacher’s implementation of hands on process oriented science instruction on elementary school pupil’s acquisition of science process skills. Pupil’s
acquisition of the science process skills was measured with the Test of Basic Process Skills (BAPS) among the primary grade pupils and the science process assessment among the upper elementary grade pupils. Students performed well in both tests, as indicated by central tendency measures.

**Poulose (1987)** assessed separately the possible influence of personality variables, sex and residence on process outcomes in physics of university entrants. The study revealed that i) Personal adjustment and manifest anxiety had influence on process outcomes in physics. But social adjustment was not having any significant influence on process outcomes in physics. 2) Sex has a dominant influence on process outcomes in physics. Male subjects were seen to be superior to the female subjects in their process achievement. 3) Residence of subjects exerts a significant influence on process outcomes and urban subjects were seen to be superior to rural subjects in their process achievement.

**Mathews (1987)** in her study on certain familial attitudes, parental expectations and child-rearing practices related to academic achievement of children, found that the expectation scores on education, wealth and health are higher in the urban groups.

**Seethamony (1987)** suggested that familial and social factors like ‘family environment’, ‘family acceptance’, ‘mutual trust and approval (within family)’, training for independence (within family)’, ‘father’s education level’ have emerged as the ‘most effective’ causal factors for underachievement.

In his doctoral study, **Suthan (1984)** viewed the quality of parent child interaction in the house as a key determinant of the child’s progress at school. The study has attempted to provide a six month period of educational intervention to improve those parent child interactions believed to directly affect the child’s school achievement. The major finding of the study is that the children’s performance at school and their development is closely related to what their parents do at home.
**Bharathi (1984)** conducted a study on self-concept and achievement motivation of early adolescents and found that the strength of achievement motivation increased significantly from twelve years to sixteen years. No sex differences were found in achievement motivation.

**Vardhini (1983)** developed a multimedia instructional strategy for teaching science (physics and chemistry) at secondary level. The study aimed to examine the relationship between achievement using the strategy and intelligence and scientific attitude. The strategy was found valid against the criterion of scientific attitude in that significantly higher performance was noted for the group in the post-test over the pre-test. A significant relationship was found between scientific attitude and achievement.

**Tiwari (1982)** found that study habit was positively correlated to the academic achievement. He also noticed better study habits in urban students in both the sexes. In general, girls showed better study habits. He identified attitude and amount of time spent as the two most important components of study habits.

**Sivappa (1980)** studied the factors affecting the academic achievement in high school pupils. He observed intelligence, manifest anxiety, educational aspirations and study habits as maximum contributing factors in predicting academic achievement.

**Keeves (1978)** noted that the structural variables of the home background are not significantly associated with final achievement in Mathematics or Science, but home attitudes were found to be associated with final achievement in these subjects.

In a study on the cause of low achievement among intellectually normal school children, **Mehta (1975)** found out the following factors that adversely affected the pupil’s achievement. They are (i) home environment (ii) lack of
encouragement and proper educational guidance (iii) poor economic conditions of
the parents (iv) lack of interest of parents (v) lack of interest of teachers (vi)
distance of home from school and (vii) inadequate curriculum

Levin et al (1974) conducted a study on the impact of the home
environment of students on academic achievement. The results suggested that
their more supportive home environments have been primarily responsible for the
relatively higher academic achievement of the students.

Bunsen (1968) conducted study on comparison of methods of science using
process approach. The results showed that the students exposed to the process
approach method scored significantly than the students who were unexposed to
that method.

Home remains as the main educational agency for mankind. Pestalozzi
(1792) regarded home as the one of the indispensable factors in the young child’s
training. Psycho-analysis (Freud: 1960; Erikson :1963) holds that the first five years
of the life of the children is the most important period. Early childhood experiences
are seen as crucial for character formation. In our culture, the family relationship is
the most frequent and pervasive of all social experiences. Walking, Sleeping,
eating, playing… the child “draws in” family ways with the very air he breathes. The
sociologists count cultural inheritance and home influences as the dominant factors
in the shaping of human character. The fact that the influences of the domestic
setting have fundamental part to play in education has been admitted by all.

According to Passow & Goldberg (1950) overachievement and
underachievement are symptomatic of a variety of basic personal and social
problems. The home and school environment may promote emotional and
personality problem leading to hostility in the children which in turn affects their
academic performance.
Summary:

The above studies throw light on the various context variables that may influence the science learner in achieving the expected science learning outcomes. A probe into the findings of the studies would lead education planners to arrive at flexible solutions for imparting the spirit of life-long learning in the learner.

(c) Studies relating to science instruction

The studies under this category include studies relating to the following areas:

- The science teacher and SPS / Achievement in Science
- Classroom practices and acquisition of Science Process Skills (SPS)

Breslyn and Mcginnis (2012) investigated the conceptions and enactment of inquiry for sixty National Board Certified Science Teachers across the secondary science disciplines of biology, chemistry, earth science and physics. They suggested that developing an understanding of the role of discipline in teaching with inquiry requires a theoretical framework to manage both the complex nature of teaching and the many contextual factors present in the classroom environment. A key implication was the critical importance of considering the discipline in understanding science teachers’ varied conceptions and enactment of inquiry.

Campbell et al (2011) pondered whether Model Based Inquiry (MBI) is a suitable mechanism for facilitating science as inquiry to allow students to develop deep understandings of difficult concepts, while also gaining better understandings of science process and the nature of science. Pre, post, and delayed revised versions of the Physics, Attitudes, Skills, and Knowledge Survey (PASKS) were administered to two groups of students. The PASKS focuses on student achievement in terms of science content, science process/reasoning, nature of science, and student attitude toward science. The findings revealed statistical differences when considering the pre, post, and delayed measures with significant
Review of Related Literature

differences found overall and on each scale, indicating improved achievement overall and on each scale with the exception of attitude scale for both groups.

**Ergul et al (2011)** used a pretest-post test control group and experimental group design to determine Turkish elementary school students’ level of success on science process skills and science attitudes and if there were statistically significant differences in their success degree and science attitudes depending to their grade level and teaching method. Results of the study showed that inquiry based teaching methods significantly enhance students’ science process skills and attitudes.

**Remziye et al (2011)** compared the effects of hands-on activities incorporating inquiry-learning approach on the development of 4-6th grade students BSPST and attitudes toward science, 7-8th grade students ISPST and attitudes toward science. The results showed that the scores of the experimental groups were higher than those of the control groups. Results of the study showed that use of inquiry based teaching methods significantly enhances students’ science process skills and attitudes.

**Elvan et al (2010)** studied the effect of Problem Solving Method on Science Process Skills and Academic Achievement. The sample of the research consisted of 86 3rd class teacher candidates who attended science teaching programme of Gazi Education Faculty. In this study, quasi-experimental design which was pre-test/post-test control group was implemented. The study displayed that experimental group students achieved higher mean scores than control group students in post science process skills. Also, the experimental group achieved higher mean scores in the post achievement test.

A study on the current status of teaching and learning science process skills in Anhui Province secondary schools by **Fang and Chen (2010)** using the survey method reveals that science teachers’ pedagogical knowledge level on the teaching
of science process skills in secondary schools is not quite high. They also found that the students’ science process skills are generally not quite high too.

**Harp (2010)** examined the relationship of teacher factors (ethnicity factor, gender, teaching experience, university selectivity etc.) on student achievement using eighth grade science TAKs in University of North Texas. No significant relationships between the variables were found.

**Schroeder (2010)** examined developmental and gender difficulties in grade 5 and 9 student’s views of uncertainty in science and the effect of classroom instruction on attitudes towards science, and motivation. **Study 1** examined views of uncertainty in a science classroom when students were taught science using constructivist pedagogy. Analysis found an interaction between grade and gender to the number of categories of uncertainty identified for both practical and formal science. Also, there was a positive correlation between the understanding of uncertainty in practical and formal science. **Study 2** compared the attitudes and instruction towards science and motivation of students in constructivist and traditional classrooms. Regardless of classroom instruction, fifth graders reported more positive attitudes towards science with ninth graders. Students from the constructivist classroom reported more intrinsic motivation than students from the traditional classrooms. Constructivists students’ views of uncertainty is formal and practical science did not correlate with their attitudes towards science.

**Panasan et al (2010)** aimed to compare learning achievement, science process skills and analytical thinking of fifth grade students who learned by using organization of project-based and inquiry-based learning activities, using cluster random sampling technique. They concluded that the plans for organization of project-based and inquiry-based learning activities were appropriately efficient and effective. Therefore, science teachers could implement both of these teaching methods in organization of activities as appropriate for learners to achieve in the future.
Skoolnick (2009) conducted a study to examine the constructivist based “case study teaching methodology” in High School Biology classes, specifically investigating the effect this methodology had on academic achievement, science attitudes, problem solving skills, and teamwork skills. The findings supported the case study teaching methodology as an effective application of constructivist theory in the secondary science classroom.

Mark (2009) examined the impact of collective teacher efficacy on high school science achievement by looking at relationships among collective teacher efficacy, its two constructs group competence and group task analysis, and high school science achievement scores at four rural high schools in Northwestern North Carolina. Analysis of the data revealed group competence is the major contributing factor for student achievement in biology and group task analysis is the major contributing factor for student achievement in physical science, chemistry, and physics.

Omer (2009) conducted a study with 30 students as experimental-1 group, 31 students as experimental-2 group and 30 students as control group to determine the effects of different laboratory techniques on students’ science process skills, views towards nature of science, attitudes towards laboratory and learning approaches in Science and Technology Course. The experimental-1 group received open-ended experiment technique and experimental-2 group received inquiry-based experiment technique while the control group received regular science education depending on the Science and Technology Curriculum (“Force and Motion” and “Electricity in Our Life” Units) over a period of 8 weeks. The results showed that there are significant differences among experimental-1, experiment-2 and control group students with respect to their science process skills and science learning approach in favor of experimental-1 and experimental-2 groups.
Modlin (2008) investigated the connection between student-teacher relationships and achievement. They suggested most students perceived that a relationship existed between student achievement and relationships they had with teachers, while most teachers’ perceptions were in contrast to the student’s perceptions. The research demonstrated that if students and teachers connect in the classroom with a more unified approach to building and sustaining positive student-teacher relationships, a more-prepared individual emerges contributing to the community, the workforce and society at large.

Zuelke (2008) conducted a study to determine the relationship between teacher qualities (experience certification type and science course work) and student achievement on the eighth grade science FCAT. The study showed that there was a significant difference at the low SES level in the eighth grade student mean Science FCAT scores among teachers with professional certification compared to teachers with temporary certification. There was no significant difference between professionally certified teachers and temporary certified teachers at the high SES level.

Coştu (2008) investigated effectiveness of PDEODE (Predict-Discuss-Explain-Observe-Discuss-Explain) teaching strategy in helping students make sense of everyday situations. For this, condensation concept was chosen among many science concepts since it is related to many everyday-life events. Forty-eight eleventh graders were involved in this study. In order to assess students’ application of their knowledge to problem solving in everyday situations, a test including two everyday problems were presented to them as pre- and post-test. As an intervention phase, two PDEODE tasks were utilized to teach condensation. The test scores were analyzed both by qualitative and quantitative methods. The results suggest that the PDEODE teaching strategy either facilitates students to help students make sense of everyday situations or helps students achieve better conceptual understanding of the concept of condensation.
Bilgin (2006) found that when hands-on learning activities are used together with cooperative learning approach, 8th grade students were more successful in SPS and had more positive attitudes towards science than the control group students following the traditional methods.

Walter & Soyibo (2001) discuss the change in the science programs that are mainly based on hands-on and minds-on activities done in laboratories, and such programs are based on basic and integrated science process skills. Their study suggests that the 7th, 8th and 9th grade students in the schools following the new program were more successful than those who were in the schools adopting traditional methods.

Roth and Roychoudhury (1993) worked with year 8 general science students and year 11 and 12 physics students in what they describe as open-inquiry laboratory sessions. They found that students develop higher-order process skills through non-traditional laboratory experiences that provided the students with freedom to perform experiments of personal relevance in authentic contexts. Students thus learned to (a) identify and define pertinent variables, (b) interpret, transform, and analyse data, (c) plan and design an experiment, and (d) formulate hypotheses.

Amma (1986) conducted a study on the strategies adopted by teachers for teaching science in upper primary schools of Quilon district. The major findings of the study were.

(i) For introducing a new lesson most of the teachers use lecture method.
(ii) Majority of the teachers provide good science club activities like conducting science Quiz and other competitions
Patricia (1971) investigated the effect of process approach on intelligence, reading comprehension and interest in science and reported about the effectiveness of process approach in enhancing the level of intelligence, interest of students. The reading ability was also found to be increased by this approach.

**Summary:**

The above studies emphasize the role of a science teacher in being instrumental in moulding his/her students fit for the twenty first century, by incorporating the expected instructional preferences in the science classroom. The science teacher and the classroom practices contribute fairly well towards the attainment of the science learning outcomes in the learner.

**Conclusion**

Conducting a literature review is not just a cognitive challenge, but also a management challenge. Through this review, the investigator has tried to characterize and summarize the relevant research done on the dissemination /development/ assessment/ acquisition of science process skills, achievement in science and other related variables, influence on the cognitive (achievement) and affective field components (scientific attitude and interest) of the learner at the secondary school level and the impact of classroom practices of the science teacher. The review of literature summarized above, flashes light on a few of the studies done in the field of science education, mainly in the recent years. A probe into the studies highlights the science process skills as a conceptual paradigm of education for global excellence.