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## **CHAPTER II**

### **REVIEW OF RELATED LITERATURE**

#### **2.0 Introduction**

Methodological review of past literature is a crucial endeavor for any academic research (Webster & Watson, 2002). This chapter is a summary of the collected literature related to the variables under study. The review of related study is preceded with the theoretical framework of the different variables considered for the study.

#### **2.1 Theoretical Frame Work**

A Research requires a strong theoretical foundation, which helps the investigator to proceed with the research in the right path. A theory provides orientation to research. The present study is based on the theoretical framework of Inquiry-Based Instruction , Achievement in Science, Science Process Skills , Attitude towards Science and Metacognition. Therefore, it is essential to make an in depth inquiry on the theoretical aspects of these variables. This chapter addresses the theoretical aspects of Inquiry-Based Instruction , Science Process Skills and Metacognition. in detail and then with the related studies conducted in the areas of Inquiry-Based Instruction , Achievement in Science, Science Process Skills , Attitude towards Science and Metacognition.

##### **2.1.1 Inquiry-Based Instruction**

It is important to remember that Inquiry-Based learning is not a technique or practice per se, but a process that has the potential to increase the intellectual engagement and deep understanding of learners, urging them to

- Develop their questioning, research and communication skills
- Collaborate outside the classroom
- Solve problems, create solutions, and tackle real-life questions and issues
- Participate in the creation and amelioration of ideas and knowledge

##### **The five steps of Inquiry Based Learning**

- Asking questions
- Probing into various situations
- Conducting analysis and providing descriptions
- Communicating findings, verbally or in writing
- Thinking about the information and knowledge obtained.

### **2.1.2 The principles in Inquiry Based Learning**

There are certain principles that govern Inquiry-Based learning and can be summarized as follows:

- Learners are in the centre of the entire process, while instructors, resources and technology are adequately organized to support them
- All learning activities revolve around information-processing skills
- Instructors facilitate the learning process, but also seek to learn more about their students and the process of inquiry-based learning
- Emphasis should be placed on evaluating the development of information-processing skills and conceptual understanding, and not on the actual content of the field

### **2.1.3 The four forms of Inquiry**

There are four forms of Inquiry that are commonly used in the Inquiry-Based Instruction such as

- **Confirmation Inquiry**

Learners are given a question, as well as a method, to which the end result is already known. The goal is to confirm the results. This enables learners to reinforce already established ideas and to practice their investigation skills

- **Structured Inquiry**

Learners are given the question and the method of achieving the result, but the goal is to provide an explanation that is already supported by the evidence gathered during and through the investigative process

- **Guided Inquiry**

Learners are only given a question. The main goal is to design the method of investigation and then test the question itself. This type of inquiry is not typically as structured as the previously mentioned forms

- **Open Inquiry**

Learners must form their own questions, design investigative methods, and then carry out the inquiry itself. They must present their results at the end of the process.

#### **2.1.4 Theories and Models of Inquiry-Based Instruction**

Dewey (1933), a renowned philosopher of education of the early 20th century, was the first to criticize the fact that science education was not taught in a way to develop young scientific thinkers. Dewey proposed that science should be taught as a process and way of thinking—not as a subject with facts to be memorized. While Dewey was the first to draw attention to this issue, much of the reform within science education followed the lifelong work and efforts of Joseph Schwab.

Schwab (1960) was one of the key founders of the Inquiry-based Learning Model that relies upon the idea that individuals are able to learn by investigating scenarios and problems, and through social experiences. The Inquiry-based Learning Model emerged in the 1960s, during the discovery learning movement and relies upon the idea that individuals are able to learn by investigating scenarios and problems, and through social experiences. Rather than having to memorize information from printed materials, instructors encouraged their students to conduct investigations that would satisfy their curiosity, help them broaden their knowledge base and develop their skills and mental frames.

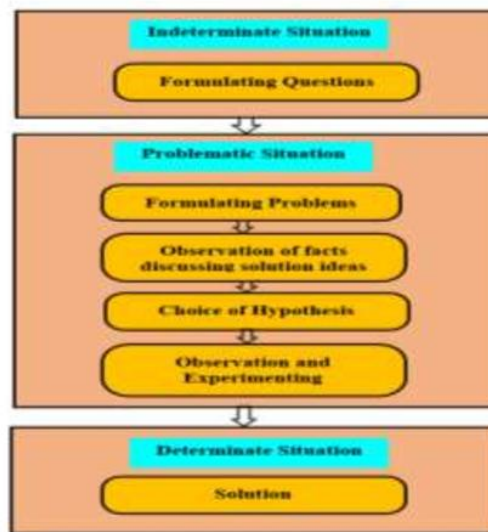
Inquiry Based Learning provides the perfect platform for the exploration of science and nature. In fact, many of the best inquiry-based learning science activities are the simplest, stemming from the experiences we have with the things around us. The activities provide below use the familiar processes or objects we encounter every day.

Following are examples of Inquiry Based Learning Model.

##### **(a) John Dewey Structure of Inquiry (1933)**

John Dewey was one of the key founder of the Experimental learning approach. His conception of reflective thought and learning was naturalistic one. Adaptation of environment forms the ways of doing things for an individual. When an uncertainty or problem emerges, and calls for reflective thought, an individual need to thought and investigate, formulate hypothesis and test it. The situation is not a separate object or event, or a series of isolated objects or events but rather objects or events which are connected to a contextual whole (Dewey, 1938). The findings can be replaced by a ‘reconstructive’ way.

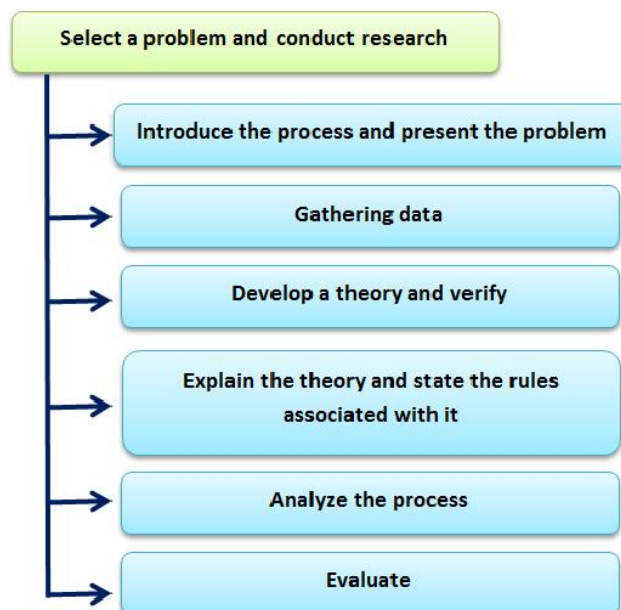
Figure 2.1 John Dewey's Inquiry Model



**(b) Suchman Inquiry Model -1962**

Richard Schuman's Inquiry Model (1962) supported that students should become autonomous and self-directed learners. The strategy presents a puzzling problem related to a concept. He called a problem as discrepant event. The students have to propose hypothesis that would explain the phenomena by asking questions. The teachers can answer with yes, no or may be. The model facilitates the learners to think through a problem and ask questions to find a solution.

Figure 2.2 Suchman Inquiry Model



**Select a problem and conduct research.** It should be interesting and meaningful for students' lives.

**Introduce the process and present the problem.** Explain that students may only ask teachers questions that can be asked in a yes or no fashion.

**Gather data.** Respond to questions posed by the students for the purpose of gathering and verifying data. Guide the students to ask questions more clearly, but avoid restating the questions for them. Encourage students to call a caucus when they need to talk to one another, but do not permit students to talk to each other during the questioning periods.

**Develop a theory and verify.** When a student poses a theory, stop the questioning and write the theory for all to see. The class then decides to accept the theory or reject it.

**Explain the theory and state the rules associated with it.** Once a theory has been verified by the students, lead them into an explanation and application of the theory.

**Analyze the process.** Discuss the inquiry process with students, and have them evaluate how they arrived at the theory and how they could improve the process.

**Evaluate.** This model uses the steps employed in scientific inquiry to approach problems in general. Inquiry learning requires students to take an active role with the material through challenging and questioning solutions. This model enhances higher-order thinking skills and problem-solving abilities.

### **(c) Kathy Short Inquiry/ Authoring Cycle**

Kathy Short developed the Inquiry/ Authoring Cycle in the year 1996. The logical step is inquiry for the teachers, who have been exploring process approaches and thematic units in various subjects. Inquiry cycle provides one possible curricular framework for supporting inquiry in classroom. Six teachers were collaborated with each other and with students to explore curriculum through inquiry. The concept of discovery were used and the students were involved in a range of activities through curriculum based thematic units. Learning together through inquiry is an accessible guide to applying the inquiry cycle and negotiating curriculum around a broad concept.

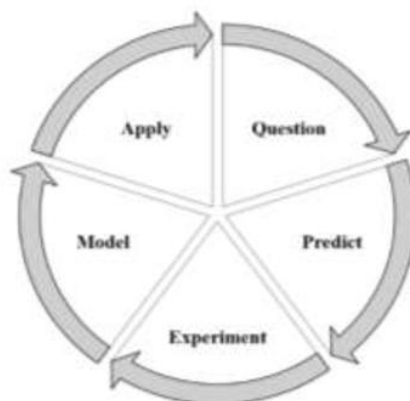
Figure 2.3 Kathy Short Inquiry/ Authoring Cycle



**(d) White and Frederickson (1998) Inquiry Cycle**

White and Frederickson (1998) proposed an inquiry cycle that identifies five inquiry phases namely Question, Predict, Experiment, Model and Apply. The Model supports the engagement of students in an authentic scientific discovery process. Following is a model of White and Frederickson Inquiry Cycle.

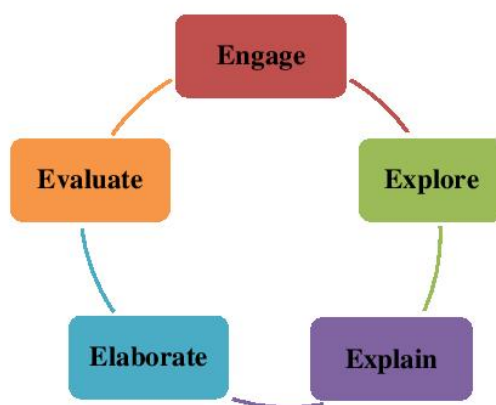
Figure 2.4 White and Frederickson Inquiry Cycle



**(e) 5E-Learning Cycle**

5E inquiry model was introduced first by Roger Bybee (1987) of Biological science curriculum study. 5E Inquiry model is an instructional model based on the constructivist approach to learning, which emphasises that learners construct new ideas based on their earlier experiences and old ideas.

*Figure 2.5 5E- Learning Cycle*



**Engage:** Students are engaged with a challenging situation prior knowledge is activated, questions are provoked.

**Explore:** Students investigate the phenomenon, prior knowledge is challenged, and ideas are created.

**Explain:** Students explain the phenomenon, new knowledge is gained and applied.

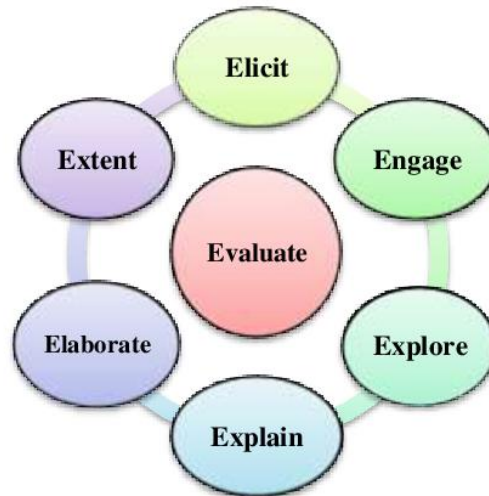
**Elaborate:** Students apply their knowledge towards new situations, knowledge is deepened and extended.

**Evaluate:** Students reflect on their knowledge and the learning process, assessment.

**(f) 7E-Learning Cycle**

The 7E-Inquiry model developed by Eisenkraft (2003) differs from the 5E learning cycle in two ways- the engage element is expanded into two stages as Elicit and Engage and places a greater emphasis on prior experience and elicits tacit knowledge used as a foundation for learning. Similarly, the two stages of elaborate and evaluate is changed to three components-elaborate, evaluate, and extend.

Figure 2.6 7E-LearningCycle



### **Elicit**

Make the students interested and ready to learn, excite the students, ask questions to students, elicit responses from the students, and pose problems to students.

### **Engage**

It gives importance to activating prior knowledge, making connections to previous lessons, asking questions, grabbing students' attention, generating curiosity, and motivating students. The different ways to activate prior knowledge and engage students include presenting a challenge to be solved, conducting a demonstration, using video clips related to the content, sharing experiences by both teacher and students.

### **Explore**

Activate hands-on activities, where students observe and gain experience with the phenomena being studied. Students collaborate during this step. The teacher is a facilitator and may provide feedback. The different ways to make students explore include, activities where students plan and perform experiments, make graphs, develop hypotheses, provide opportunities for making observations and collecting data, provide opportunities to interpret results, and organize findings.

### **Explain**

In this stage, the students analyze their data, observations and begin to form ideas. This is where the teacher may facilitate discussions; provide definitions and explanations of concepts. The teacher can explain the terminology and definitions, laws, theories and

provide students with questions to guide them and help them by facilitating the connection between the exploration of concepts and matching vocabulary to explain their results. The teacher can provide an opportunity for students to go back and attempt the activity again after it has been explained.

### **Elaborate**

This stage gives an opportunity for students to apply their knowledge to new domains, by asking new questions and formulating new hypotheses to explore. The elaboration can be said to have a connection with the psychological construct called transfer of learning.

### **Evaluate**

A continuous and comprehensive evaluation, including both formative and summative assessment, needs to be carried out throughout all stages of the cycle. It could be done by using different methods and techniques like observation, graphic organizers, and activities like a discussion. Ask questions relating to in-class investigations. Ask students to design experiments, draw conclusions from results, and interpret similar data.

### **Extend**

In this step, the teacher helps the students to analyze the results and generate new questions and develop new hypotheses, apply knowledge to alternative concepts, new situations, and provide students with a new practice. These steps may cycle back through explain and explore several items.

## **2.1.5 Inquiry Based Science Education**

Inquiry learning has been used as a teaching and learning tool for thousands of years, however, the use of inquiry within public education has a much briefer history. Ancient Greek and Roman educational philosophies focused much more on the art of agricultural and domestic skills for the middle class and oratory for the wealthy upper class. It was not until the Enlightenment, or the Age of Reason, during the late 17th and 18th century that the subject of Science was considered a respectable academic body of knowledge. Up until the 1900s the study of science within education had a primary focus on memorizing and organizing facts. Unfortunately, there is still evidence that some students are still receiving this type of science instruction today.

### **2.1.6 Achievement in Science**

Academic achievement is a set of educational goals that are achieved by the student, and is strongly related to the mental ability of the students, which reflects the ability of the student to accomplish a particular work through the actions of sensory and mental, where this ability varies from person to person.

Academic achievement is commonly measured through examinations or continuous assessments but there is no general agreement on how it is best evaluated or which aspects are most important procedural knowledge such as skills or declarative knowledge such as facts. Students academic performance depends on a number of socio-economic factors like test anxiety, environment, motivation and emotions require conservation when developing models of school achievement student's attendance in the class, family income, mothers and father's education, teacher student's ratio, presence of trained teacher in school, sex of the student, and distance of the school.

Achievement in Science refers to the extent to which a learner is profiting from instructions in science. It indicates the knowledge attained and skill developed in the science subject, generally designated by test scores.

### **2.1.7 Science Process Skills**

The Enhanced Basic Education Act of 2013, states that every graduate of basic education shall be an empowered individual who has learned, through a program that is rooted on sound educational principles and geared towards excellence, the foundations for learning throughout life, the competence to engage in work and be productive, the ability to coexist in fruitful harmony with local and global communities, the capability to engage in autonomous, creative, and critical thinking, and the capacity and willingness to transform others and one's self. For this purpose, the State shall create a functional basic education system that will develop productive and responsible citizens equipped with the essential competencies, skills and values for both life-long learning and employment.

Based on the K-12 science curriculum's conceptual framework, science education aims to develop scientific literacy among students that will prepare them to be informed and participative citizens who are able to make judgments and decisions regarding applications of scientific knowledge that may have social, health or environmental impacts. It integrates science and technology in the civic, personal, social, economic and

the values and ethical aspects of life. It is designed around the three domains of learning science: understanding and an applying scientific knowledge, performing scientific process and skills and developing and demonstrating scientific attitudes and values.

Science Process Skills are the things that scientists do when they study and investigate. Observing, Classifying, Communicating, Measuring, Inferring and Predicting are among the thinking skills used by scientists, teachers and students when doing science. Much of the pleasure of both learning and teaching science is experiencing science. Mastering these process skills will help use develop the kind of science program that mirrors real science (Rezba, et al., 1995).

Science as an academic discipline relates learning the key concepts, as well as the processes of science. The increasing value of Science Process Skills poses a serious challenge of finding ways to amend teaching as a means of elevating these educational outcomes. Recent revitalization of interest in developing thinking skills has encouraged added importance on process skills instruction.

Development of basic process skills is important as well as development of proper scientific attitude and values. Science Education aims to train students to think like scientists and emphasis would be expected on the development of attitude that good scientists are able to display (Opulencia, 2011). One of the purpose of teaching is inculcation of desirable attitudes and values (Pacia, 2014). Shaping students' attitudes, behaviors, and motivations is necessary today for without these broader skills and strengths, students will be unprepared for the challenges they, and their world, will face (Miller, 2017).

Process Skills and Attitude toward Science are important elements that may influence students' performance. According to Johnston (2009), Science Process Skills are significant in improving students' cognitive development and facilitating students' active participation during the teaching and learning process Attitude toward science is positively correlated with science achievement (Papanastasiou and Zembylas, 2004). Developing mastery in basic process skills and positive Attitude toward Science is aiming for quality students' performance. The students' performance (academic achievement) according to Mushtaq and Khan (2012) plays an important role in producing great leader and manpower for the country thus responsible for the country's economic and social

development. The researcher believes that basic process skills mastery and attitude toward Science may affect the performance of Grade VII students. This study was conducted to prove the correlation of the aforementioned variables

### **2.1.8 Attitude towards Science**

Scientific attitudes are the most important outcomes of the science teaching. Though some people view the scientific attitudes as the by-products of teaching science, yet a majority of the people consider them as equally important as the knowledge aim. Science should be taught directly and systematically because developing scientific attitude is very essential for teaching and learning science

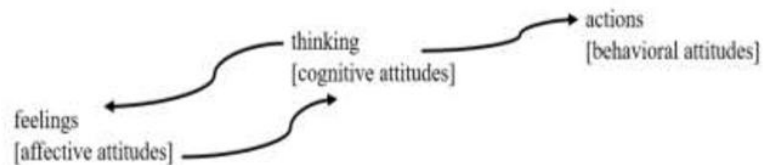
#### **2.1.8.1 A Man with Scientific Attitude**

The scientific attitude of an individual helps to be critical in observation and thought, and open minded. It helps to be curious about the things around, respect others points of view and to change their decision on presentation of new and convincing evidence. It is objective and does not believe in superstitious and false beliefs. Scientific attitude of an individual suspends judgments until suitable support is obtained and believes in cause and effect relationship. It supports a person to be truthful in his observations, adopt a planned procedure in problem solving, draw conclusions, unbiased, and impartial on the judgments. One of the key factors of scientific attitude is, it believes on truth that never changes but may alternate the ideas which already exists. Finally, the scientific attitude seeks the most recent, authoritative, and accurate evidence related to the problem and adopt various techniques to solve the problem to establish the facts.

Attitudes can be described as postures or positions adopted or expression of views or thoughts that have an effect on behaviour, ideas or emotions. This has led to a tripartite view of attitude, arising out of Hovland's Learning Theory Model (Hovland, Irving & Kelly, 1963) which separates affective, cognitive and behavioural aspects of attitude. This division has been both useful and confusing and there does appear to be as much overlap as division, with interaction occurring between the way an individual feels and the way they think and act. Indeed, we can argue that affective attitudes are the root of both cognitive and behavioural attitudes, so that how we behave is a result of how we think and an inter-relation of how we feel and think.

In science and science education, the major division has been in terms of scientific attitudes, that is cognitive and behavioural attitudes necessary to undertake scientific inquiry, to be scientific, and attitudes towards science or affective attitudes (Gardner 1975, Johnston 1996).

*Figure 2.7 Hovland's Learning Theory Model*



### **2.1.9 Metacognition**

Metacognition is defined most simply as thinking about thinking. Metacognition consists of two components: knowledge and regulation. Metacognitive knowledge includes knowledge about oneself as a learner and the factors that might impact performance, knowledge about strategies, and knowledge about when and why to use strategies. Metacognitive regulation is the monitoring of one's cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies. Metacognition also improves with appropriate instruction, with empirical evidence supporting the notion that students can be taught to reflect on their own thinking. Assessment of metacognition is challenging for a number of reasons: (a) metacognition is a complex construct; (b) it is not directly observable; (c) it may be confounded with both verbal ability and working memory capacity; and (d) existing measures tend to be narrow in focus and decontextualized from in-school learning. Recommendations for teaching and assessing metacognition are made.

#### **2.1.9.1 Definition of Metacognition**

John Flavell originally coined the term metacognition in the late 1970s to mean cognition about cognitive phenomena, or more simply thinking about thinking (Flavell, 1979, p. 906). Subsequent development and use of the term have remained relatively faithful to this original meaning. For example, researchers working in the field of cognitive psychology have offered the following definitions

- The knowledge and control children have over their own thinking and learning activities (Cross & Paris, 1988, p. 131)

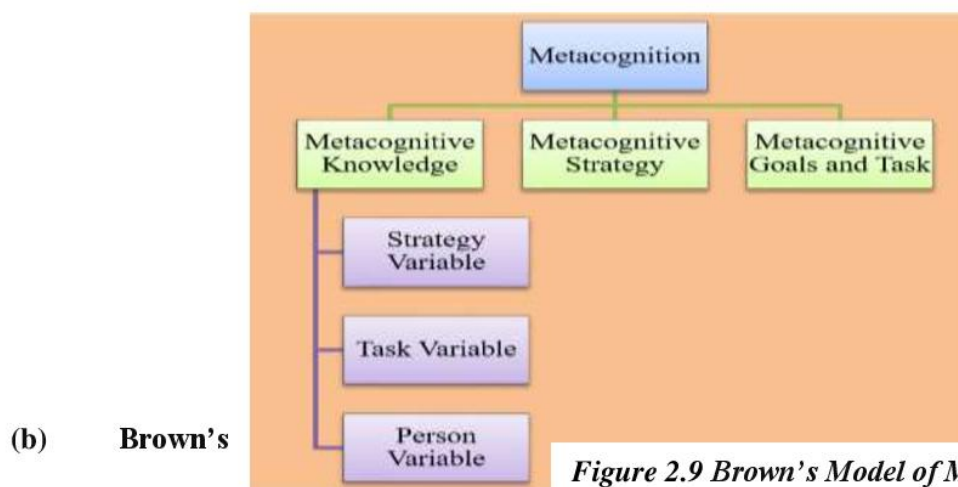
- Awareness of one's own thinking, awareness of the content of one's conceptions, an active monitoring of one's cognitive processes, an attempt to regulate one's cognitive processes in relationship to further learning, and an application of a set of heuristics as an effective device for helping people organize their methods of attack on problems in general (Hennessey, 1999, p. 3)
- Awareness and management of one's own thought(Kuhn & Dean, 2004, p. 270)
- The monitoring and control of thought (Martinez, 2006, p. 696) ]

### **2.1.9.2 Models of Metacognition**

#### **(a) Flavell's Model of Metacognition**

Flavell (1979), proposed a formal model of metacognitive monitoring. The model includes four classes of phenomena i.e.(a) metacognitive knowledge,(b) metacognitive experiences, (c) tasks and goals, and (d) strategies and actions. First of all, he defined metacognitive knowledge as one's knowledge or beliefs about the factors that effect cognitive activities. The second class of phenomena was metacognitive experiences includes the subjective internal responses of a person to his own metacognitive knowledge. Goals and tasks, the third class phenomena,were the desired outcomes of a cognitive venture, includes comprehension, committing facts to memory, or producing something e.g. a written document. Achievement of a goal draws heavily on both metacognitive knowledge and metacognitive experience for its successful completion (Flavell, 1979)

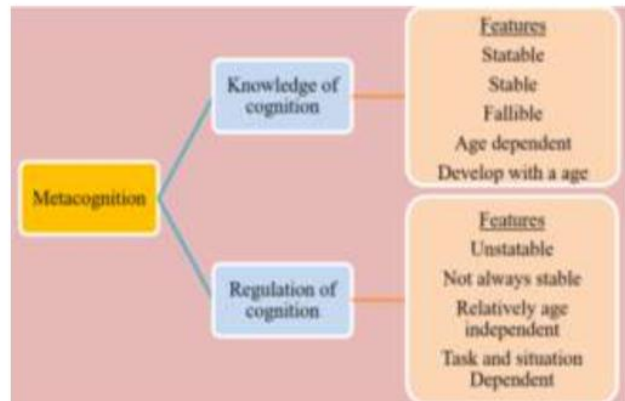
*Figure 2.8 Flavell's Model of Metacognition*



*Figure 2.9 Brown's Model of Metacognition*

**Model of Metacognition**

Brown (1987) divided metacognition into two broad categories (1) knowledge of cognition, as activities that involve conscious reflection on one’s cognitive abilities and activities and (2) regulation of cognition, as activities regarding self-regulatory mechanisms during an ongoing attempt to learn or solve problems. According to

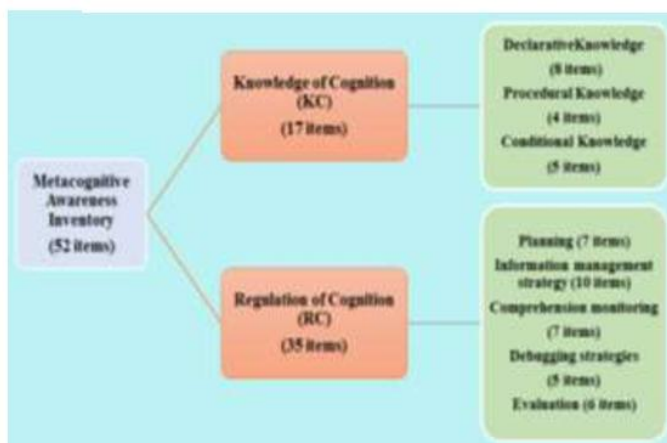


Brown, this two forms of metacognition are closely related. Each feeding on the other recursively, although they can be readily distinguishable. This model emphasis the executive processes, stressing the importance of the control that people bring or fail to bring cognitive endeavours. Moreover, Brown points to important characteristics of regulation of cognition, that have to be taken into account for those interested in the applications of these concepts into instructional research.

**(c) Schraw and Dennison Model of Metacognition**

Schraw and Dennison (1994) defined Metacognitive Awareness as referring to the ability to reflect upon, understand, and control one's learning to some extent. The Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison, 1994 was used to assess the Metacognitive

*Figure 2.10 Metacognitive Awareness Inventory*



Awareness of the sample selected for the investigation. The MAI, which is a 52 item inventory, is a wide-scale evaluating various facets of metacognition.

### **Knowledge of Cognition**

Knowledge of cognition or metacognitive knowledge refers to knowledge individuals have about themselves as cognitive beings, capabilities, and limitations. Knowledge of Cognition consists of declarative, procedural, and conditional knowledge (Schraw and Dennison, 1994) as its subcomponents.

### **Declarative Knowledge**

It includes knowing about the self and strategies or factors that influence performance and is, therefore, a more objective type of knowledge.

### **Procedural knowledge**

It refers to the application of knowledge to complete a procedure or process. It includes knowing how to use different strategies in various situations.

### **Conditional knowledge**

This knowledge refers to knowing when, how, and why to implement the different strategies. These three types of knowledge are believed to assist the reflective aspect of metacognition.

### **Regulation of cognition**

The second component of Metacognitive Awareness is regulation of cognition, reflecting on people's perception about how they plan, monitor, comprehend, and evaluate the strategy. The component is further subdivided into five sub-components, namely, planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation.

### **Planning**

Planning refers to setting goals, selecting strategies or resources, and it is usually used in learning. It is about goal setting, what to learn, when to learn, and how to learn.

### **Information management strategies**

This refers to the structure of skills and strategies used to effectively process information such as organizing, summarizing, and elaborating.

### **Comprehension Monitoring**

This refers to the assessment of learning or strategy use. It involves checking about one's own progress and comprehension, about what alternatives are available, and whether the strategies are useful to understand the content.

### **Debugging Strategies**

This refers to the strategies used to correct errors in comprehension and performance. It involves deciding about different strategies when facing difficulties, such as what should be done if one does not understand.

### **Evaluation**

This refers to the evaluation of performance and the effectiveness of the strategy used after learning has occurred. These subcomponents are believed to assist in the control of learning Schraw and Dennison (1994).

## **2.2 Review of Related Studies**

Every ongoing research needs to be linked with the work already done, to attain an overall relevance and purpose. The review of literature thus becomes a connection between the research proposed and the studies done already. Studies conducted in India and Abroad in the field of Inquiry-Based Instruction , Achievements in Science, Science Process Skills , Attitude towards Science and Metacognition are reviewed in this section. These studies are being given under various subheadings.

### **2.2.1 Studies Related to Inquiry- Based Instruction**

Marfilinda et al. (2020) studied the effect of 7E learning cycle model toward students' learning outcome of basic science concept. This research is a quasi-experimental study with a randomized pretest-posttest control group design. The sample consisted of 24 control class students and 28 experimental class students. The experimental class uses the 7E Learning Cycle model while the control class uses the conventional model. The data collection technique is in the form of a learning outcome test (cognitive). The study reported that, there were differences in student learning outcomes taught using learning model Cycle 7E and conventional learning. Learning with 7E Learning Cycle model gives an effect of 72% (moderate) to the improvement of student learning outcomes in the Basic Science Concept Course.

Maskur et al. (2019) studied the 7E Learning Cycle Approach to understand Thermal Phenomena. This research intended to reveal the effectivity of physics learning using the 7E Learning Cycle in improving students' understanding of temperature and heat concepts. The research design was quasi-experimental with a non-equivalent control group design. The sample consisted of 240 senior high school students. Cluster random sampling technique was used in the study. Objective test in the form of multiple choices equipped with reason was employed as the data collection instrument. The use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. This could be seen from the success of the learning process that integrates the whole seven stages with the seven indicators of conceptual understanding in detail.

LabaLaksana et al. (2019) examined the effects of inquiry-based learning and learning style. This research was factorial experiment with the quasi-experimental design. There were total of 157 primary school students in Bali, Indonesia being involved as the subjects of the study. There were two instruments used in this research. The first instrument was a questionnaire adapted from Index of Learning Style (ILS) developed by Felder and Solomon for measuring the verbal-visual learning styles. The second instrument was the conceptual understanding test for measuring students' conceptual understanding in the form of multiple-choice test. The research discovered that there was a significant difference in terms of conceptual understanding between students who are taught by inquiry-based learning and direct instruction strategy.

Wibowo and Suyanta (2019) studied Integrated thinking ability and activities on eleventh grade students through learning cycle 7E. The quasi experimental model with Post-test only design was used as a research design. Sixty students were randomly selected for this study and then divided into two groups- there are 28 students in the experimental group who were taught by using the 7E learning cycle and 32 students in the control group taught by the expository model. Data were collected using the following two instruments: 5-item integrated thinking ability test, and 29 questionnaire statements of student's activity. Multivariate Analysis of Variance (MANOVA) was used. The results showed that students who learned using 7E learning cycle and the expository model had statistical differences in integrated thinking ability and activities towards chemistry learning at 0.05 level of significance; the students who learned using the 7E learning cycle showed more integrated thinking ability than did the students who learned using the expository model.

Amoah et al. (2018) investigated the effect of inquiry-based learning approach in science on junior high school students in paradise international school. The study employed the Quasi-experimental research and action research methods under both quantitative and qualitative paradigms of research design. The selection of the school was done through purposive sampling method. The research participants were JHS 2 students (N=30) in two science classes at the research school. The traditional class was the control group. Two data collection instruments -Science Knowledge Assessment and Engagement checklist were used. It was found out that inquiry based teaching allow students to engage, discover, draw conclusions and report their findings increased their abilities to reason and problem solving. It was recommended that discussion in science should be the focus of enquiry based learning.

Naade et al. (2018) investigated the effect of 7E's constructivist approach on students' achievement in electromagnetic induction topic in senior secondary schools in Rivers State, Nigeria. The study employed a quasi-experimental design. Specifically, it was a pretest Post-test non-equivalent control group design. Two intact classes were randomly selected from each school, making a total of four intact classes of 58 Senior Secondary physics students. Results from the study showed that the mean score of the experimental group was higher than the mean score of the control group. The study also revealed that there was statistically significant difference between the mean scores of those exposed to 7E's constructivist approach and those exposed to the traditional method. Therefore, it was recommended that teachers should use 7E's constructivist instructional model in teaching science subjects.

Sandika and Fitrihidajati (2018) made a research on Improving Creative Thinking Skills and Scientific Attitude through Inquiry-Based Learning in basic Biology Lecture toward Students of Biology Education. The study aimed at improving creative thinking skills and scientific attitude through inquiry-based learning in basic biology lecture toward students of biology education at the Institute Agama Islam Negeri (IAIN) Jember, Indonesia. The research focused on the topic of cell transport which was taught toward 25 students of Biology 2 class from 2017 academic year of Biology Education Department at the IAIN Jember. The enhancement of students' creative thinking skills was determined by one group Pre-test and Post-test research design using test instrument meanwhile the scientific attitude focused on curiosity and objectivity were observed using the non-test

instrument. Research result showed that students' creative thinking skills enhanced highly and students' scientific attitude improved excellently through inquiry-based learning in basic biology lecture.

Sarac (2017) studied Effect of multimedia assisted 7E learning model applications on academic achievement and retention in students. In this research, a quadruple pattern of Solomon was used as a semi-experimental design. As a data collection tool, the Matter's Change Unit Success Test was used. Ninety-two fifth grade students were participated in this study. Experimental groups were given instructional materials prepared according to 7E model with multimedia support and control groups were taught with traditional method. According to the analyzed results; there is a statistically significant difference between the Post-test and retention test scores of the experimental groups. There is also a statistically significant difference between the Post-test and retention test scores of the control groups. But this difference is in favor of experimental groups. According to the results of the study, it can be said that the learning material prepared according to the multimedia supported 7E model influenced the academic achievement positively and the learned information is more memorable.

Nurhadi et al. (2016) studied Implementation of Inquiry Based Learning to Improve Understanding the Concept of Electric Dynamic and Creative Thinking Skills (An empirical study in Class IX Junior High School Students State 4 Kendari). The research approach was an experiment with the design of The Randomize pretest-posttest control group that carried out in grade IX junior high school students 4 Kendari for the school year 2015/2016. Collecting data through instrument (questionnaire) was performed using the initial test and final test for the understanding of the concept and creative thinking skills of students. Results of this study gained an average of N-gain students understanding of the concept of 0.49 for the experimental class and 0.22 for control class. Results of hypothesis testing using t test and Mann Whitney (Utes) two independent samples showed that an improved understanding of the concepts and creative thinking skills of students who take the inquiry-based learning is higher than students who take conventional learning.

Marshall et al. (2016) found Inquiry-based instruction: A possible solution to improving student learning of both science concepts and scientific practices. The study, involving 219 teachers and 15,292 students, examined the relationship between teacher

participation in a sustained professional development (PD) intervention designed to improve the quantity and quality of guided inquiry-based instruction in middle school science classrooms and subsequent student academic growth. Utilizing a quasi-experimental design, the growth scores of students of participating and non-participating teachers were compared to a benchmark measure established by a virtual comparison group (VCG) of similarly matched students. The results indicate that for all three Measures of Academic Progress (MAP) tests (Scientific Practices, Science Concepts and Science Composite) the students of participating teachers had significantly higher than expected growth relative to the VCG when compared to students of non-participants.

Parkash and Hooda (2016) carried out a comparative Study on the Effectiveness of Science Inquiry Model and Advance Organiser Model in Achievement in Biology. In this research study, Pre-test, experimental treatment, and Post-test design were used. The sample 120 students were divided into three groups of students, two experimental groups, and one control group. Purposive sampling was used for the research study. Students in Experimental Group-I were taught Biology through Science Enquiry 49 Model. Experimental Group-II was taught Biology by using Advance Organizer Model and the Control Group was taught Biology by using Conventional Method. Results revealed that the students who were taught Biology through Science Inquiry Model and Advance Organiser Model had shown more significant improvement in the Achievement in Biology than the students who were taught through the Conventional Method.

Shaheen (2015) studied improving students' achievement in biology using 7E instructional model: An experimental study. The main purpose of the study was to compare the effectiveness of the instruction based on 7E Instructional Model and Traditional Instructional Model for the teaching of Biology on 9th grade students' achievement. Pretest posttest control group design was used in this study. A total number of 122 ninth grade students (62 boys and 60 girls) from four classes of a biology course of two schools were purposively selected. The students in the control group were instructed with traditional instructional model, while the students in the experimental group were instructed with 7E Instructional model. It was concluded that the 7E instructional model was more effective than the traditional instructional in terms of students' achievements.

Adesoji and Idika (2015) found effects of 7E Learning Cycle Model and Case-Based Learning (CBL) Strategy on Secondary School Students' Learning Outcomes in

Chemistry. A total of two hundred and eight (208) chemistry students participated in the study. The study adopted pretest, posttest, control group, quasi-experimental design. Data collected were analyzed using analysis of covariance (ANCOVA). Multiple classification analysis (MCA) was used to present the magnitude of the mean scores while Scheffemultiple range test was used for post-hoc test to determine the source(s) of significant main effects. The two strategies, 7E learning cycle model and CBL, were found to be more effective in improving senior secondary school students' achievement in and attitude to chemistry than conventional teaching strategy. However, CBL proved to be the most efficacious. Therefore, it was recommended that, chemistry teachers should adopt constructivist/inquiry methods like 7E learning cycle model and case based learning as these strategies will help students perform better in chemistry and also positively enhance the attitudes of many more students to the subject.

Samsudin (2015) investigated comparing the effect of inquiry-based multiple intelligence approach and non-inquiry based multiple intelligence approach on achievement in science. The study employed a quasi-experimental research design that used two intact classes of thirty (30) pupils each assigned to two groups, the inquiry-based group (A) and a non-inquiry based multiple intelligence approach group (B). The study employed a quantitative analysis of descriptive statistics and inferential statistics in a bid to compare the effects of the two teaching approach. The mean, median and standard deviation with the ANCOVA were found suitable statistical test for comparing the effects of two different interventions as well as to confirm of there exist any statistically significant difference for the mean variables between the two groups after controlling newly formed defendant variables means on one or more covariates were used. Result shows that the inquiry-based multiple intelligence approach was better in arousing pupils' interest to learning science.

Abdi (2014) studied the Effect of Inquiry-based Learning Method on Students' Academic Achievement in Science Course. A total of 40 fifth grade students from two different classes were involved in the study. They were selected through purposive sampling method. The group which was assigned as experimental group was instructed through inquiry based learning method whereas the other group was traditionally instructed. The experimental study lasted eight weeks. To determine the effectiveness of inquiry-based learning method over traditional instruction, an achievement test about

science which consisted of 30 items was administered as Pre-test and Post-test to students both in the experimental and control groups. For the statistical analysis, Analysis of Covariance (ANCOVA) was used. The results showed the students who were instructed through Inquiry – based learning achieved higher score than the ones who were instructed through the traditional method.

Singh and Chirayu (2014) found Effectiveness of Inquiry Training Model for Teaching Chemistry at IX grade level. A total of 120 students participated in the study. The study was designed to prepare study material for teaching chemistry for class IX using inquiry training model, study the effectiveness of inquiry training model on academic achievement of students and compare the academic achievement of students studying through inquiry training model and traditional method for teaching chemistry. The researcher selected the two groups randomly each comprising 60 students and were labeled as experimental group and control group. The students of control group were taught with traditional method while the students of experimental group were taught with inquiry training model. Result showed that there was a statistical significant effect of Inquiry Training Model over conventional teaching method on academic achievement of students. It was observed that the students taught with Inquiry training method performed better than the students taught with traditional method.

Smitha and Rao (2011) conducted a research study to find the relative effectiveness of two approaches of teaching (Inquiry Training Model and guided discovery learning). A Pre-testPost-test quasi-experimental design with a 3×2 factorial matrix was employed. One hundred and twenty six students belonging to three different sections of the eighth standard of a school were selected as the sample for the study. Two sections, consisting of 42 students each, were selected as experimental groups in which the Inquiry Training Model and Guided Discovery Learning were applied for teaching and the third section was the control group which used conventional lecture demonstration method. The study revealed that both teaching approaches, i.e., Inquiry Training Model and Guided Discovery Learning were equally effective in developing critical thinking in students and that both these approaches were more effective than the conventional lecture-demonstration method.

Blyth (2010) studied Effectiveness of using Inquiry-Based Instruction to Increase Students Performance in High School Biology as Bardwell Institute. A total of 128

students participated in this study. Students were taught using an inquiry based method of teaching and the traditional lecture method. Both groups also participated in laboratory activities. Teachers were randomly assigned to teach using either the traditional lecture method or teach using inquiry. The independent variables of this study were the traditional lecture method and inquiry method of teaching. The resulting dependent variable of the study was the knowledge gained by the students. Findings of the study was that the students who were taught biology using the inquiry method of teaching at Bradwell Institute scored higher on a standards based assessment than students who learn from the lecture/laboratory method of teaching.

### **2.2.2 Studies related to Achievement in Science**

Aliand Faaz (2019) attempted to find out the relationship and contribution of different variables (Scientific Attitude, Socioeconomic Status, School Environment and Parental Involvement) on the academic achievement of the Senior Secondary School Students. A sample involving 240 Students (130 Boys and 110 Girls) of class XI from different schools of both urban and rural parts of Aligarh district were drawn by employing Simple Random Sampling technique by using standardized tools. The findings of the study explored that all the four variables (Parental Involvement, Socio Economic Status, School Environment, and Scientific Attitude) had a positive contribution on the academic achievement of the senior secondary school students. The study also revealed a significant difference in the academic achievement of the students in relation to gender and locality.

Ma et al. (2018) studied Consistency of science achievement across science subjects among Chinese students and schools. A multivariate multilevel model was developed for secondary data analysis of 110,520 eighth grade students from 592 middle schools in China to examine the educational issue of consistency in science achievement across different science subjects among Chinese students and schools. Results indicated that Chinese students were highly consistent in science achievement across science subjects and this consistency did not depend on student and school characteristics. Meanwhile, Chinese schools were extremely consistent in science achievement across science subjects and this consistency did not depend on student and school characteristics.

Joseph et al.(2018) examined the synergy and relationship between academic achievement of students in Basic science and parent's socioeconomic and educational

status (SES), alongside school location. It adopted a correctional design to examine the relationship between parent's SES, educational level and the location of schools with students' academic achievement in Rivers State. The population of the study consisted of all the students in the selected schools in the three senatorial districts of the state; out of which a sample of two hundred (200) students were randomly selected. The study revealed that the educational background of the parents does not synergize with other variables to influence the academic achievement of students.

Samaresh (2017) found the effectiveness of constructivist approach on academic achievement in science at secondary level. investigated the effectiveness of constructivist approach on academic achievement in science at secondary level using Pre-test, post-test, experimental and control group design, with 58 samples grouped as experimental group (29) and control group (29) on the basis of matching by intelligence test. The investigators conducted this experiment over three weeks by using both traditional and constructivist 7E-model. The study found that the students exposed to the constructivist 7E-model significantly achieved better than traditional method. In addition, students exposed to the 7E-model performed significantly higher than those exposed to the traditional teaching method in respect of their gained scores at every intelligence levels.

Rizzo and Taylor (2016) analysed the studies related to Effects of inquiry-based instruction on science achievement for students with disabilities. Twelve studies, meeting inclusionary criteria, were included in the literature review with a total of 426 participants with disabilities. The twelve studies, meeting selection criteria, report improvement in science achievement using inquiry practices. The participants and settings, variations of inquiry-based instruction, science achievement measures, and teacher training were addressed in the review. Two major contributions have resulted from analyzing the twelve studies. First, students with disabilities require supports to participate in an inquiry-based lesson and demonstrate progress on science achievement measures. Second, science achievement improves when components of explicit instruction are utilized in both the general and special education setting for students with disabilities.

PritiKumari et al. (2015) aimed on the inquiry-based teaching model with aiming of delimiting the limitations of the traditional teaching model effortlessly. This quantitative study provide information obtained through the use of inquiry-based social science teaching verses traditional social science teaching in 9<sup>th</sup> class students of different schools belonging to both rural and urban areas. One hundred twenty students of 9<sup>th</sup> grade

have been representing the sample population. Results of data analysis showed that the students receiving instruction through inquiry based teaching showed significantly more improvement over the traditional teaching model.

Supasorn and Lordkam (2014) aimed to enhance students' learning achievement of matter separation by using five science inquiry learning activities (12 hours) on separation of natural substances. The participants, purposively selected, were 33 Grade 7 students in the first academic semester of 2011 at Ban-Nat hung School in Sisaket province of Thailand. The data collecting tools consisted of a learning achievement test of matter separation and a survey of students' attitudes towards learning science. In conclusion, the implementation of inquiry learning activities was effective to enhance students' learning achievement of matter separation as well as their attitudes towards learning science.

Ahmar and Anwar (2013) examined the effects of gender and socio-economic status on academic achievement of higher secondary school students of Lucknow city. The sample consisted of 102 males and 98 females in age range of 15 to 19 from five higher secondary schools of Lucknow city Uttar Pradesh (India). The study showed that gender does not influence the achievement in science at higher secondary school (Standard-XI) level. Also the result of the study showed the difference between high and low socio-economic status groups. It was found that the academic achievement was influenced by the socio-economic status and those who belonged to high socio-economic status showed better performance.

Narmadha and Chamundeswari (2013) investigated the attitude towards learning of Science and academic achievement in Science among students at the secondary level. Using random sampling technique 422 students, from the secondary level in different systems of education, namely, state, matriculation and central board schools were chosen. Results showed that the students belonging to the central board schools have a higher level of attitude towards learning of Science compared to students in state board but did not differ with students in matriculation board schools at the secondary level. A positive correlation was found to exist between attitude towards learning Science and academic achievement in Science among the students.

Sheerasagar and Kavyakishore (2013) attempted to know the relationship of achievement in science and scientific attitude among students and found that there was no

significant relationship in achievement in science and scientific attitude. The sample for the present study consisted of 600 IX standard secondary school students of Bangalore city. The sample was drawn using stratified random sampling technique from government and private secondary schools in Bangalore city. The interpretation of the results prompted the researcher to draw the following important conclusions. The girls of IX standards have better Achievement in science than boys of IX Standard. The students of IX standard studying in private schools have better achievement in Science than the students studying in Govt. Schools.

Khan (2005) studied Scholastic achievement of higher secondary students in science stream. The study was conducted on 400 students (200 Boys and 200 Girls) selected from Senior Secondary School of Aligarh Muslim University (A. M. U.) Aligarh; India to establish the prognostic value of different measures of cognition, personality and demographic variables for success at Higher Secondary level in Science stream. A sample of students (N= 400) participated in the study. The score obtained on different variables were factor analysed to get a smaller number of meaningful variables or factors to establish the predictive validity of these predictors. Factors responsible for success in Science stream were identified. The prognostic value of the predictors was compared with high achievers and low achievers in order to identify the factors which differentiate them.

### **2.2.3 Studies related to Science Process Skills**

Herda et al. (2020) found the Science Process Skill Ability Level of Senior High School Students in Learning Chemistry in Jambi using survey method. 414 respondents of 11<sup>th</sup>-grade students (206 males, 208 females) of 16 schools in Jambi Province were studied by using a test on Science Process Skills . The research results showed that the students' achievements of Science Process Skills for each indicator were 60% (observing), 29% (measuring), 64% (classifying), 51% (interpreting), 54% (making hypothesis), 46% (identifying), 70% (predicting), 40% (experimenting), 43% (concluding), 40% (communicating).

Ahuja (2019) studied Science Process Skills and Academic Achievement among Secondary School Students. Descriptive survey, research design was used to test the hypotheses. One hundred and seventy boys and one hundred and sixty six girls of ninth

standard were randomly selected for the study. The study showed significantly better mean scores for boy students, in comparison to girl students, with respect to Science Process Skills and academic achievement at secondary school. The study also reported that the dependent variables namely academic achievement and Science Process Skills are positively correlated.

Chokchai (2019) studied to investigate the Integrated Science Process Skill (ISPS) of Thai lower secondary school students. From the use of stratified random sampling, 350 Bangkok, Thailand Grade 8 secondary school students were selected. The SPSS statistics software was used for data analysis of the mean and standard deviation. A first-order confirmatory factor analysis (CFA) and a two-way analysis of variance (ANOVA) were also employed. Findings from the research determined that student ISPS consisted of five indicators, including (a) controlling variables (c) defining variables operationally (d) experimentation, and (e) data interpretation. Findings also revealed that overall, student ISPS were at a level that needed improvement.

Derilo (2019) sought to investigate students' SPS acquisition level and its relationship with their academic performance in science. The Science Process Skills Test, a 24-item test intended to quantify students' basic and integrated SPS, was administered to the 100 randomly selected Grade 7 students of a private secondary school in Northern Luzon, Philippines. The data were analyzed using descriptive and correlational research methods. The results of the study revealed that the students have an average level of basic Science Process Skills, and a low level of integrated Science Process Skills. Hence, it was recommended that students' Science Process Skills be improved through proper designs of inquiry-based experiments and activities to enhance and elevate students' achievement in science.

Saban et al. (2019) aimed to determine the acquisition level of 5<sup>th</sup>-grade students in SPSs with classroom activities. The research was a case study, and the data were collected by focus group interviews, document analysis, and observations. The sample of the research was six students from the fifth grade selected based on maximum variation sampling. Science Process Skills focused worksheets, focus group interview schedule, and observation forms were used as data collection tools. As a result, it was found out that the students were at the average or above the average level in observing, predicting,

measuring, comparing and classifying skills; and they were at below the average level in inferring, organizing data, identifying and using experimental materials, processing data and formulating models, controlling variables, experimenting, interpreting and inferring.

Achor et al. (2018) investigated the effect of laboratory strategy on senior secondary school students' acquisition of Science Process Skills in biology. The nonrandomized control group, pretest-posttest design was used for the study. A sample of 275 senior secondary II biology students from six secondary schools was drawn from population of 2,754 students across 20 schools in Makurdi metropolis using purposive sampling technique. The findings revealed that there were significant differences in the mean acquisition of Science Process Skills scores of students who were taught Biology concepts using laboratory strategy and expository method which was in favour of the laboratory strategy group. Based on the findings, it was concluded that the use of investigative laboratory strategy enhanced students' acquisition of Science Process Skills scores in Biology than the expository method.

Tilakaratnea and Ekanayakeb (2017) assessed the level of understanding of basic Science Process Skills (BSPS), among the grade six and seven students. The sample consisted of 3183 grade six students and 3289 grade seven students from one of the educational zones of Central Province of Sri Lanka. Results for both grades, indicated that there are statistically significant differences in the level of understanding of BSPS between the medium of instruction (English and native languages) as well as between national and provincial schools. In addition, gender too plays a similar role for sixth graders. Nevertheless, no relationship was identified between the understanding level of SPS and gender for seventh grades.

Ongowo (2017) investigated secondary school students' mastery of Integrated Science Process Skills (ISPS) among co-educational schools and the influence of grade level, gender, and school location in Siaya County, Kenya. The study used a causal-comparative design with purposive sampling technique. The instrument was administered to 429 students. The following conclusions were made with regard to integrated Science Process Skills : Mastery of ISPS increases with grade level; boys have a higher mastery of ISPS than girls; the urban school has a higher mastery of ISPS than the rural school.

Jeon and Park (2014) studied the teaching insights for improving scientific literacy by analyzing the effects of scientific communication skills, Science Process Skills, and logical thinking skills of elementary school students on academic achievement level. The participants are 64 sixth grade elementary school students. Survey materials included the results of Scientific Communication Skill Test (SCST), Test of Science Process Skills (TSPS), Group Assessment of Logical Thinking (GALT), multiple choice test & short answer test, descriptive answer test on science, and academic achievement level test on all subjects. In conclusion, setting the model, Science Process Skills and logical thinking skills influenced scientific communication skill, and the skill directly influenced the learner's academic level. Further analysis of the results showed that scientific communication skill influences the academic achievement level of all subjects the most.

Feyzioğlu et al. (2012) studied the validity and reliability of Science Process Skills for secondary students. The test was applied on 222 students from a vocational high school in Turkey. The test consisted of 30 multiple-choice questions; the reliability of the test was (0.83). The test consisted of sub-dimensions such as, observing, classifying, measuring, communicating, inferring, predicting, formulating hypotheses, identifying variable, organizing data, and interpreting it, designing investigations, acquiring data. The results of the confirmatory factor analysis supported validity and reliability of the test.

Oztürk et al. (2010) determined the science process skill and 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. The sample of the study consisted of 828 seventh grade students. 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 the students' SPS do not change in terms of gender.

Simsek and Kabapınar (2010) aimed to investigate the effects of Inquiry-Based Learning (IBL) environments, on students' conceptual understanding of matter, scientific process skills and attitudes towards science. A teaching intervention was designed on the basis of IBL principles, which was put into practice in a 5th grade science class (n = 20). Instruction lasted 8 weeks in total as provided by normal science curriculum. The success

of teaching intervention was tested via concept test, scientific process skills test and attitude scale. The findings indicated that IBL had a positive impact on students' conceptual understanding and scientific process skills, but did not make any difference on their attitudes towards science.

#### **2.2.4 Studies related to Attitude towards Science**

Binwal (2020) tried to check felt problems in studying science and Attitude towards Science among adolescent students of 9th grade. The study covered 100 students from the different government schools of Almora and nearby places of Almora city, in Uttarakhand. Stratified random sampling technique has been used for the selection of the subjects. Scientific Attitude Scale (SAS) was administered to collect the data. t-test was used to analyse quantitative data to check the mean difference among different groups. The findings of the study revealed that there was significant difference observed in Attitude towards Science between rural and urban adolescent students and as well as in Attitude towards Science of adolescent students of Almora city owing to difference in their achievement in previous class.

Mirana (2019) evaluated the Attitude towards Science and the Science Process Skills of grade 10 students including the prevailing conditions in terms of teaching approaches and school resources of selected secondary schools in the Philippines. It involved 256 students and 19 teachers from 4 schools categorized into; big school, small school, laboratory school and a private school. The results revealed that students have overwhelmingly highly positive Attitude towards Science but not well-developed Science Process Skills. Findings from this study also show that teachers must provide interesting lessons in science to develop Science Process Skills which are the foundations of critical thinking and higher order thinking skills necessary for the technology-based society of today and the future.

Singh et al. (2019) investigated to find out whether gender differences still exist in Attitude towards Science. An Attitude towards Science-Questionnaire was administered on approximately 200 students, both male and female who have offered science at Secondary School level. From data analysis involving use of descriptive statistics (mean, SD, and t-test) it was found that there was significant difference between the attitudes of females with respect to males towards science. The results of the study showed that there was a significant level of attitudinal differences towards science subjects between male

and female students at secondary school level and that might be influencing the enrolment at higher level of studies in science streams.

Kayacanand Ektem (2019) aimed to investigate the effects of biology laboratory practices that are supported by self-regulated learning strategies on students' readiness for self-directed learning and their attitudes towards science experiments in laboratory settings. This study, which was undertaken as a quasi-experimental study in accordance with the pretest-posttest design with a control group, was implemented. In order to measure the students' self-directed learning readiness levels, Scale of Self-Directed Learning Readiness in Laboratory was used and to measure attitudes towards science experiments Scale of Attitudes towards Science Experiments was utilized. According to the findings of the study, biology laboratory practices supported with self-regulated learning strategies were observed to make a significant difference in favour of the experimental group considering their self-directed learning readiness and their attitudes towards science experiments.

Asiri (2018) aimed to investigate secondary school students' attitudes towards science in Saudi Arabia. Questionnaire of 24 items was developed considering a variety of attitudes toward science instruments, and then administered to a sample of 150 secondary school students (78 males & 72 females). The findings indicated that secondary school students in Saudi Arabia have positive attitudes towards science. At the meantime, the results showed that there was no significant difference in attitudes towards science between males and females.

Ahuja (2017) conducted a study on Scientific Attitude in relation to Science Achievement Scores among Secondary School Students. A descriptive survey was conducted on 208 students of secondary school students in Delhi. The data analysis showed that there was gender difference, in favour of girl students, with respect to scientific attitude and science achievement scores. A significantly positive co relation between scientific attitude and science achievement scores of students was found. Interaction effects also supported these findings.

Reddy and Rao (2017) studied the Attitude towards Science of secondary school students in relation to 9 variables derived from Gender, Locality, Management and Type of school status these were tested on significance of difference. A sample of 800 students was taken for the study. There was no significant difference in Attitude towards

Sciencebased on gender, locality, Medium of Instruction. Significant difference was found in the scientific scores of high school students between the following pairs of sub sample group's boys and girl students ,rural and urban students and Private and Government school students.

Esme (2016) determined the relationships among the seventh grade elementary students' attitudes toward science, their learning approaches, motivational goals, science achievement and students' nature of science (NOS) views. The questionnaires for this study were administered online to 3,598 seventh grade students in different regions and cities of Turkey. The convenience sampling method was used in this study. The correlation results revealed the positive relationship between attitude toward science and the other variables. Multiple regression analysis indicated that while students' meaningful learning, self-efficacy, and nature of science views have a positive contribution, rote learning contributed negatively to the model. The findings also showed that parents' income and education level had a significant effect on students' attitude toward science.

Sakariyau et al. (2016) investigated the attitudes of secondary school students towards science in Odeda Local Government Area of Ogun State, Nigeria. Two hundred senior secondary school students consisting of 84 males and 116 females were selected from five secondary schools using stratified random sampling techniques. A 20-item Attitude to Science Questionnaire on a five-point Likert scale was adopted for the study. The instrument has a reliability coefficient of 0.73 using Cronbach's reliability method. Findings showed that a higher proportion of the students display positive Attitude towards Science. Also, there was no significant difference between the attitude of male and female students towards science.

Gupta (2015) aimed to assess the influence of living place, gender and stream of study on scientific attitude and Attitude towards Science of higher secondary level students. The study was conducted on a sample of 200 higher secondary students of district Badaun (Uttar Pradesh). Attitude towards Science was assessed by employing the Scale (ATSS) developed by Pandey and Singh (2002) and Scientific Attitude was measured by the scale (SAS) constructed by Gohit and Sreedevi (2008). The findings of the study revealed that gender does not affect the scientific attitude and attitude of students towards science while stream of study plays significant role in determining the scientific attitude and attitude of students towards science.

Jebson and Hena (2015) investigated the attitude of students toward science subjects in senior secondary schools in Adamawa state. Three objectives were raised and to these objectives one research question and two hypotheses were raised. The target population was all the Adamawa state government secondary school students. The study is survey type which used stratified random sampling technique to select a sample of 250 science students. These students responded to valid and reliable instrument known as Science Students' Attitude Questionnaire (SSAQ). The data obtained were subjected to descriptive statistics as well as t-test and chi-square test. The results showed that students in Adamawa state have positive Attitude towards Science subjects and gender has significant effect ( $p < 0.05$ ) on their attitude. The results indicated that boys have more positive attitude toward science subjects than their girls' counterpart.

Sethi (2015) conducted a study on attitude of the students towards science in relation to certain non-school factors. The sample consisted of 100 students. The main findings of the study were that significant difference exists between urban and rural students but no significant difference was found on the basis of gender and socio-economic status.

Singh and Imam (2014) explored the effects of gender, Attitude towards Science, parental education, and family size on science achievement. A convenience sample of 2006 students, 1080 males and 926 females from twenty-one schools of central UP was used for study. The Science Attitude Scale, Science Achievement Test and Personal and Environmental background assessment questionnaire were used for data collection. The results revealed that there was a significant difference between science achievement of boys and girls. The results of analysis showed that there was positive co-relation between Attitude towards Science and achievement in science. The family size of the students was positively associated with the science achievement of the students.

Mensah (2006) made an attempt to found the attitudes of junior secondary school students (JSS) towards the study of science and whether differences in attitudes exist among boys and girls towards the study of science. The participants were 320 (150 boys and 170 girls) students from eight randomly selected Junior Secondary Schools in Cape Coast Municipality of Central Region of Ghana. In the four public schools, there were 85 boys and 92 girls, giving a total of 177 students. In the four private schools, there were 65 boys and 78 girls giving a total of 143 students. A survey instrument adapted from

Mathematics Attitude Scale, developed by Fennema Sherman (1986), was adapted to determine JSS students' responses to 16 items. Findings revealed that girls don't like science as much as boys.

### **2.2.5 Studies related to Metacognition**

Bakkaloglu (2020) investigated the Metacognitive Awareness of primary and secondary school students according to the variables gender, grade level and region. The model of this research, which was conducted to determine the Metacognitive Awareness levels of the students in primary and secondary school, was a survey model. Metacognitive Awareness Scale was administered to 399 students (195 girls, 204 boys) in third, fourth and fifth grade. The research showed that the Metacognitive Awareness scores of primary and secondary school students do not differentiate in gender. According to another result obtained in the research; Metacognitive Awareness scores of primary and secondary school students differentiate in locality.

Sari et al. (2019) found Correlation between students' Metacognitive Awareness and cognitive learning outcome on plant material in al Abidin bilingual boarding school Surakarta. Research was conducted with a quantitative research design. The participants were 50 students (27 females; 23 males) of grade X in Al Abidin Bilingual Boarding School Surakarta. Quantitative data were collected from the Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison and cognitive test on Plant material based on Bloom Taxonomy. The data were analyzed using the Pearson Correlation. The significant positive correlation between Metacognitive Awareness and cognitive learning outcome were revealed ( $r=0.705$ ). Finally, this research indicates that Metacognitive Awareness successfully correlates with the cognitive learning outcome.

Sonowal and Kalita(2019) explored the Metacognitive Awareness and academic achievement of Higher Secondary Level Students of Science Stream of Dibrugarh District. A sample of 115 students of XII Standard was selected by using purposive sampling technique for the investigation. The standardized tool 'Metacognitive Awareness Inventory' (MAI) developed by Schraw and Dennison (1994) has been used as a measure of Metacognitive Awareness of students. The Descriptive Survey method was used to collect the data. The finding of the study revealed that there was a negative correlation between Metacognitive Awareness and academic achievement, Knowledge of cognition and Academic Achievement, Regulation of cognition and academic achievement of the

Higher Secondary Level Science Stream Students. There was a significant difference between Higher Secondary Level Science Stream Students with respect to Gender, Type of management, Locale and Medium of Instruction.

Dhyaniand Maikhuri, (2018) studied the Metacognitive Awareness in primary school students and tried to map-out whether there exists any significant difference between the Gender, Locality, Caste on their Metacognitive Awareness. The population of the study consisted of 140 primary school students from different schools of Dehradun district of Uttarakhand. Metacognitive Awareness Scale, used in this study was developed by investigator. The study showed that the metacognitive ability of students is not affected by gender and locality.

Kaur and Kaur (2017) investigated the academic achievement in relation to metacognition and problem solving ability among secondary school students. The sample constituted of 200 students studying in XI grade both boys and girl's belonging to science stream from central board of secondary education (CBSE) as well as Punjab State Education Board (PSEB) of Amritsar District were randomly selected. The findings of the study revealed that there exists no significant difference in metacognition and problem solving ability among girls and boys of CBSE and PSEB School students belonging to medical stream. But there exists significant difference in problem solving ability among students of CBSE and PSEB schools belonging to medical stream.

Sabna and Hameed (2016) determined the extent of Metacognitive Awareness among Higher Secondary School Students and examined whether there exists any significant difference in the mean scores of Metacognitive Awareness based on Gender and Locale. In accordance with this purpose the investigator applied Metacognitive Awareness Inventory (Schraw&Dennison, 1994) to 100 Higher Secondary School Students (50 boys and 50 girls) in Malappuram district of Kerala. The study reveals 13 percentage of students are with High Metacognitive Awareness, 76 percent of students with Average Metacognitive Awareness and 12 percentage of students having Less Metacognitive Awareness based on Gender and Locale. There was a significant difference in the mean scores of Metacognitive Awareness based on Gender and Locale.

Indu and Vinitha (2015) conducted a study to find out the Metacognitive Awareness of higher secondary school students in Coimbatore district. The sample consisted of 1005 higher secondary school students. Schraw and Dennison tool was used

for data collection. From results it was seen that the male students possess better metacognitive ability than their female counterparts and it is also interesting to note that students who read the newspaper regularly possess better cognition and they knew to regulate their cognition. Finding that Tamil medium students possess better metacognitive ability reveals the fact that when students learn in their mother tongue their thinking ability and recognition is better than when reading in a foreign language.

Jayaprabha and Kanman (2013) examined the effects of inquiry based learning and cooperative learning on Metacognitive Awareness in science class room. Participants were 170 students. A quasi experimental design involving three groups namely, two treatment groups- inquiry based learning and cooperative learning and control group was adopted. Standardized tool developed by Schraw and Dennison (1994) was used to measure Metacognitive Awareness in three groups. Results revealed that students in cooperative learning received higher Metacognitive Awareness compared to other groups. The researchers recommend that cooperative learning be adopted regularly in classroom to enhance Metacognitive Awareness of higher secondary students.

Ibe(2009) examined Meta cognitive Strategies on Classroom Participation and Student Achievement in Senior Secondary School Science Classrooms. The design for the study was a quasi-experimental design involving 3 intact groups namely two treatment groups: - Think –Pair-Share (TPS) strategy and the Metacognitive Questions (MQ) and a control group. The study lasted for 11 weeks. The sample comprised of 24, 22 and 21 subjects for control, TPS and MQ respectively. A researcher made achievement test in the topic-density was used to measure achievement in the 3 groups. Results revealed that the Metacognitive strategies were most effective in enhancing academic achievement followed by the TPS. The researcher recommends that Metacognitive strategies and questions be infused in the classroom so as to help students learn material more efficiently, retain information longer and generalize skills.

### **2.3 Discussion on studies reviewed**

The studies reviewed by the investigator gave insights into the process and results of studies conducted in the related areas. All the studies reviewed on Inquiry-Based Instruction revealed that it is one of the best methods to teach science than the traditional lecture method. It was also seen that majority of the studies had reported a positive relationship between Inquiry-Based Instruction and achievement in science. It is also seen

from the studies that Science Process Skills ,Attitude towards Science and achievement in science are related. In majority of the studies Metacognition plays an important role in learning process. It is seen that Metacognitive Awareness successfully correlates with the cognitive learning outcome and it is also dependent on various variables like gender, locality, type of managementand Medium of Instruction. The studies also helped the investigator to acquire a clear knowledge about the different methodology and tools used in different researches.

#### **2.4 Conclusion**

The theoretical overview enabled the investigator to trace the history of Inquiry-Based Instruction, Conventional method of instruction, Science Process Skills, Achievement in Science, Attitude towards Science and Metacognition. Thus the theoretical overview empowered the investigator with a strong theoretical support in all areas of the present study and to understand the roots in the development of the concept of Inquiry-Based Instruction. Studies and literature support of constructs underlying major areas on Inquiry-Based Instruction has been portrayed in the subsequent chapter.