CHAPTER I

INTRODUCTION

Tell me and I forget,
Teach me, and I may remember,
Involve me, and I learn
- Benjamin Franklin

"The highest education is that which does not merely give us information but makes our life in harmony with all existence".

-Rabindranath Tagore

Education is an enduring process that is always progressive and dynamic. There is a consensus that it is the basis of the progress of societies. Many reflections, proposals, and efforts have been made to provide young people with the best tools and educational practices from early childhood, but the results are always seen in the long term. One of the main aims of education is to develop each pupil an understanding of the various social, economic, and political problems in the world. Each pupil must be trained to think and solve problems whenever a situation arises with the courage to defend their views and opinions reasonably.

The Gurukula system was followedin ancient bharathwhere students were taught under a single teacher which was slowly transformed into teaching different subjects by different subject experts. In the traditional teaching method, individual differences were not considered and most of the students remained passive and was highly teacher centered.In the present context of knowledge explosion students are quite advanced in their mental age and in their intellect, and simultaneously the teaching methods also have undergone a lot of transformation.

Education is essential for the progress of the individual and society. It is through education that man develops his thinking and reasoning, problem solving and creativity, Attitude, Intelligence, and aptitude, positive sentiments, values, and skills. Education is a process of modification or change of transformation of behaviour. Education is thus enlightenment and empowerment of total behavior.

In modern society, knowledge increases at a terrific pace, and social changes are very rapid, requiring a radical transformation in the educational system. Education without an aim is relatively meaningless. In the words of John Dewey, An aim is a foreseen end that gives direction to do an activity or motivates behavior.

In response to traditional education, in the 1960s, a research-based teaching method was developed, now known as Inquiry-Based Education (IBE). Dewey first introduced this type of education in 1910, and since then, several researchers have used and developed it. Inquiry-Based Education is a process whereby children and young people answer their questions and satisfy their curiosity about the world around them through activities and experiments. Inquiry-Based Instruction offers students opportunities to seek out answers. Today students are quite advanced in their mental age in their intellect, ideas, and outlook. They are curious to know and have many doubts, and teachers have to meet the queries and satisfy this hunger with confidence. Therefore, they have to democratize their approach, methods, and class organization. There must be adequate freedom and flexibility in the classroom.

A proper method of teaching helps a teacher to interpret the world of knowledge into child's mind. Every teacher should be trained in different methods of science teaching. Expertise is needed in both teacher-centered and pupil-centered method of teaching. The later one is more focused on the need, talents,and interest of the pupils. The pupil-centered teaching method's implementation develops more in-depth knowledge, various learning skills, application in the life situation, and a positive attitude towards solving problems.

1.1Teaching

Teaching is the process of imparting knowledge and skills according to the students mental and chronological age. It takes the form of questioning, listening, giving information, explaining some phenomenon, demonstrating skill or process, testing and understanding and facilitating learning activities.

1.1.1Teaching Science

Teaching science is making students to learn about the changes that happen in our surroundings and helping them to cope with challenges of their lives. It also focuses on the mastery of content with emphasis on developing specific skills and attitudes.

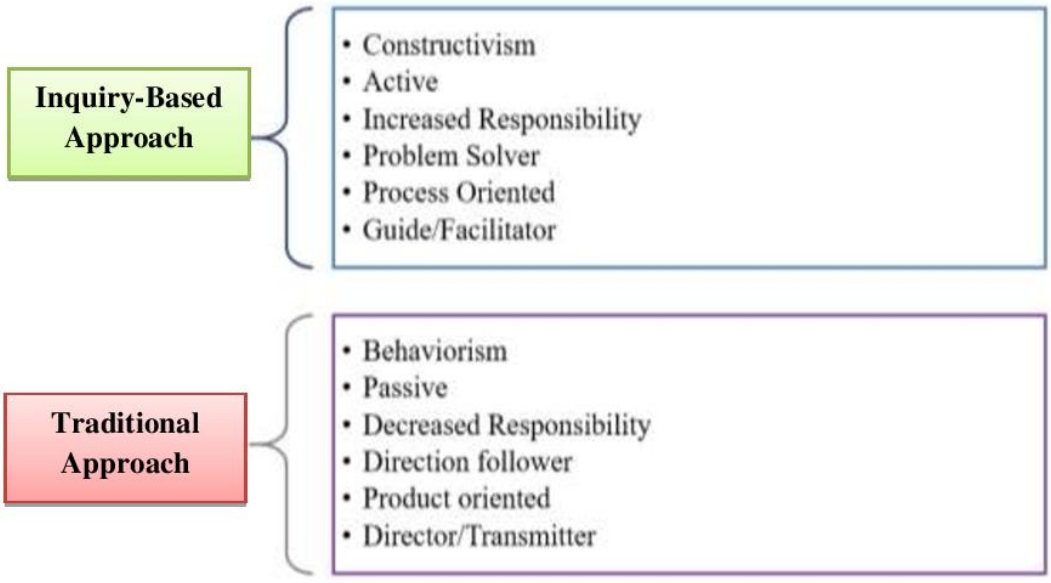
1.2 Inquiry-Based Instruction

Inquiry-Based Instruction is an approach that enhances students' academic excellence by engaging them in the learning process through various classroom activities that strengthen their confidence and understanding of the subject matter. It appreciates the sense of inquiry and investigation in which questions are answered, and students are facilitated to memorize the information through the instructional materials.Inquiry-Based Instruction helps involve students to do activities, have opportunities to explore possible solutions, develop cause and effect relations, and understand concepts based on the evidences available. Inquiry-Based Instruction isa term covering a range of teaching approaches that involve stimulating learning with a question or issue and engaging learners in constructing new knowledge and understanding. The teacher's role in this method is to act as a facilitator and help students for self-learning.

1.2.1 Difference between Inquiry-Based Approaches and Traditional Approaches

The difference between Inquiry Based approach and Traditional approach includes components such as principles of learning theory, student participation, student involvement in outcomes, students' role, curriculum goal and teachers' role are given

Figure 1.1 Differences between Inquiry-Based Approach and Traditional Approach



1.2.2 5E Inquiry Model

5E Inquiry model was introduced first by Roger Bybee (1987) of Biological Science Curriculum Study (BSCS). 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. According to Bybee(1987) the 5E steps are defined as

Engage – Students are engaged in the classroom through different learning tasks.

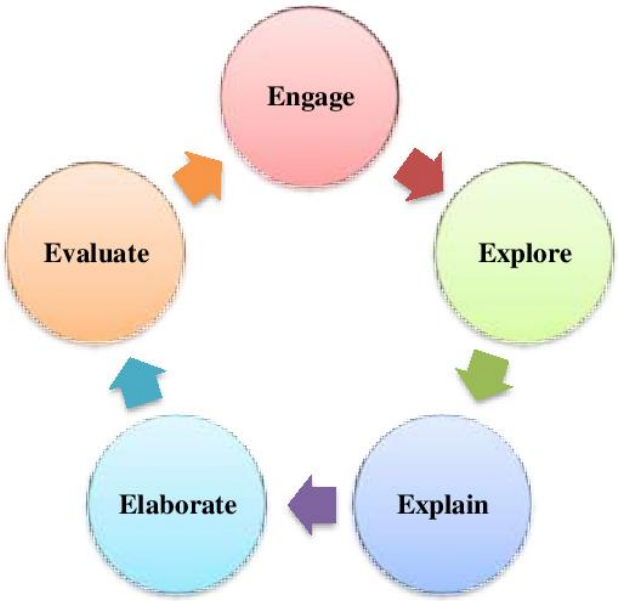
Explore – Students have an opportunity to get directly involved with the phenomena and materials.

Explain – It is the point at which the learner begins to put the abstract experience and clarify their misconception through discussion in the classroom.

Elaborate – This phase of learning cycle provides an opportunity for students to apply their knowledge to a new situation, which may include raising new questions and hypotheses to explore.

Evaluation - In this phase, students assess their understanding and abilities and the teacher can evaluate student progress toward achieving the learning objectives framed for the activity.

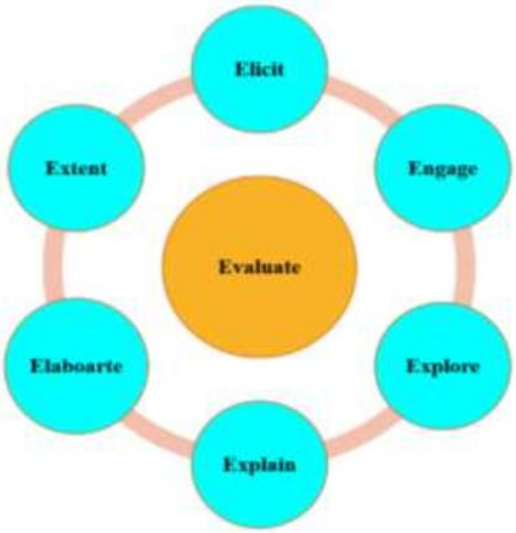
Figure 1.2 5E Enquiry Model



1.2.3 7E – Inquiry Model

The 7E-Inquiry model developed by Eisenkraft (2003) is an extension of the 5E learning cycle, as the engage element is divided into two stages - Elicit and Engage. Similarly, the stages elaborate and evaluate is added with a third component extend.

Figure 1.3 7E Inquiry Model



Elicit: Activate prior knowledge.

Engage: Engage the students by posing questions.

Explore: Active, hands-on activities.

Explain: Students analyze their data; observations help to form ideas.

Elaborate and Extent: Students are allowed to transfer their knowledge from one concept to another.

Evaluate: Both formative and summative assessments are given to the students.

1.3 Science Process Skills

Science Process Skills are the skills and abilities required in science learning which ranges from simple observation to interpreting data and was popularized by the Curriculum Project Science-A Process Approach (SAPA) which defines Science Process Skills as a set of broadly transferable abilities appropriate to many Science disciplines and reflective of scientists' behaviorgrouped into two types, namely-basic and integrated skills.

1.3.1 The Basic (Simpler) Process Skills

- **Observing** – Most simple skill done by five senses.
- **Classifying** – Sorting and arranging materials and concepts based on similarities and differences.
- **Communicating** – Experiences, data or results are shared effectively.
- **Inferring** – Explanation of observed data.
- **Measuring –** Assessing or evaluating the data collected and compared.
- **Predicting –** Guessing scientifically on a future event based on the existing evidence.

1.3.2 Integrated (more complex) Process Skills

- **Controlling Variables –** Identifying variables, keeping variables constant, and manipulating.
- **Defining operationally –** Stating how to measure a variable in an experiment.
- **Formulating hypotheses –** Stating the expected outcome of an experiment.
- **Interpreting data –** Organizing, concluding from data, and making sense of data.
- **Experimenting –** Testing by following procedures to produce verifiable results.
- **Formulating models –** Creating or constructing a mental or physical replica of a process or event.

1.4 Need for the study

The world with life and life with science is inseparable; thus, the students have to learn science to know more about their surroundings and themselves. Science is a lovely subject and a subject fulfilling a man's life with its new advancements and discoveries. Science subjects differ from non-science subjects in many aspects, such as using more technical and scientific terms, diagrams to describe different concepts, and are more fact-oriented.

Higher Secondary School Science is a subject that introduces new terms to the students and also expands the already learnt concepts. Here more abstract concepts are learned by the students. Therefore, they must understand the concept and learn, and this could be done through hands-on activities and by involving them actively in many experiments. Inquiry-Based Instruction helps in making students use their cognitive, affective and psychomotor skills in learning science. The National Education Policy (2020) of India emphasizes that the Curriculum content will be reduced in each subject to its core essentials and provide opportunities for critical thinking and more holistic, Inquiry-based, discovery-based, discussion-based, and analysis based learning. The policy also stressed that teaching and learning need to be more interactive with many inquiries by the students on concepts, and classroom sessions should be filled with more fun, creative, collaborative, and exploratory activities for students for deeper and more experiential learning. (National Education Policy,2020). Which brings out the importance of Inquiry-Based Instruction in the teaching-learning process.

1.5 Scope of the study

Inquiry-Based Instruction is followed in different countries, and many schools have incorporated this method into their lessons. It is a truth that scientific facts should not be inculcated directly. Instead of imparting facts, the teacher can provide activities where the students work independently and get training in scientific methods. Science education should develop the inquisitiveness, creativity, and achievement of students. Furthermore, this is possible only if science is taught to make the learners constructive, curious, and develop a quest for cause-effect relationship. The study on Inquiry-Based Instruction was chosen to provide students with activities to enhance learning science, motivate them to ask more questions about the scientific phenomenon, and improve their Attitude towards Science. This approach is used for the present study hoping that students will acquire the knowledge of fundamental principles and concepts in science that are useful in daily life and acquire different Science Process Skills like Observation, Classification, Communicating, Experimenting, Collection and Interpretation of data, and Formulating Models.

1.6 Statement of the Problem

After contemplating the need for the study related to the aspects of Inquiry-Based Instruction, the researcher identified and selected the research problem as **Effectiveness of Inquiry-Based Instruction on Science Process Skills, Achievement in Science and Metacognition of Higher Secondary School Students** for the study. In addition to these variables effectiveness of Inquiry-Based Instruction onAttitude towards Science was also studied by the investigator.

1.7 Definition of the Key Terms

1.7.1 Effectiveness

Effectiveness in teaching learning process refers to the degree to which instructional objectives are achieved and the targeted problems are solved. In the present study, effectiveness refers to the degree to which the intervention helped the students to achieve content knowledge in Science, develop Science Process Skills , inculcate a positive Attitude towards Science and acquire knowledge about their cognitive processes.

1.7.2 Inquiry-Based Instruction

Inquiry-Based Instruction is a process where students formulate and investigate questions, obtain factual information, and then build knowledge that reflects their answer to the original questions. (Jakes et al. 2002).

1.7.3 Science Process Skills

The skills and abilities required in science learning range from simple observation to interpreting data. In the present study, the skills, namely Observation, Classification, Communicating, Experimenting, Collection and Interpretation of data, and Formulating Models, were considered.

1.7.4 Achievement in Science

Achievement stands for the extent to which a student has achieved his/her educational goals. The marks scored by the students in Science Achievement Test constructed by the investigator are taken in this study for Achievement in Science.

1.7.5 Attitude towards Science

Attitude is a phenomenon acquired by learning, directs an individual's behaviours, and causes subjectivity in the decision-making process(Durmaz&Ozyıldırım, 2005). It includes the behaviour showing a positive attitude toward a course or subject. Attitude towards Science means Students' affective orientation towards learning science, which means to have a positive orientation towards learning science.

1.7.6 Metacognition

Metacognition generally means "Thinking about Thinking", or "Cognition about Cognition" or "Knowing about Knowing". Etymology of the term is from the word "Meta", meaning beyond. The term has been part of the vocabulary of educational psychologists for many years. Metacognition has two constituent parts: knowledge about cognition and regulation of cognition. Metacognition is an essential aspect of successful learning because it enables individuals to better manage their cognitive skills and determine weaknesses that can be corrected by constructing new cognitive skills.

1.7.7 Higher Secondary

It refers to a two-year course involving diversified and vocational education after completing ten years of school education. The investigator selected the first year higher secondary students of the Science group, which comprises subjects like Physics, Chemistry, Botany, and Zoology. Getting a pass certificate in Higher Secondary is mandatory for pursuing higher education or undergraduate courses in India.

1.8 Objectives of the Study

- To prepare Inquiry–Based Instruction lesson transcripts based on 7E model of learning and Conventional lesson transcripts based on Herbartian steps for teaching the units *Plant Morphology* and*Reproduction Biology*for the Higher Secondary School Students.
- To construct and validate an Achievement Test in Science, Science Process Skills Questionnaire and a Rating scale on Attitude towards Science for the Higher Secondary School Students.

- To determine the relationship among the variables, Achievement in Science, Science Process Skills ,Attitude towards Science, and Metacognition.
- To find out the effectiveness of Inquiry based instruction on Achievement in Science, Science Process Skills, Attitude towards science and Metacognitive Awareness of Higher Secondary School Students.
- To compare the mean Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness of Boys of Inquiry-Based Instruction group and Conventional method group.
- To compare the mean Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness of Girls of Inquiry-Based Instruction group and Conventional method group.
- To compare the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness of Boys of Inquiry-Based Instruction group and Conventional method group.
- To compare the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness of Girls of Inquiry-Based Instruction group and Conventional method group.
- To compare Adjusted mean scores of Achievement in Science, Science Process Skills , Attitude towards Science and Metacognitive Awareness of Boys and Girls of Inquiry-Based Instruction group and Conventional method group by considering their Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness scores as covariate.

- To compare the mean Pre-test scores in Achievement in Science, Science Process Skills ,Attitude towards Science and Metacognitive Awareness of Inquiry-Based Instruction group and Conventional method group based on gender.
- To compare the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science and Metacognitive Awareness ofInquiry-Based Instruction group and Conventional method group based on gender.
- To find out the retention effect of Inquiry based instruction on Achievement in Science and Attitude towards science of Higher Secondary School Students

1.9 Hypotheses of the study

There is no significant relationship among the following variables

a) Achievement in Science

b) Science Process Skills

c) Attitude towards Science

d) Metacognitive Awareness

- There is no significant difference in the mean Pre-test scores of the Experimental group and Control group in the variables, namely Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness.
- There is no significant difference in the mean Post-test scores of the Experimental group and Control group in the variables, namely Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness.
- There is no significant difference in the mean Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness of Boys of Inquiry-Based Instruction group and Conventional method group.
- There is no significant difference in the mean Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness of Girls of Inquiry-Based Instruction group and Conventional method group.

- There is no significant difference in the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awarenessof Boys of Inquiry-Based Instruction group and Conventional method group.
- There is no significant difference in the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness of Girls of Inquiry-Based Instruction group and Conventional method group.
- There is no significant difference in the mean Pre-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness of Inquiry-Based Instruction group and Conventional method group based on gender.
- There is no significant difference in the mean Post-test scores in Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness of Inquiry-Based Instruction group and Conventional method group based on gender.

1.10 Limitations

The present study is confined to Chennai City of Tamil Nadu only. Only a representative sample (90) of students from XI Standard of one Government School alone was taken for the experiment. The sample is not a statewide one. In order to study the group differences in Achievement in Science, Attitude towards Science and Science Process Skills, only gender was considered. The content selected for intervention was only two units, namely Plant Morphology and Reproduction Biology.

1.11 Chapterisation

This thesis is organised into five chapters, as outlined below.

Chapter 1: ***Introduction***. This chapter introduces the research area to be investigated, statement of the problem, need, and scope of the study, objectives and hypotheses of the study and limitations of the study.

Chapter 2: ***Review of related literature***. The chapter provides an in-depth review of the research relating to the central research areas of this thesis. It examines the theoretical aspects related to Inquiry –Based Instruction, Achievement in Science, Science Process Skills, Attitude towards Science, and Metacognitive Awareness. It also looks at the different research findings by reviewing the related studies.

Chapter 3: ***Methodology***. This chapter deals with the method used in the study, sample, tool construction, reliability and validity of the tool, sampling techniques, and the administration of the tool and data collection procedure.

Chapter 4: ***Results and Discussions***. This chapter discusses and analyses the findings of the study.

Chapter 5: ***Summary and Conclusion***: This chapter summarises the main findings of this study. It also discusses on the recommendations for future research and practice.

References and Appendix follow this chapter.