CHAPTER I

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1.1 Background of the Study

“The world we have created is a product of our thinking; it cannot be changed without changing our thinking”

-Albert Einstein

Change is always endogenous and we need a paradigm shift in the teaching and learning process. Each human being is unique and has infinite potential for life enhancement for him and others. “The principal goal of education is to create men who are capable of doing new things, not simply repeating what other generations have done” (Piaget, 1950).

To make education an effective one, it must be ensured that every child is nurtured to the maximum possible levels of attainment where the role of a teacher is pivotal. In the context of modern society, the function of education is not an attempt to supply some amount of knowledge to the educand but to develop in him desirable habits, interests, attitudes and skills along with developing physical, intellectual, moral and spiritual power that help him to lead a successful life. A teacher should understand how the child could improve his modes of behaviour in the light of his own reactions and experiences.

In the modern era, learning and teaching are much different from the traditional face to face educational environment. Teachers and students do not need to get together at a particular time and the role of
teachers changed from speakers to assistants and students changed from listeners to active participants. Fundamental changes have taken place in the basic process of our thinking and these are beginning to affect profoundly our everyday life.

According to Confucious, (510 B.C) “the wise man in his teaching, guides his students but does not pull them along, he urges them to go forward and does not suppress them, and he opens the way but does not take them to the place.... If his students are encouraged to think for themselves we may call the man a good teacher”.

1.2 Importance of Science Education

We are living in an age of science and technology and the horizon of knowledge is expanding in every seconds. The information superhighway is spreading tremendous amount of knowledge to mankind. The study of science sharpens our intellect and explores the unknown world and leads to inventions that transforms the world and make life more interesting.

“Science made the world jump forward with a leap, built up a glittering civilization, opened up innumerable avenues for the growth of knowledge and added to the power of man to such an extend that for the first time, it was possible to conceive that man could triumph over and shape his physical environment” (Jawaharlal Nehru, 1956).
Science has tremendous impact on the cultural life of the present day society which is the product of science. Its effect is seen pronounced in every walk of human life, thoughts, words and deeds. Thus the study of science brings behavioural changes in the learner and enriches his character and personality.

Science plays vital and pivotal role in the development of many qualities of head and heart in the individual, there by helping him to be a good citizen in the society. Science helps him to be useful, productive and progressive member of the society. Science develops in students the qualities like truthfulness, honesty, open mindedness and goodness. The study of science proposes explanations for “what is” in the natural world, where as the study of technology provides solutions to human problems of adaptation. They go together a hand in glove and will have a mounting impact on our social and personal environment.

The increasing need for scientists and technologists have made it all the more important to provide science based education in schools. The dawn of space age and explosion in knowledge also necessitated the teaching of science to every student. The National policy on education (1986) states that science education will be strengthened so as to develop in the child well defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question and aesthetic sensibility.
Our own enthusiasm and encouragement in teaching can make the difference in our student’s present and future encounters with science.

**1.3 Importance of Learning Physics**

In this ‘age of science’, knowledge of Physics is essential, as it is the part and parcel of science. The physical and biological world has been fascinating man from time immemorial and man is born with an urge to understand and control the physical world in which he lives and Physics helps him greatly in this endeavour. Further, more number of people are being employed in scientific pursuits requiring more knowledge of Physics.

The purpose of Physics teaching in Secondary school is not only to enable students to grasp systematically the basic knowledge of Physics needed for further study of science and technology but also to unsettle the mind of the young and inflame their intellect. In Physics curriculum, more emphasis is put on scientific method and attempt is made to develop scientific attitude and scientific temper in students.

Physics learning helps students in thinking and to satisfy the basic urge of curiosity and creativity and the insight obtained from scientific process develops intellectual honesty, positive attitudes, social skills etc.

The motivating force behind the study of Physics and its application must be the desire of the student eventually to be a responsible person in the society, to understand the world around and to
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enrich the life of the people he is associated with. A student of Physics should be able to observe, think logically, draw conclusions and to make the right decisions. With such a background of training, he could meet any challenge in whatever position of responsibility he is employed. After their formal education they will be forced with new situations, circumstances and problems. They will be called upon to analyse each new problem critically, to discuss with their colleagues and finally to make the right decision.

1.4 McCormack and Yager Taxonomy

The traditional view considered that science was the knowledge of the universe and only recently has there been much attention directed to science processes, the skills that scientists use to discover new knowledge. However it is clear today that there is much more to science education than content and processes. McCormack and Yager (1989) developed a new “Taxonomy for science Education” that broadens the view of science education beyond the two domains of content and processes. The domains which come under McCormack and Yager Taxonomy are

Domain I – Knowing and Understanding (Knowledge Domain)

Science aims to categorize the observable universe into manageable units for study and to describe physical and biological relationships. Ultimately, science aims to provide reasonable explanations
for observed relationships. Part of any science instruction always involves teach students some of the information developed through science.

The knowing and understanding domain includes

- Facts
- Concepts
- Laws (Principles)
- Existing hypotheses and theories being used by scientists.
- Science and societal issues

**Domain II- Exploring and Discovering (Process Domain)**

This domain focuses on the use of the processes of science to learn how scientists think and work. Some processes of science are

- Observing and describing
- Classifying and organizing
- Measuring and charting
- Communicating and understanding communication of others.
- Predicting and inferring
- Hypothesizing
- Hypothesis testing
- Identifying and controlling variables
- Interpreting data
- Constructing and using instruments, simple devices and physical models.
Domain III – Imaging and Creating (Creativity Domain)

Most science programmer's view a science program as something to be done to students to help them learn a given body of information. Little formal attention has been given in science programs to development of student’s imagination and creative thinking. Here are some of the human abilities important in this domain:

- Visualizing- producing mental images
- Combining objects and ideas in new ways
- Producing alternate or unusual uses for objects
- Solving problems and puzzles
- Fantasizing
- Pretending
- Dreaming
- Designing devices and machines
- Producing unusual ideas.

Much research and development has been done on developing student’s abilities in this creative domain, but little of this has been purposely incorporated into science programs.

Domain IV – Using and Applying (Application Domain)

It seems pointless to have any science program if the program does not include some substantial amount of information, skills and attitudes that can be transferred and used in student’s everyday lives. Also, it
seems inappropriate to divorce ‘pure’ or ‘academic’ science from technology. Students need to become sensitized to those experiences they encounter which reflect ideas they have learned in school science. Some dimensions of this domain are:

- Seeing instances of scientific concepts in everyday life experiences.
- Applying learned science concepts and skills to everyday technological problems.
- Understanding scientific and technological principles involved in household technological devices.
- Using scientific processes in solving problems that occur in everyday life.
- Understanding and evaluating mass media reports of scientific developments.
- Making decisions related to personal health, nutrition and life style based on scientific knowledge.
- Integrating science with other subjects.

Domain V- Feeling and Valuing (Attitude Domain)

In these times of increasingly complex social and political institutions, environmental and energy problems, general worry about the future, scientific content, processes and even attention to imagination are
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not sufficient parameters for a science program. Human feeling, values and decision making skills need to be addressed. This domain includes;

- Developing positive attitudes towards science in general, science in school and science teachers.
- Developing positive attitudes towards oneself.
- Exploring human emotions.
- Developing sensitivity and respect for the feelings of other people.
- Expressing personal feelings in a constructive way.
- Making decisions about personal values.
- Making decisions about social and environmental issues.

1.5 Bloom's Taxonomy

Bloom's Taxonomy is a classification of learning objectives within education proposed in 1956 by a committee of educators chaired by Benjamin S. Bloom. It refers to a classification of the different objectives that educators set for students (learning objectives). Bloom's Taxonomy divides educational objectives into three domains: Cognitive, Affective, and Psychomotor (sometimes loosely described as knowing/head, feeling/heart and doing/hands respectively). Within the domains, learning at the higher levels is dependent on the attained prerequisite knowledge and skills at lower levels. A goal of Bloom's Taxonomy is to motivate educators to focus on all the three domains, creating a more holistic form of education.
Bloom's Taxonomy identified three domains of educational activities:

- **Cognitive**: mental skills
- **Affective**: growth in feelings or emotional areas
- **Psychomotor**: manual or physical skills

The cognitive domain (Bloom, 1956) involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. There are six major categories, which are listed in order below, starting from the simplest behaviour to the most complex and the categories can be thought of as degrees of difficulties. That is, the first one must normally be mastered before the next one can take place. The six major categories of objectives which come under cognitive domain are Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

The affective domain (Krathwohl, Bloom, Masia, 1973) includes the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes. The five major categories are receiving, responding, valuing, organization and characterization.

The psychomotor domain (Simpson, 1972) includes physical movement, coordination, and use of the motor-skill areas. Development
of these skills requires practice and is measured in terms of speed, precision, distance, procedures, or techniques in execution. The seven major categories are perception, set, guided responses, mechanism, complex overt responses, adaptation and organisation.

1.6 Need and Significance of the Study

Science is not a thing to be talked about, but a practical subject: it should be learned through a disciplined and systematic approach. Teaching of science should not be done only through lecturing and discussion, but should be carried out in a problem solving and decision making environment.

In actual practice, what is known in science is inseparably linked to the methods of investigation. Knowing science is more than knowing content; it also knows how to gather evidence and how to relate evidence to interpretation. Scientists and science educators today believe that approaches to learning and teaching science should basically parallel the procedures and attitudes scientists use in doing science. We must provide planned activities and instructions, feedback for children as they think about and interpret their science experiences.

Unfortunately our present method of teaching science is believed in giving information as bits. In a developing country like India due to financial and administrative hazards we usually follow the chalk and talk method. The students in schools often complaint that science teaching
and learning is boring and our boys and girls hardly goes beyond making measurements and solving problems mechanically.

In education there is no common view about the different objectives of teaching. For example some teachers say that the student should understand knowledge, others say that they should grasp the core or essence; still others say that they should comprehend. There are different interpretations of the same objective by different people. With the help of Taxonomy of Educational objectives, teacher should be able to define and translate the objectives in the same way. This will facilitate the exchange of information, curriculum development and evaluation devices. It will also help in modifying the educational outcomes.

In the present scenario, the society is facing many social, political and environmental issues. So it is the duty of the teacher to mould his disciples in such a way so as to become creative citizens in the coming future for solving such problems. A science teacher, especially Physics teacher if effectively use a Taxonomy which gives more emphasis to creativity and process skills, can improve the creative ability, process skills etc. of students. In Bloom's Taxonomy, the educational objectives are arranged under three domains in a hierarchy, so that items in each domain are ranked by its importance. But according to McCormack and Yager Taxonomy, the categories are arranged under five domains.
As a preliminary step to start the study, the investigator conducted a pilot survey. The investigator consulted school teachers teaching Physics and also experts in SSA, DIET and SCERT to know which Taxonomy is currently using in the schools for curriculum transaction and also to know their opinion and suggestions in using other educational taxonomies in the school curriculum.

From the pilot survey, the investigator came to know that many of the teachers are not aware of the different types of educational Taxonomies. A few are aware of some of the educational Taxonomies but are not able to explain the mental process and competencies associated with each of the domain. Most of them are aware of only Bloom's Taxonomy and its domains -cognitive, affective and psychomotor. The teachers reported that they are following the cognitive domain of Bloom's Taxonomy while preparing the lesson transcripts and achievement tests.

The investigator discussed about McCormack and Yager Taxonomy with the school teachers and compared it with the objectives of Bloom's Taxonomy. The teachers were of the impression that using of such Taxonomies in curriculum transaction will enhance psychosocial abilities and ultimately achievement in children.

The DIET and SCERT experts opined that in school curriculum, the instructional strategies used are in accordance with the Activity oriented method but the achievement is measured following the
objectives in the cognitive domain of Bloom's Taxonomy. They suggested that there should be necessary actions in incorporating McCormack and Yager Taxonomy and other taxonomies while curriculum transaction and evaluation of the outcomes.

The investigator reviewed a number of studies based on taxonomies of educational objectives conducted in India and could find that not much has been done in the field of McCormack and Yager Taxonomy. A Physics teacher, who is sincerely trying to meet individually the needs of the students, should have a thorough knowledge regarding the advantages of different educational Taxonomies in curriculum transaction.

The investigator, a teacher of Physics for several years thought of taking a study to understand the effectiveness of a Taxonomy other than the usually following Bloom's Taxonomy. Thus a study is envisaged for understanding the Effectiveness of McCormack and Yager Taxonomy in Teaching Physics at Secondary level. Hence the importance of the study.

1.7. Statement of the Problem

The overall purpose of education is to bring about worthwhile changes in the behavioral patterns of students. To implement the national objectives on education such as Education for productivity, Education for social and national integration etc., the aims and purpose must be stated in terms of the kinds of behavior expected from students who have
achieved them. Thus to judge the success of one’s teaching, educational progress should be measured in relation to definite instructional goals. The Taxonomy of educational objectives enables the teacher to set her teaching tasks and evaluate the success of her pupil’s efforts according to the specific objectives under each domain. The instructional objectives are classified under three major domains according to Bloom's Taxonomy and under five domains according to McCormack and Yager Taxonomy.

The study was undertaken with the aim of finding out the effectiveness of McCormack and Yager Taxonomy than the present using Bloom’s Taxonomy in Teaching Physics. Hence the study is entitled “EFFECTIVENESS OF MCCORMACK AND YAGER TAXONOMY IN TEACHING PHYSICS AT SECONDARY LEVEL”.

1.8 Operational Definition of Key Terms

1.8.1 Effectiveness

It refers to the effect of the presentation of ideas or activities involved in a teaching unit that produces a favourable learning outcome.

1.8.2 McCormack and Yager Taxonomy

It includes the classification of domains/objectives given by two eminent educationists McCormack and Yager. McCormack and Yager (1989) developed a new “Taxonomy of Science Education” that broadens the view of science education beyond the two domains of content and process into five domains that should be considered crucial for any good
science curriculum. The five domains include Knowledge, Process, Creativity, Application and Attitude.

1.8.3. Teaching Physics

Teaching is the act of providing activities, materials and guidance that facilitate learning either in formal or in informal situations. Teaching Physics means imparting knowledge or information by means of lessons based on Physics.

In this study Teaching Physics means measuring the effect of teaching on Achievement in Physics using an Achievement test and also to measure the effect on other associated variables such as Physics Interest, Scientific Attitude, Science Creativity, Science Process Skills and Metcognitive Awareness.

1.8.4. Secondary level

Secondary level as used in the study refers to students attending Standards VIII, IX and X in schools of Kerala. For the present study, the investigator has selected students of Standard-X following Kerala state syllabus.

1.9 Objectives of the Study

1. To find out the Achievement in Physics of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.
2 To find out the Achievement in Physics of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy under the different domains/objectives.

3 To compare the Achievement in Physics of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.

4 To compare the Achievement in Physics of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy under the different domains/objectives.

5 To compare the Physics Interest of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.

6 To compare the Scientific Attitude of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.

7 To compare the Science Creativity of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.

8 To compare the Process Skills in Science of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.

9 To compare the Metacognitive Awareness of students taught using McCormack and Yager Taxonomy and Bloom’s Taxonomy.
1.10 Hypotheses of the Study

The following hypotheses were formulated for the present study.

1. The Achievement in Physics of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.

2. The Achievement in Physics of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy under the different domains/objectives.

3. The Physics Interest of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.

4. The Scientific Attitude of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.

5. The Science Creativity of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.

6. The Science Process Skills of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.
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7. The Metacognitive Awareness of students taught using McCormack and Yager Taxonomy is significantly higher than that of those taught using Bloom’s Taxonomy.

1.11 Methodology in Brief

Experimental verification was necessary to determine the effectiveness of McCormack and Yager Taxonomy in teaching Physics to Secondary school students. Thus experimental method was used for conducting the study and the design selected was pretest - posttest nonequivalent group design (Best and Kahn, 2004).

Sample selected for the study

The sample for the study consisted of 340 students of Standard-X from eight divisions in four secondary schools of Alappuzha district. Four divisions (one from each school) were considered as experimental group and the other four divisions (one from each school) were considered as the control group. Both the experimental and control groups consisted of 170 students each.

Tools used in the study

The tools used for the study were

1. Raven’s Standard Progressive Matrices
2. Lesson Transcripts based on McCormack and Yager Taxonomy
3. Lesson Transcripts based on Bloom’s Taxonomy
4. Achievement Tests in Physics based on McCormack and Yager Taxonomy and Bloom’s Taxonomy (prepared by the investigator)

5. Physics Interest Inventory (prepared by the investigator)

6. Scientific Attitude Scale (prepared by the investigator)

7. Science Creativity Test

8. Science Process Skills Test (prepared by the investigator)

9. Metacognitive Awareness Inventory

Procedure adopted in the study

Before starting the experimental treatment, the investigator classified the selected students into two groups (four divisions each) by comparing their previous Achievement in Physics and their general mental ability and also with the opinion of the Physics teachers in the concerned schools. Then in both groups Achievement tests, Physics Interest Inventory, Scientific Attitude Scale, Science Creativity Test, Science Process Skills Test and Metacognitive Awareness Inventory were administered as pre-tests. After that the investigator herself conducted classes in both the groups. The Experimental group was taught using McCormack and Yager Taxonomy and the Control group was taught using Bloom’s Taxonomy. After the treatment, all the tests given as pre-tests were administered again to both the groups as post-tests.
Statistical techniques used

The scores obtained by the students in the pre-test and post-test were classified, tabulated and subjected to statistical analysis. This includes comparison of mean scores of pre-test scores, post-test scores and gain scores using ‘t’ test with a view to get a formal conclusion of the comparative effectiveness of the treatment. More precise conclusion was arrived at using the technique – Analysis of Covariance.

1.12 Scope of the Study

McCormack and Yager Taxonomy was adopted as an effective means to attain the accomplishment in learning Physics. This can help the secondary school students to learn more meaningfully and effectively the content of Physics, which is usually abstract in nature. This will also help the young learners to develop an interest in Physics and ultimately develop a positive attitude towards the study of Physics.

It is hoped that the findings of the study will be useful for the learners, teachers, trainers and curriculum designers. Work in this area will help to create robust, well designed and pedagogically sound learning strategies.

Strategies of teaching and learning triggered by McCormack and Yager Taxonomy will open new perspectives for the education and training of skills and abilities in terms of flexibility, interactivity and autonomy. This will help the students to properly structure their schemata
of conceptual knowledge and allow them to become better learners as well as problem solvers.

It is further hoped that the procedure adopted for the present study is adequate to throw light on the problem under investigation. It is hoped that the suggestions of the study may serve as guidelines for teachers and students to make teaching and learning a more enjoyable task.

1.13 Limitations of the Study

In spite of all possible precautions taken up, certain limitations have crept into the study.

- The study was confined to schools in Alappuzha district. More generalized result would have been obtained if different districts had been taken for the study.

- The study was limited to students of Standard-X studying in Kerala State Syllabus.

- Due to practical difficulties 48 lesson transcripts on three units could be prepared for the treatment.

- The investigator selected the classroom intact groups for experimenting, as the one to one equalized group was not possible practically.

Despite the above mentioned facts, all possible attempts have been made to make the study as valid and reliable as possible. It is hoped that
the results of the present study would be helpful in finding new frontiers in the field of education.

1.4 Organization of the Report

The report of the study is structured in six chapters.

**Chapter I** is the introductory chapter which contains background of the study, the need and significance of the study, statement of the problem, definition of key terms, objectives of the study, hypotheses formulated for the study, methodology in brief, scope of the study, limitations of the study and organisation of report.

**Chapter II** contains the theoretical background of McCormack and Yager Taxonomy and Bloom’s Taxonomy.

**Chapter III** presents a brief review of related literature and research findings pertaining to McCormack and Yager Taxonomy and Bloom’s Taxonomy.

**Chapter IV** is the methodology chapter which gives the description of the method adopted, design of the study, description of tools used, sample selected for the study, data collection procedure, scoring, consolidation of data and the statistical techniques used in the study.

**Chapter V** gives a detailed analysis and interpretation of the results of the data.
Chapter VI contains a summary of the findings and major conclusions of the study together with educational implications and some suggestions for further research.

The Report is followed by a fairly exhaustive bibliography. The bibliography is followed by a series of appendices pertaining to the study.