Chapter I
INTRODUCTION

1.1 Nature of Science and Science Teaching

1.1.1 Nature of Science Concept

Science is a human enterprise that contributes enormously towards extending the intellectual horizons and also in solving many of our practical problems for example (Ahmad et al, 2011, 99), i. Science is an important way to understand the world. Understanding means to gain insight into the way all nature works in a causal and mechanistic sense. Science helps us to understand motions in the heavens, the tides, and the movement of terrestrial bodies, the chemical constituents of matter and the nature and evolution of living organisms. There is no other way to understand such objects and processes, ii. Science attempts to explain natural phenomena in terms of the underlying causes in as economical way as possible - preferably using mathematics. The ideas have to be self consistent and correspond with reality. They must be tested scientifically, iii. Scientific knowledge is self-consistent. The self-consistency implies that one branch of science must be consistent with all the others; Biological theories cannot contradict Chemistry, iv. Science is a special form of knowledge. But the differences lie both in the subject matter and the techniques. In science the ideas are value-free and v. A surprising aspect of science is that almost every important idea can be expressed in a precise manner.

The Nature of Science (commonly abbreviated as NOS) is defined in various ways. It can be defined simply as what science is and how science works (Lederman, 2007). The term also refers to the epistemology of science, science as a way of knowing, or the values and beliefs inherent in scientific knowledge. The wide range of definitions is not surprising given that science itself is a wide-ranging subject (Abd-El-Khalick et al., 2001). While there is little agreement on a specific definition of the term, most researchers do agree that the lack of an exact and widely used definition is not necessary for K-12 education.
McCormack and Yager (1991) identified five domains of development in science education as given below:

**Figure 1.1: Five Domains of Science Education**

1. **Knowledge domain (knowledge and understanding):** Knowledge about scientific facts, concepts, principles, laws, knowledge about science and social issues.

2. **Process domain (exploring and discovering):** Process domain involves encouraging students in constructing knowledge through exploration, inquiry and discovering knowledge. Students are to be trained to enquire and discover knowledge. There are sixteen process skills: observing, collecting and recording data, classifying, measuring, comparing, Analysing and interpreting data, experimenting, identifying and controlling variables, raising questions, generalizing, problem solving, formulating hypothesis and testing, making conclusion, decision making, inferring and predicting and handling apparatus.
3. Creative domain (Imagining and creating): students should be encouraged to think differently where new ideas and imagination emerge. There are eight subset under this domain: visualization (production of mental images), combining objects and ideas in a novel way, applying ideas in a new situation, solving problems and puzzles, fantasizing, designing of devices and machines, dreaming and lateral thinking.

4. Attitudinal domain (feeling and valuing): by product of learning science is the development of attitude and values. The science learning should promote required attitudes and values in a positive direction, as well as help learners in decision making and in becoming good problem solvers. Six subsets under this domain are: positive attitude towards science, confidence, give respect to others emotional state, give respect to others point of view, present ones thoughts and emotions in a creative way and take correct decisions by analyzing emotional situation.

5. Application domain (using and applying): students should be made capable of applying knowledge, skills, and values in their daily life. There are seven subsets under this domain: observing examples of science concepts, applying science knowledge to solve problems related to daily life, understanding the scientific principles behind home appliances, use of scientific processes in solving problems that occur in daily life, ability to evaluate science related incidents, decision making related to personal health, nutrition and lifestyle based on knowledge of scientific concepts rather than on hearsay and emotions and ability to make integration of science with other subjects.

1.1.2 What is Science?

Science is a way of knowing, a method of learning about nature. Rooted in common sense, its formal, systematic method is called scientific inquiry. In doing scientific inquiry, scientists use a variety of empirical approaches, techniques, and procedures to collect data from nature, examine and analyze that data, and construct knowledge based on it. This knowledge relates to living organisms, non-living matter, energy, and events that occur naturally. To analyze data scientists often, but not always, use mathematics, and they always apply logical arguments that obey strict empirical standards and healthy skepticism (Leaderman, 2007).
Science has several aspects that need to be understood in working with children:

1. Science is a way of searching for information-for facts about the universe and for the everyday information that people need.

2. Science is a body of knowledge organized as a result of careful investigation.

3. Science is a way of thinking about ordinary life experiences – a way of reducing fear with facts, of making reasoned guesses, of withholding judgment for more information.

4. Science is a way of using knowledge in solving practical problems of life.

   Essentially, then, science must be considered a way of life. It is the way we discover, organize and use information to improve living. It is the composite of what we may more formally speak of as “scientific method,” “scientific knowledge,” “scientific thought” and “scientific technology” (Huey, 1965, 54).

1.1.3 Teaching Science in School

   School must be concerned with teaching science in its composite form—as discovery, relatedness, interpretation and practical usefulness—all facets present but seldom isolated. More than emphasizing the teaching of science, the elementary school needs to foster the living of science. To teach science merely as a body of facts and principles is to leave to chance the possibility that students will use this knowledge in interpreting phenomenon and in solving problems. School living of science, or teaching science as a way of life, utilizes the natural tools of science that the student develops as he grows (Huey, 1965, 55).

   Science teaching activities provide the opportunity to involve students, so that the three aspects of science can be covered. Useful and relevant information in the historical perspective can be presented by the teacher in class. This can be followed by laboratory activities to develop in students a feel for the ‘method’ of science. Laboratory activities help students not only to collect data and test the validity of the concepts learned, but they also serve to develop scientific attitude and Creative Thinking (Mohan, 2007, 7).

   The reality of the current methods of teaching science in many of our schools is not in line with the objectives of science teaching. Teaching methods still depend on the
teacher as the only source of information whereas the role of students in the classroom is passive. They listen, memorize, and then repeat what they memorized without any understanding of the information they got and without any knowledge of how to apply them in their daily lives. Traditional teaching methods give emphasis more on providing content than on developing thinking skills of students. Science education, in particular, needs to go beyond the scope of content knowledge because it essentially has to develop attitude and Creative Thinking in student. At the school level, science education can be improved by adopting suitable teaching methods that promotes attitude, knowledge cognitive processes and Creative Thinking. Dimensions of Learning Model focuses on learning environment in which students have the opportunity to construct knowledge themselves. Yager (1991, 420) confirms that one of the main problems in education is the students’ inability to use what they learnt in new situations. Students do not feel a correlation between what they learnt in the school and what they face in their public lives from the situation and problems (Albohai, 2001, 240).

Therefore educators called for different teaching strategies and suggested that teachers need to be given resources and other opportunities to change their instructional strategies that would in turn support the quality of science teaching and help to provide an integrated experience for students suited to their level and relevant to their needs and problems. Muncie (2003, 38) notes that one of the fundamental objectives of the learning is that students should learn ‘how to learn’ and how they become active actors as the center of the learning process. Abdulwahab (2004, 128) confirms that it is necessary to shift from the teaching of science to the learning of science. This means transition from learning of memorization and repetition into active learning, which engages the students in the learning process and leads to increasing the curiosity of the students and the formation of positive attitudes towards science and the development thinking capabilities of the learner.

The report of UNESCO planning mission (1964) recommended that “science and mathematics should be taught on a compulsory basis to all students as a part of general-science education during the first ten years of schooling” (Anwar, 1991, 4).
1.1.4 Teaching Science in Yemen

Science curriculum has been designed and developed based on the educational ladder of basic education that includes primary and higher primary stages. These stages cover the period of the first nine years of which six years should be studied by students at the primary school and three years at the high primary school. The secondary education comes next covering the last three years of school.

The following table shows the time plan for teaching science in higher primary school and secondary school (Center of Researches and Educational development, 2000):

Table 1.1: Time Plan for Teaching Science

<table>
<thead>
<tr>
<th>Subject</th>
<th>Higher Primary Stage</th>
<th>Secondary Stage</th>
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<tbody>
<tr>
<td></td>
<td>Seventh</td>
<td>Eighth</td>
</tr>
<tr>
<td>General Science</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Physics</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chemistry</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Biology</td>
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The table shows that science in higher primary standards (7-9) is taught in an integrated form under the name of general science including the fields of chemistry, physics and biology. At the secondary stage (10-12), however, science is taught as separate subjects-chemistry, physics, biology and geology. Students in higher primary standards (7-9) Study science at the rate of 5 sessions per week where each session is approximately 45 minutes and with Arabic as a medium.

1.1.5 Objectives of Teaching Science in School

There are seven objectives for teaching science in the school curriculum. They are:

i. Towards Better Understanding of the Nature of the Science

The student should begin to understand the cumulative nature of scientific knowledge. After studying science, the student should acquire knowledge of the following:
Fundamental principles and concepts useful in daily life
A body of facts to understand scientific literature
Inter-relationship and interdependence of different branches of science
Knowledge of general rules of health and human body.

ii. Towards Acquisition of Skills
Exposure to scientific concepts both in the classroom and in the laboratory leads to the acquisition of following skills in the student:
- Experimental skills handling apparatus and instruments.
- Constructional skills of making improvised aids.
- Drawing skills involving drawing diagrams of experiments.
- Problem solving skills.
- Observational skills like taking readings and noting color changes.

iii. Towards Development of Scientific Attitudes
The student should begin to develop scientific attitude characterized by:
- Open mindedness
- Curiosity
- Honest doubt
- Respect for other’s point of view
- Critical observation and thought
- Judgment made on scientific facts
- A planned procedure in solving problems.

iv. Towards Training in Scientific Method
As result of science education, the student should habitually and skillfully employ sound thinking habits, in meeting problem situations in the daily walks of life. He should be able to adopt the following steps in problem solving:
- Sensing a problem
- Defining a problem
- Collecting relevant evidence
- Organizing and interpreting the data
- Formulating the hypothesis
Testing its validity and accuracy
Drawing rational conclusions.

v. Towards Development of Interest and Appreciation
The teaching of science should enable a student to develop and enjoy personal interest, some of which are related to science.

vi. Towards Helping the Students fit themselves Better into Society
The science curriculum gives extensive practice in working together.

vii. Towards Helping the Students Develop Suitable Career Interest
The science curriculum should prepare the student for some vocation and specialization in the individual subjects and professional courses, like engineering, medicine, aeronautics, sericulture and so on.

1.2 Rationale and Significance of the Study

It is already accepted that both Creative Thinking and Attitude towards Science are the two important outcomes of science learning. Science education of the present day cannot ignore these elements, since we are aiming at shifting away from the predominance of knowledge transfer in the classrooms to a curriculum that promotes higher order thinking skills in students. Moreover, the profusion of knowledge in every field of learning demands promotion of autonomous learning skills in students to help them seek information that they need in their career and life and the skills that are required to effectively exploit the available information. Thus the focus must now shift from ‘what and how much’ the students have learnt to ‘how the students learn’.

Despite science is around us everywhere and makes our lives easier from the technological aspect, science has not been taught very efficiently. The research done either in this country or abroad has found the same failure (Van Heuvelen, 1991). Research done abroad has showed that conventional teaching has negative effects on most of the students. Even in well-developed countries, it has been discovered that goals cannot be reached in the teaching of science (Rivard and Straw, 2000), that Achievement in Science is lower than other fields (Mattern and Schau, 2002), that students do not like science lectures (Neathery, 1991), and that most of them do not prefer the science area (Boylan, 1996).
Students with positive attitudes toward science are more likely to be found in classrooms that have high levels of involvement, teacher support, and use of innovative teaching strategies. Teachers who lack ability, confidence, and enthusiasm for the subject tend to use less stimulating, more didactic methods and do not respond effectively to students’ questions. Those teachers also are more likely to have students with poor attitudes toward science. Effective teachers adapt learners’ needs and evaluate how information should be presented. To meet these demands, teachers need to adjust instruction to student ability levels and background.

It would be necessary to find out the main reasons behind this low Achievement level in the science area. Also, this question is one of the main concerns for science educators and researchers in Yemen. Related to this problem, Jelinek (1998) reported that one of the most important reasons for the low Achievement seems to be students’ low interest and negative attitudes toward science. A study by Haladyna, Olsen and Shaughnessy (1982) indicated similar results that showed students’ feeling toward science, their Achievement in Science area and their future career preferences strongly correlated with students’ attitudes toward science. (Cited in Turkmen, 2007, 67). Also one of the obstacles to thinking is the teacher himself in his adoption of the traditional methods of teaching used in the classroom. Alshaabi (2009) confirm that the main obstacle to the enhancement of the thinking and attitudes of the learner at the present time in general education is the teacher’s methods used in the classroom. Teacher should cause his students to be more initiative and more capable of doing creative activities (Shehata, 2004, 107).

However, it is true that most of the successful students are the passive receptors of the schools in which knowledge is transmitted (Fensham et al., 1994). The cause for the failure of science teaching may be the result of presentation of science as a prepared and inexperienced knowledge to the students. In addition, many teachers lack the training needed for teaching science using novel strategies. As can be seen from here, generally rote learning is dominated at schools and as a result of this it causes students memorize rather than meaningfully understand what they learn at school. Besides, students can not relate what they learn as science at school with their daily lives.
In order to strengthen the quality of science education at all levels, there seems to be an urgent need to practice learner-centered, approach for teaching science at the high primary level, which will make the learning of science an enjoyable experience for students. An effect Model of teaching-learning intends to empower the learners with the ability to master various competencies.

Science education has great importance in achieving the goals of education and is an indispensable part of school curriculum. Creative Thinking and Attitude towards Science are two important outcomes of science education. More studies needs to be conducted in this area so as to improve science education and its outcomes. Though traditional methods of teaching science have been effective, better teaching methods that give due importance to these two outcomes need to be studied.

Although the Project of Science Curriculum Development in Yemen (2000) gave emphasis to the development of Creative Thinking, Achievement in Science and attitude towards science, most of the teachers were not aware of these learning outcomes as they are not oriented in these lines, partly because of insufficiencies in the in-service training inputs they have received.

The problem of the Study and its significance is premised on the following sources: the Investigator’s feeling and experience in the field as a science teacher and through his supervision of student teachers as a demonstrator, as well as through his observation of the traditional methods followed in schools which were characterized by complete activeness on the part of the teacher and complete passivity on the part of the students. A number of recent studies such as (Al-Dobai, 2004; Al-Homaidi, 1999; Al-Hudabi & Al-Doais, 1995; Mie, 1999; Raweh, 2001; Bamoqabel, 2007) which have indicated that the Achievement of Yemeni students in science is very low due to the use of traditional methods. In addition, the researcher has found that Creative Thinking and Attitude towards Science is a neglected aim of school teaching and most students have a negative Attitude towards Science lectures because they feel that learning process is based on theoretical knowledge which they cannot employ in their ‘practical’ life. Also, students feel that there is a gap between the syllabi they learn at school and their actual day-to-day needs. Besides, the World Bank report issued in New York in 2008 observes
that “Yemen is ranked penultimate in the field of education at the level of the Middle East and North Africa”. All of these indicators require a serious re-consideration of the educational process. The present Study is nothing but a step towards achieving this goal.

Nevertheless, several studies were conducted on the low level of Achievement in Yemen, using modern methods and strategies such as cooperative learning, concept map, learning cycle, inquiry, problem solving, constructive learning, brainstorming, and structured education etc. The results of these studies indicate that there is a positive effect in favor of the Experimental Group in the development of the Achievement, Attitude, Science Processes, Decision-making, and Critical Thinking. Nevertheless, there is not any improvement in the deployment of the Creative Thinking and attitude towards science, and the day-to-day constituent of teaching of science has not paid considerable attention.

Furthermore, although several studies were made on the pedagogical deficiencies in the educational system in Yemen, little has been done with regard to Dimensions of Learning Model. Consequently, this Study acquires importance by attempting a close examination of the effect of Dimensions of Learning Model on Achievement in Science, Creative Thinking and attitudes towards science, focusing on eighth standard students in Yemen as a case in point.

This Study proposes that Dimensions of Learning Model, which is based on the principle that the students are required to construct knowledge in the classrooms, can help identifying the various teaching and classroom management techniques to effectively implement a curriculum that aims at fostering Creative Thinking and attitude towards science.

Further, by focusing on the development of Creative Thinking and attitudes towards science through science education, the Study is expected to be useful in finding means and methods to develop these in students effectively in the classrooms. Also, it is hoped to be helpful in restructuring the science education curriculum and reinforcing the pedagogical approach from teacher-oriented to learner and learning centeredness.

The significance and value of the Study comes from its introduction of a new method and approach of teaching to the students of science subject. Besides, the Study
will be of a paramount importance to educators, Investigators and teachers in developing
the teaching of science in Yemen through the examination of the application of the Model
of Dimensions of Learning to the educational system. It will also be helpful to educators
who specialize in setting up and re-formulation of curriculum content according to the
Model of Marzano.

1.3 Statement of the Problem

Various instructional Models or programs are based on cognition and learning. One of the latest Models of instruction is Dimension of Learning (DOL). The DOL Model is derived from the theory and research base of Dimension of Thinking. The five dimension of thinking are “metacognition, critical and Creative Thinking, thinking processes, core thinking skills and the relationship of content-area knowledge to thinking” (Marzano et al., 1988, p. 4). These form the theoretical basis from which the DOL Model evolved (Marzano, 1992). The DOL Model provides a practical framework that can be used for all grade levels and content area (Marzano, 1992). The DOL Model provides a teacher’s manual with a full repertoire of teaching strategies that can be used by a teacher in planning instruction, reorganizing curriculum, and assessment. With its wide variety of strategies for each dimension, the teacher’s manual provides a practical tool from which teaching strategies relevant to a unit can be chosen.

In essence, the DOL Model is an integrative framework for instructional planning because it incorporates a number of instructional strategies from other popular programs. The premise of this Model is that a teacher actions cue student thinking, eliciting certain behaviors (Marzano & Pickering, 1991). With the emphasis on systemic reform, if research based teaching strategies are used students might learn more. Marzano (1992) states, “The belief underlying the DOL Model is that both content knowledge and thinking and reasoning processes need to be taught if we want students to become proficient learner” (P. 32).

Dimensions of learning are Model to teaching that emphasis to the concept that knowledge is constructed. This Model help the students, not only in acquiring and integrating knowledge but also in extending and refining knowledge and using knowledge meaningfully. This is particularly essential in science education, where
development of Creative Thinking and Attitude towards Science are seen as outcomes of science learning.

The problem of the present Study is stated as follows:

"Impact of Marzano’s Dimensions of Learning Model on Achievement in Science, Creative Thinking and Attitude towards Science among Students of Eighth Standard"

1.4 Delimitation of the Study

Following delimitations were the self imposed restrictions by the Investigator due to paucity of time, limited availability of resources and several other aspects that cannot be covered in the present Study due to practical constraints.

1. The Study was confined to the teaching of science for eighth standard class students during the period March-May of 2011-2012 academic year
2. The Study was delimited to selected two Public higher primary schools (boys' school & girls' school) of Adhehar District, Ibb City, Republic of Yemen.
3. The Study was delimited to investigate the effect of Dimensions of Learning Model on Achievement in Science, Creative Thinking and Attitude towards Science of higher primary school.

The next Chapter presents the background related to the topic of study viz. Dimensions of Learning Model, Creative Thinking and Attitude towards Science.