CHAPTER II

THEORETICAL BACKGROUND

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2.1 Marzano’s Dimensions of Learning Model

2.1.1 Design of Dimensions of Learning Model

Dimensions of Learning Model is a program designed to improve students’ thinking skills that provides a comprehensive basis for instructional planning and curriculum design. Based on the best of current research in learning theory and cognitive psychology, Dimensions of Learning is the product of collaboration between the Association for Supervision and Curriculum Development and a team of authors headed by Robert J. Marzano of the Mid-continent Regional Educational Laboratory (Brown, 1995, 6).

The Dimensions of Learning Model was developed in United States at MCREL, the Mid-Continent Region Educational Laboratory, in Colorado, by Marzano and a team of Investigators. Dimensions of learning translate the research and theory explicated in dimensions of thinking into a practical Model that K-12 teachers can use (Marzano, 1992). The program brings together what recent educational and psychological research has reported about the way students learn, into an integrated structure, incorporating a wide range of strategies, suitably packaged for use in schools. It grew out of an earlier project, dimensions of thinking (Marzano et al, 1988).

Dimensions of Learning Model based on constructivism theory which emphasizes that the learners generate knowledge and meaning from their experience. (Marzano, 1996, 13).

Marzano suggests the Dimensions of Learning Model are six assumptions (Marzano, 1992, Brown, 1995, 6).

1. Instructional should reflect the best of what we know about how learning occurs.
2. Learning involves a complex system of interactive processes that includes five types of thinking.
3. What we know about learning indicates that instruction focusing on large, interdisciplinary curricular themes is the most effective way to promote learning.
4. The K-12 curriculum should include explicit teaching of higher level attitudes and perceptions and mental habits that facilitate learning.

5. A comprehensive approach to instruction includes at least two distinct types of instructions: one that is more teacher-directed and another that is more students-directed.

6. Assessment should focus on students use of knowledge and complex reasoning rather than on their recall of low-level information.

2.1.2 What are the Five Dimensions of Learning?

The Dimensions of Learning program suggests that for effective learning to take place, the teacher and the students should participate in five different dimensions. These five Dimensions are the following (Marzano, 1992, 4):

2.1.2.1 Dimension 1: Positive Attitude and Perceptions about Learning

It indicates that for learning to be effective, students must feel safe, secure and valued in their learning environment, because without positive attitudes and perception, students have little chance of learning proficiently. There are two categories of attitudes and perceptions that affect learning: attitudes and perceptions about the learning climate and attitudes and perceptions about classroom tasks.

1-1 Learning Climate

There are two types of attitudes and perceptions that affect learners' mental climate: a sense of acceptance and a sense of comfort and order. (Marzano, 1990) suggests many ways help teacher to foster learner's sense of acceptance (59):

- By making eye contact with each learner in the class being sure to pay attention to all quadrants of the classroom.
- By calling all learners by their first or preferred name.
- By deliberately moving toward and staying close to learners.
- By touching learners in appropriate and acceptable ways.
- By greeting learners at the door.
- Providing time to allow a learner to answer instead of moving on to another learner.
- Restating the question-asking the question a second time.
- Rephrasing the question-using different words.

Comfort means here physical comfort. A teacher will foster learner's sense of physical comfort in the classroom through arranging a desk and other furniture in the classroom and giving breaks when the learners need it (Marzano, 1992, 22).

1-2 Classroom Task

Proficient learners believe that the tasks they are asked to perform have value, that they have a fairly clear understanding of what the tasks require, and that they have the resources necessary to complete the tasks. Teachers can use specific classroom techniques to bolster these beliefs.

1-2-1 Task Value

The perceived value of task is the most important to the learner's success because the learners are most motivated when the tasks are relevant to their daily live. The teacher must first find out what his learners are interested in, for example, knowing that many students in the class are fans of professional of basketball, a teacher might use the box scores from the newspaper to illustrate the concept of the “average”.

Capitalizing on the natural curiosity of learners is another way of making task relevant. The learners want to know why things happen, how they work, what the parts are, what will happen if, and so on. Teacher can tap the natural curiosity through present of some natural phenomena associated with the lives of learners. For example, when a teacher describes the phenomenon of lightning and thunder, he explains the causes that lead to the occurrence of this natural phenomenon. After that the teacher asks learners to watch a film about this phenomenon, then the learners will be fascinated and their enthusiasm to learn all information on this phenomenon will be increased.

1-2-2 Task Clarity

If learners don’t have a clear Model of how a task will look when it is completed, their efforts to complete the task will often be ineffective. A teacher will provide guidelines about how to make tasks and expectations about tasks clear for learners through provide Models of completed tasks. The teacher will present a Model of how
each task should look when complete. For example, the teacher presents the Model of how to install parallel electrical circuit.

1-2-3 Resources

Learners must perceive that they have the necessary materials, time, equipment, and so on, to complete a task, learners must also perceive that they have the necessary internal resources such as ability and effort. The teacher will continually reinforce the importance of effort and boost learner's sense of their ability. Slavin (1995, 80) suggests that learners should occasionally receive rewards (such a marks) based on their efforts rather than on their successful completion of tasks.

2.1.2.2 Dimension 2: Acquiring and Integrating Knowledge

A fundamental principle of learning is that acquiring knowledge involves a subjective process interaction between what the students already know and what they want to learn. If they can’t link new knowledge with their prior knowledge, learning is much more difficult. (Paris et al, 1983, 301; Marzano, 1992, 32) indicated that there are two types of knowledge, declarative knowledge that is knowledge of facts or knowledge about something and procedural knowledge or knowledge of how to perform some task. For declarative knowledge, the program provides strategies for constructing meaning, organizing the knowledge and for storing the knowledge. Also for procedural knowledge there are strategies for constructing Models of the processes to be learnt, for shaping the processes and for internalizing these processes.

Helping learners acquire and integrate basic declarative and procedural knowledge requires attention to the three aspects of learning specific to each type of knowledge.

2-1 Declarative Knowledge

Learning declarative knowledge involves three phases: constructing meaning, organizing, and storing.

2-1-1 Constructing Meaning for Declarative knowledge:

The learners use what they already know about topic to interpret what they are learning. Without prior knowledge with which to interpret new declarative knowledge, nothing makes much sense. The teacher will use one of the most popular strategies is the
K-W-L strategy developed by Donna Ogle (1986). During the first phase of the strategy, learners identify what they think they know about the topic. For example, before reading a chapter describing how lakes die, students would list the facts they already know about this phenomenon. Next, they would list what they want to know about the topic: interesting questions that have come to mind as a result of identifying what they think they know. For the topic of dying lakes, students might ask these questions: How long does it take for a lake to die? What exactly is the process? Can dead lakes be revived?

Students then read the chapter with an eye toward answering the questions they have posed. The last step in the K-W-L process for students to identify what they have learned. Here students record the answers to their questions as well as other information they have learned. In many cases, they also find out that what they thought they knew was inaccurate.

2-1-2 Organizing Declarative Knowledge

There is another process is necessary for learners to truly make the information their own. This process is called “Organizing”.

The teacher will use advance organizers which it considers the most obvious strategy for helping learners organize their information, as described by Ausubel (1968). These usually take the form of questions provided to learners before they read a section in a textbook, watch a film, or complete some other activity. The questions guide learners in organizing the information they will encounter. Some other ways of helping learners organize information include using physical and symbolic representations, and using graphic organizers.

2-1-2-1 Using Physical and Symbolic Representations

A physical representation is a physical Model of the information, and it includes any three-dimensional representation of information. For example in Force of attraction between objects lesson, learner might great a physical Model of the solar system using materials like plastic balls, and wire.

In symbolic representation the teacher will use the following equation:

\[ F = \frac{(M1 \times M2) \times G}{R} \]
The learners might understand the equation through internalizing the relationships among the various quantities.

### 2-1-2-2 Using Organizational Patterns

Declarative knowledge can be organized in various types of semantic pattern. There are at least six general Organizational Patterns:

- **Descriptive Patterns** organize facts or characteristics about specific persons, places, things, and events. The facts or characteristics need be in no particular order. For example, information in a film about the Respiratory system, how many organs it has?, the roll of each organ, Disorders of the respiratory system and so on might be organized as a simple descriptive pattern.

- **Sequence Patterns** organize events in a specific chronological order. For example, the oxygen cycle in nature might be organized as a sequence pattern.

- **Process/Cause Patterns** organize information into a causal network leading to a specific outcome or into a sequence of steps leading to a specific product. For example, information about the events leading to the extinction of the dinosaurs might be organized as process/cause pattern.

- **Problem/Solution Patterns** organize information into an identified problem and its possible solutions. For example, information about the various types of consumption errors that occur when we use electricity in our daily lives and the ways of correcting those errors might be organized as a problem/solution pattern.

- **Generalization Patterns** organize information into a generalization with supporting examples. For example, metals might be organized using this generalization:” Metals is conductive materials of electric current.” It would be followed by examples of specific metals.

- **Concept Patterns** organize general categories or classes of persons, places, things, or events. Concept patterns usually include the defining characteristics and specific example the concept. For example, a film on the concept of “Ions” might contain defining characteristics of this concept.
2-1-2-3 Using Graphic Organizers

Using different types of graphic representations to organize information is very popular in the classroom. The following figure shows six types of organizational patterns:

Figure 2.1: Types of Organizational Patterns
2-1-3 Storing Declarative Knowledge

Being able to recall some information, however, is vital for success in all content areas, imagine, for example, how difficult much of physics would be if they, the learner couldn’t remember the timetable. All memorization techniques use some form of elaboration. One of the most powerful ways to elaborate on information is to imagine mental pictures with the information. For example, a teacher can help students elaborate on the information about alcohol when he tells the story of the person who drank too much. As he described sounds, smell, taste and so on, he helps students create images that are elaborations on the basic information about alcohol.

2-2 Procedural Knowledge

Learning procedural knowledge involves three phases: constructing Models, shaping, and internalizing.

2-2-1 Constructing Model for Procedural Knowledge

Among the most powerful techniques are think aloud modeling, and flow charting. Think aloud modeling involves the teacher expressing his thoughts and, thus, presenting a Model for the procedure as he works through a skill or process. A flow chart is another method of Model construction, the flow chart provide learner with visual representations and greatly improve their ability to construct a Model. For example, a teacher helps learners develop a Model for the process of the difference between the parallel and series circuits. He will think aloud as he perform practically (explain the steps aloud), and write the steps on an aboard. As he do so. He will also ask learners to create a flow chart of the steps.

2-2-2 Shaping Procedural Knowledge

In this phase, learners alter the initial Model of the skill or process. There are some suggestions for that: guided practice is a powerful instructional technique for helping learners understand procedural knowledge, and demonstrate a variety of errors that learners can make while performing the skill or process. Therefore a teacher will ask a few learners about the difference between the parallel and series circuits in front of the
whole class. For example, explain the steps of the installation of parallel circuit? What is the difference between PC and SC? As they do so, he will ask “What if” questions that will make learners aware of the errors they might easily make. For example, what happened to glow of bulb when you connect the three batteries in parallel? Why?

2-2-3 Internalizing Procedure Knowledge

The final stage of learning a skill or process is to internalize the knowledge: to practice it to the point where the learners can perform it with relative ease. To help learners develop their ability to a level of automaticity, the teacher will provide time for learners to practice the experiment in pairs or groups.

2.1.2.3 Dimension 3: Extending and Refining Knowledge

Learning does not stop with acquiring and integrating knowledge. Learners develop in-depth understanding through the process of extending and refining knowledge (e.g., by making new distinctions, clearing up misconceptions, and reaching conclusion) they analyze what they have learned by applying reasoning process that will help them extend and refine the information. There are a number of complex reasoning processes which encourage students to examine their knowledge in different ways. These processes are infinite but there is a finite set of processes that are suited to content area instruction. This forces them to be engaged in their learning and reinforces their understanding. These complex reasoning processes include comparison, classification, induction, deduction, analyzing error, constructing support, abstraction and analyzing perspectives that help in thinking critically (Ennis, 1987; Marzano, 1998, 269).

3-1 Comparing

Identifying and articulating similarities and differences between things. For example, how is the electrostatic and electric current alike? What particular characteristics are similar?

3-2 Classifying

Grouping things into definable categories on the basis of their attributes. For example, in to what groups could you organize these things: iron, plastic, wood, glass,
stone, cooper, paper, rubber, and wet paper? What are the defining characteristics of each group?

3-3 Inducing

Inferring unknown generalizations or principles from observation or analysis. For example, based on the following observations: Thin wire is heated more than a thick wire at the passage of electric current. What can you conclude?

3-4 Deducing

Inferring unstated consequences and conditions from given principles and generalizations. For example: based on the following principle: ionic bonds are stronger than covalent bonds? What conclusions can you draw that must be true?

3-5 Analyzing Errors

Identifying and articulating errors in your own or others’ thinking. For example, Teacher views three pictures of three persons make wrong behavior when dealing with electricity. Then he asks the following question: what are the errors in reasoning in these pictures?

3-6 Constructing Support

Constructing a system of support or proof for an assertion. For example, what is an argument that would support the following claim: you must use medicine according to the instructions of the doctor?

3-7 Abstracting

Identifying and articulating the underlying theme or general pattern of information. For example, teacher presents the following questions after getting the data that show the relationship between electrical current intensity (I) and resistance (R) shown in table. Then he asks the following question: What is the general thought underlying this data in the table which illustrate the relationship between I&R?

3-8 Analyzing Perspective

Identifying and articulating personal perspectives about issues. For example, why was salt used to preserve food in ancient time? What is an alternative perspective about Alternative sources of electric energy to get rid of the problem of environmental pollution?
2.1.2.4 Dimension 4: Using Knowledge Meaningfully

The most effective learning occurs when we use knowledge to perform meaningful tasks. For example, we might initially learn about computer by talking to a friend or reading a book, however, when we are trying to decide what kind of computer will buy. This dimension uses the complex reasoning processes of decision making, investigation, experimental inquiry, problem solving and invention, which like the dimension three processes, further encourage the students to take apart and re-construct their knowledge (Huot, 1996, 80; Marzano, 1992, 106).

4-1 Decision Making

Decision making is the process of answering such questions as “What is the best way to…?” Or “Which of these is most suitable…?” It is process that people of all ages use throughout their lives – usually without thinking much about it. Used in the classroom, however, it is an excellent way to improve learning. To find out how decision making can be used in the classroom. For example, suppose you are one of the employees of the electricity institution, and you are asked to take the appropriate decision to reduce the consumed electricity energy in the lamps that adorn the streets during wedding and national events, what is the appropriate decision will be taken?

4-2 Investigation

There are three basic types of investigation. Definitional investigation involves answering such question as “What are the defining characteristics of …?” or “What are the important feature of …?” Historical investigation involves answering such questions as “How did this happen?” and “Why did this happen?” And projective investigation involves answering such questions as “What would happen if…?” and “What would have happened if….”

4-2-1 Definitional Investigation

Definitional investigation involves identifying the defining characteristics of a concept for which such characteristics are unknown or, at least, not readily apparent. For example, what are the defining characteristics of alternative sources of electric energy?
4-2-2 Historical Investigation

Historical investigation involves identifying why or how some past event occurred. For example, how were the pyramids built?

4-2-3 Projective Investigation

Projection investigation involves identifying what will happen if some future event occurs or what would have happened if some past event had occurred.

4-3 Experimental Inquiry

Experimental inquiry is the process we engage in when answering such questions as “How can I explain this?” and “Based on my explanation, what can I predict?” For example, a student might first observe that water in a shallow pan left overnight evaporates. The student would then analyze the event in an attempt to explain what happened e.g., the water evaporated because it was exposed to dry air). Based on this analysis, the student would predict what might happen under certain conditions (e.g., the lower the humidity, the quicker water evaporates). The student would then tests his prediction by setting up an experiment. Finally, based on the outcome of his experiment, the student would reevaluate his original explanation.

4-4 Problem Solving

Problem solving involves answering such questions as “How will I overcome this obstacle?” or “How will I reach my goal but still meet these conditions?” At its core, it is the process of achieving a goal that is blocked by some obstacle or limiting condition. But this is a fairly narrow definition of problem solving. In a very broad sense, any attempt to achieve a goal can be characterized as problem solving. Problem solving involves selecting an alternative and trying it out. For example, How can you have preserved food without salt and using refrigerator?

4-5 Invention

Invention is the process of creating something that fills an unmet need or desire. In effect, you are inventing when you attempt to answer such questions as “What would I like to create?” “What is a new way?” “What is a better way?” For example, try to make a simple Model of the electric bell?
2-1-2-5 Dimension 5: Productive Habits of Mind

Students are encouraged to develop those mental habits which will enable them to think critically, think creatively, and regulate their behavior, and become life-long learners. These mental habits include those of Self-regulation thinking, Critical Thinking, and Creative Thinking (Marzano et al, 1988, 17; Marzano and Pickering 1991, 23).

5-1 Self-regulated Thinking and Learning

There are some performances that teacher will do them to develop Self-regulated Thinking and Learning of learners. For example, he encourages students to use resources necessary to complete a task by reminding students about its importance. Besides, he provides some time for groups to evaluate their action so they help themselves to learn from their mistake.

5-2 Critical Thinking and Learning

There are some performances that teacher will do them to develop critical Thinking and learning of learners. For example, he acknowledges that a student was trying to be particularly accurate. Also he encourages students do not respond to any question immediately without much thinking prior to their response.

5-3 Creative Thinking and Learning

There are some performances that teacher will do them to develop Creative Thinking and learning of learners. For example, he encourages learners to engaging in tasks even when answers or solutions are not immediately, he use problem solving as a sponge activity to reinforce the Creative Thinking especially when students’ energy starts to wane, he encourages students to engage intensity in task even when answers/solutions are not immediately apparent and he encourages students to generate new ways of viewing things.

The following figure shows the schematic representation of Dimensions of Learning Model:
Figure 2.2: Schematic Representation of Dimensions of Learning Model
2.1.3 The Relationship among the Dimensions of Learning

Briefly, as the graphic in figure (2) illustrate, all learning takes place against the backdrop of learners’ attitudes and perceptions (Dimension 1) and their use (or lack of use) of productive habits of mind (Dimension 5). If students have negative attitudes and perceptions about learning, then they will likely learn little. If they have positive attitudes and perceptions, they will learn more and learning will be easier. Similarly, when students use productive habits of mind these habits facilitate their learning (Marzano, 2000). Dimensions 1 and 5, then, are always factors in the learning process. This is why they are part of the background of the graphic shown in figure (2).

Figure 2.3: The Dimensions of Learning (Marzano, 2000)

![Diagram of Dimensions of Learning]

When positive attitudes and perceptions are in place and productive habits of mind are being used, learners can more effectively do the thinking required in the other three dimensions, Dimension 2, Dimension 3 and Dimension 4. We notice the relative positions of the three circles of Dimensions 2, 3 and 4. The circle representing Dimension 4 subsumes the other two Dimensions, and the circle representing Dimension 3 subsumes the circle representing Dimension2. This communicates that when learners extend and
refine knowledge, they continue to acquire knowledge and when they use knowledge meaningfully, they are still acquiring and integrating knowledge and extending and refining knowledge.

2.1.4 The Dimensions Planning Models

The three Dimensions Planning Models have in common one primary characteristic namely, the manner in which Dimensions 1 and 5 are considered. Most teachers using the Dimensions of Learning framework tend to deal with Dimension 1 and Dimension 5 as “background consideration”. In other words, positive attitude and perceptions about learning and productive habits of mind are learning goals in any unit of instruction in any content area at any grade level.

2.1.4.1 Model 1: Focus on Knowledge

When using this Model, the teacher focuses on Dimension 2, acquiring and integrating declarative and procedural knowledge. This means that specific concepts, principles and skills are the focus of the unit. Every-thing that happens in the classroom “serves” these learning goals. Thus, the teacher selects extending and refining activities (Dimension 3) and meaningful use tasks (Dimension 4) that will reinforce and deepen student’s understanding of the declarative and procedural knowledge identified as the focus of the unit. The planning sequence for this Model might be depicted as follows:

**Step 1**
Identify the declarative and procedural knowledge (Dimension 2) that will be the focus of the unit.

**Step 2**
Select extending and refining activities (Dimension 3) that will reinforce and deepen students understanding of the declarative and procedural knowledge identified in step1.

**Step 3**
Select a meaningful- use task (Dimensions4) that will reinforce and deepen students understanding of the declarative and procedural knowledge identified in step1.
Model 1 has these General Characteristics

- Concepts and principles tend to be the focus of a unit. A skill or content area procedure is the focus and when it is selected declarative knowledge.
- Extending and refining activities (Dimension 3) are usually emphasized more than meaningful use tasks (Dimensions 4).
- Usually, only one meaningful use task is used in the unit and the teacher makes sure that students know the task is essential to helping them understand the knowledge identified in step 1.

2.1.4.2 Model 2: Focus on Issues

Teachers identify an issue related to the general theme of the unit and decide what kind of meaningful-use task might be associated with the issue. For example, if there is an issue about how or why something happened, then historical investigation becomes the focus of the unit. If there is a phenomenon to be studied, then experimental inquiry becomes the focus, and so on. Once the issue and its related meaningful-use task are identified, the Dimension 2 and Dimension 3 needed to complete the task are identified. Work in Dimensions 2 and 3 supports the meaningful-use task that has been selected. The decision-making process for Model 2 might be represented in this way:

**Step 1**
Identify an important issue and its related meaningful-use task (Dimension 4).

**Step 2**
Identify the declarative and procedural knowledge (Dimension 2) needed to complete the meaningful-use task

**Step 3**
Identify the extending and refining activities (Dimension 3) needed to complete the task
Model 2 has these General Characteristics:

- The unit contains only one meaningful-use task. In the primary grades, an extending and refining activity is usually more appropriate for young students.
- Acquiring and integrating declarative and procedural knowledge is a secondary goal.
- Extending and refining activities are frequently deemphasized (unless one is selected as the focus of the unit in the primary grades).

2.1.4.3 Model 3: Focus on Student Exploration

Model 3 most closely resembles the developers’ original concept of the workings of the Dimension of learning framework. As in Model 1, the teacher first identifies the declarative and procedural knowledge (Dimension 2) that will be highlighted in the unit. She also identifies the extending and refining activities (Dimension 3) that will reinforce that knowledge. In a departure from both Models 1 and 2, however, the teacher does not identify a meaningful-use task (Dimension 4), but asks student to select their own tasks, for making meaningful-use task of knowledge. The teacher’s job is not to assist students in choosing a project. Although these projects will certainly be related to the declarative and procedural knowledge the teacher has identified, the teacher does not try to force a close fit, but encourages student to explore issues and interesting questions that arise naturally in the unit. The planning process might be depicted in the following way:

- **Step 1**
  Identify the declarative and its procedural knowledge (Dimension 2) it be highlighted in the unit.

- **Step 2**
  Identify the extending and refining activities (Dimension 3) that will help students understand the declarative and procedural knowledge.

- **Step 3**
  Identify ways to help students’ select meaningful-use tasks (Dimension 4).
Model 3 has these General Characteristics:

- He types of meaningful-use tasks undertaken by students are very diverse.
- A greater proportion of class time is devoted to these projects (Dimension 4) because students develop their own.
- In choosing which of the Dimensions planning Models to use, some teachers look at how well each Model helps them achieve specified’ outcomes.”

2.1.5 Assessing the Dimensions of Learning

In the Dimensions of Learning terminology, they tend to measure students’ ability to acquire and integrate information, not to extend and refine it or to use it meaningfully. In a series of studies conducted on two standardized test batteries, my colleagues and I found that the tests focused on the ability to recall and recognized factual information, not on the ability to use or apply knowledge (Marzano and Costa 1988, Marzano and Jesse 1987), Similar conclusions have been reported by many others (Carey and Shavelon 1989, Frederiksen and Collins 19889, Shepard 1989) (as cited in Marzano, 1992, 171).

If we expect students to honor the five Dimensions of Learning, we must assess students use of the Dimensions or at the very least, comment on their use. The specific of how each dimension can be assessed and addressed in depth the Dimensions of Learning Teacher’s Manual. Briefly, though a teacher might use all these type of information to assess the five Dimensions (Marzano, 1992, 171):

- Direct observation of students behavior
- Regular classroom tests
- Students self – reports
- Free responses and answers to probes in learning logs
- Products of students’ long-term projects.

One of the most powerful features of an assessment profile is that it allows teachers to better quantify student performance. The issue of quantifying performance – assigning scores and grades – is a hotly contested one.
2.2 Creative Thinking

2.2.1 Creative Thinking Concept

Creative Thinking is defined in the dictionary of the American Psychological Association (Vanderbos, 2006) as mental processes leading to a new invention, solution, or synthesis in any area.

Creative Thinking is a thinking style which enables the individuals to produce new and authentic products, find new solutions, and reach a synthesis. A creative person is the one who searches for the new fields, makes new observations, makes new guesses, and propose new implications. Creative people need to have the ability to think fluently, authentically, and flexibly (Torrance 1965, 5).

2.2.2 How to Develop Creative Thinking?

Creativity though cannot be created, but it can certainly be cultivated. In other words, creativity which is latent is capable of being developed. If creativity is capable of being developed, it can be taught also. Just as teachers are trained by developing their teaching skills, students can also be trained to think creatively by developing Creative Thinking skills. There are three broad approaches to develop Creative Thinking among students in class room environment:

i) Provide Creative Climate:

(Parnes, 1967) Indicates that Creativity can be developed by providing a climate which is conductive to creativity. The five principles for inducing Creative Thinking are:

a) Treat unusual questions with respect.
b) Treat unusual ideas with respect.
c) Show children that their ideas have value.
d) Provide opportunities for self-initiated learning and give credit for it.
e) Provide period of non-evaluated practice.

ii) Using Creative Teaching Methods:

To develop Creative skills in students, Torrance has emphasized important teaching skills:

a) Recognize and acknowledge the potentialities of the students.
b) Being respectful of questions and ideas.
c) Asking provocative questions.
d) Recognizing and valuing originality.
e) Applying scientific approach in solving a problem.
f) Using unevaluated practice and experimentation.
g) Guiding planned experiences.

iii) **Training Creativity Directly:**

Students are given instruction on the nature of creative process and Creative Thinking abilities. They are given practice and training in Creative Thinking skills. This is the most direct approach in teaching creativity. It also makes use of different techniques as already discussed in Creative Teaching.

Feldhusen and Treffinger (1984) and Davis (1991) also believed establishing a “Creative Climate” was important to stimulate Creative Thinking. Feldhusen and Treffinger (1980) provided several recommendations for establishing a classroom environment conducive to Creative Thinking:

1. Support and reinforce unusual ideas and responses of students.
2. Use failure as a positive to help students realize errors and meet acceptable standards in a supportive atmosphere.
3. Adapt to student interests and ideas in the classroom whenever possible.
4. Allow time for students to think and develop their creative ideas.
5. Create a climate of mutual respect and acceptance between students and between students and teachers.
6. Be aware of the many facets of creativity besides arts and crafts.
7. Encourage divergent learning activities. Be a resource provider and director.
8. Listen and laugh with students.
9. Allow students to have choices and be a part of the decision-making process.
10. Let everyone get involved, and demonstrate the value of involvement by supporting student ideas and solutions to problems and projects. (p. 32)

Fisher (2004, 2) offers a list of four points to check whether a lesson has stimulated the students’ Creative Thinking. Are students
Applying their own imagination
Generating their own questions, hypothesis, ideas, and outcomes
Developing skills or techniques through creative activity
Using judgment to assess their own or others creative work

2.2.3 Stages of Creative Thinking Process

Creative Thinking process is a complex process and is fulfilled in four steps as preparation, incubation, enlightenment, and approval (Bartzer, 2001; Fresman, 1996; Gordan, 1995; Osborn, 1991):

(i) **Preparation Period** includes approaching the problem systematically and logically.
(ii) **Incubation Period** follows the preparation period. As there is no control of consciousness in this period, new synthesis and original ideas appear.

(iii) **Enlightenment Period** is the period in which the individual makes various syntheses among the information he obtained in previous period and finds new solutions.
(iv) **The Approval of the Findings** is a conscious and logical period. The pitfalls of the solutions found before are fixed their accuracy is reviewed.

2.2.4 Skills of Creative Thinking

Fisher (1990) believes that Creative Thinking consists largely of rearranging what we know in order to find out what we do not know. (Feldhusen, 1984; Guilford, 1966; Fisher, 1990; and Torrance, 1965) find indicators of Creative Thinking skills in:

- **Fluency** of thinking (the ease with which we use stored information when we need it).
- **Flexibility** (the ability to overcome mental blocks and apparent obstacles).
- **Originality** (the ability to produce an unusual or rare response).
- **Elaboration** (the ability to add extensively to an idea, including divergent thinking).

Fisher (1990) stresses that Creative Thinking should involve critical judgment: ‘Creativity is not merely a question of generating new solutions to problems but of
creating better solutions’ (thus reminding us that creativity is strongly linked to problem-solving, too).

2.2.5 The Role of the Teacher for Developing Creative Thinking

Renzulli’s (1992) Model also emphasizes the role of the teacher, as a mentor and role Model, in developing creativity. In fact, Chambers (1973 as cited in Fasco, 2001, 322) found that the following behaviors of college teachers fostered creativity in students: (a) conducting classes in an informal manner, (b) being well prepared, (c) welcoming unorthodox views and rewarding originality and creativity; and (d) encouraging student participation. Renzulli (1992) suggests that students should be provided with opportunities to engage in “ideal acts of learning” (p. 171).

To develop the Creative Thinking abilities of the students, the NACCCE (1999) report sets up three main principles for the teachers to address:

- Encouraging students to believe in their creative potential, engage their sense of possibility, and give them the confidence to try;
- Identifying students own creative strengths in different areas; and
- Fostering the creative potential of all children and by realizing that the best way to enhance creativity is through the process of being creative.

2.2.7 Measurement of Creative Thinking Ability

The instruments most frequently used to measure Creative Thinking over the years are domain-general measures of Creative Thinking, which invariably include the measure of ideational fluency (e.g., Torrance, 1974, 1998). The measures based on ideational fluency have a long history since Guilford (1950, 1956), Wallach and Kogan (1965), and Torrance (1966). Measures of Creative Thinking ability typically provide scores on fluency (the number of ideas or solutions), flexibility (the number of different categories of ideas), originality (the number of unusual categories of ideas judged by expert raters or by statistical infrequency), and/or elaboration (the number of details involved) (Hong, & Milgram, 2010, 273).
2.2.7 Obstacles to Creativity and How Can they be Overcome

In fact, there are many ways that educators can “kill” creativity. Hennessey and Amabile (1987) listed five methods for “killing” creativity: (a) have children work for an expected reward, (b) set up competitive situations, (c) have children focus on expected evaluation, (d) use plenty of surveillance, and (e) set up restricted-choice situations.

Shaughnessy (1998) noted that Torrance stresses that the greatest obstacles to creativity are:

- Lack of opportunity to use ideas or what has been learned
- Lack of interest in the problem or the importance of the problem
- The problem is impossible or too difficult to solve or too easy
- Lack of challenge to one's best abilities
- Lack of change to do things in one's own way
- Lack of purposefulness

From this Shaughnessy (1998) indicated that Torrance suggests that these obstacles may be overcome by:

- Giving opportunities to use what they learn as tools in their thinking and problem solving;
- Giving a change to communicate what they learn;
- Showing an interest in what they have learned rather than in their grades;
- Providing learning tasks of appropriate difficulty;
- Giving a chance to use their best abilities;
- Permitting them to learn in their preferred ways;
- Recognizing and acknowledging many different kinds of excellence; and
- Giving genuine purpose and meaning to learning experiences.

In addition, Torrance (1966) recommended the creation of a game-like, thinking, or problem-solving atmosphere, avoiding the threatening situation associated with testing. His intent was to set the tone so that the expectation that examinees would enjoy the activities was created. Examinees should be encouraged to “have fun” and should experience a psychological climate that is as comfortable and stimulating as possible.
2.3 Attitude towards Science

2.3.1 Attitude towards Science Concept

Research on students’ attitudes toward science began to appear in the 1960s and increased significantly during the 1970s and 1980s (Koballa, 1995). Science educators agree that the promotion of positive attitudes toward science remains an important goal of science education (Francis & Greer, 1999; Papanastasiou & Papanastasiou, 2004).

Attitude towards Science denotes interest or feeling towards studying science. It is the students’ disposition towards ‘like’ or ‘dislike’ science while attitude in science means scientific approach assumed by an individual for solving problems, assessing ideas and making decisions (Olatunde, 2009, 336).

2.3.2 Component of Attitude towards Science

Attitudes can be defined as the feelings that a person possesses about an object, based on his/her belief of that object (Kind, Jones, & Barmby, 2007). A common definition has involved describing attitudes as including the three components of cognition, affect and behavior. Triandis (1971) defines attitude as an idea charged with emotion, which predisposes a class of actions to a particular class of social actions. He identifies three main components attached to attitudes. First, a cognitive component, that is the idea which is generally some category used by humans in thinking. Second, an affective component, that is the emotion, which charges the ideas. Third, a behavioral component associated with a predisposition to action.

2.3.3 Methods of Attitude Measurements

Osborne et al. (2003) reviewed the numerous approaches to the measurement of attitudes, listing the following five main methods:

i. Preference Ranking: This is an easy-to-use method where students simply rank their liking of school subjects. It is effective for answering the question ‘How popular is science compared to other subjects?’, but as it is a relative scale, is unsuitable for measuring attitude change.
ii. **Attitude Scales:** This is probably the most common method of measuring attitudes and occurs in a variety of forms. Differential (Thurstone-type) scales involve students choosing statements on a continuum that best reflect their attitudes. Semantic differential scales require students to rate a particular object (e.g. science lessons) according to a number of bipolar adjectives (e.g. good/bad). More commonly, summated rating scales are used which consist of Likert Scale items. Students respond to a number of statements that relate to the same construct (usually choosing from a five-point score such as ‘strongly agree, agree, neutral, disagree, strongly disagree). The use of more than one response for the same construct greatly increases the reliability of the summated rating scores.

iii. **Interest Inventories:** This method requires students to choose the items that they are interested in from a list. Osborne et al (2003) commented that ‘such inventories are generally restricted to their specific focus, yielding only a limited view of what may or may not be formative on attitudes to science.’

iv. **Subject Enrolment:** This method involves the collection of data on enrolment in various subjects. Osborne et al (2003) comments on the limitations of this method as a measure of interest in science, as subject choice can be influenced by a number of other factors including gender identity and economic factors.

v. **Qualitative Methods:** Although limited in number, a few studies explore attitudes using student interviews and focus group interviews. What these methods lack in the ability to generalize the findings, they make up for in the richness of understanding that they offer.

In the present study, we developed and used Attitude Scales to measure student’s attitudes towards science. As mentioned above, a major justification for using an Attitude Scale is the use of more than one question to measure the same construct (Al-Thobity, 1998, 121). In addition, such scales are relatively simple to use, in terms of using them in questionnaires and distributing them to respondents.

The next Chapter presents the relevant literature related to the topic of study and its important variables viz. Dimensions of Learning Model, Creative Thinking and Attitude towards Science.