

## **CHAPTER 2**

### **REVIEW OF RELATED LITERATURE**

In the field of education, the research worker needs to acquire up-to-date information about what has been taught and done in particular area from which the problem for research can be taken up. One of the most important early steps in a research study is to conduct the literature review. A literature review is designed to identify related research, to set the current research study within a conceptual and theoretical context.

While collecting the review, first we might be able to find a study that is quite similar to the one that we are thinking of doing. Second, prior research will help to ensure that we include all of the major relevant content in our study. We may find that other similar studies routinely look at an outcome that we might not have included. Finally, the literature review will help to anticipate common problems in researcher's context.

A review can illuminate a method of dealing with a problem situation that may suggest events of approach to similar difficulties faced. It can help to see the historical and associational perspectives as in relation to earlier and more primitive attacks on the same problem.

This chapter provides the theoretical frame work for this study, and also records a range of existing research under taken on the theoretical frame work in India and abroad. It commences with a brief overview of cognitive strategies considered for the study, followed by an analysis of the myriad of literature relating to learning style preference, metacognitive awareness and academic achievement.

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

##### **2.1.1 Cognitive Strategies**

Cognitive strategies are useful tools in assisting students with learning problems, the use of the mind (cognition) to complete a task and known as procedural facilitators (Bereiter & Scardamalia,1987), procedural prompts or scaffolds. A related term is metacognition, the self-reflection or "thinking about thinking" necessary for students to learn effectively (Baker, Gersten, & Scanlon, 2002). Cognitive strategies provide a structure for learning when a task cannot be completed through a series of steps. A cognitive strategy serves to support the learner as they develop internal procedures that

enable them to perform tasks that are complex (Rosenshine, 1997). The use of cognitive strategies can increase the efficiency with which the learner approaches a learning task. These academic tasks can include, but are not limited to, remembering and applying information from course content, constructing sentences and paragraphs, editing written work, paraphrasing, and classifying information to be learned.

The reason for focusing on two interrelated concepts in this study, academic achievement and cognitive strategies, stems from the goals set for education in general. As outlined by several researchers, schooling should not focus on transferring domain specific knowledge, but on developing self-regulated learners who are able to purposefully engage in challenging learning tasks in diverse contexts by using self-regulated learning strategies to fulfill self-set goals (Paris & Paris, 2001). Hence, it is assumed that learning is a goal directed, deliberate process where cognitive strategies are used to accomplish the goal, and thus cognitive elements are required (Pintrich, 2000).

Cognitive strategies mainly function in control phases, which follow the first phase involving goal setting and the second phase involving monitoring. Generally, by selecting appropriate cognitive strategies, learners try to realize their selected goals of the learning task. More specifically, the cognitive area of self-regulation begins with cognitive goal setting, prior knowledge activation, and planning, continues with metacognitive activities and cognitive regulation, and finishes with final cognitive judgments and attributions. Cognitive learning strategies still play a major role by providing the means for a learner to regulate cognitive efforts. Research on cognitive strategies has demonstrated important linkages between cognitive learning strategies and academic performance (Pintrich & De Groot, 1990; Pintrich & Garcia, 1991; Weinstein & Mayer, 1986, Zimmerman & Martinez-Pons, 1986). Hence, researchers have been interested in finding out how the use of cognitive strategies contribute to performance. Effective, appropriate, and independent strategy use has been seen as a characteristic of a skillful learner. Furthermore its use leads to higher academic achievement (Zimmerman & Martinez-Pons, 1986).

#### **2.1.1.1 Definition of cognitive strategies**

The term cognitive strategy refers to learners' cognitive actions that are performed in order to attain a particular learning goal or to accomplish a learning task at hand (Mayer, 1988; Paris et al., 2001; Schneider & Weinert, 1990).

An extensive amount of information on different types of cognitive learning strategies has been generated during the last few decades. It has been shown that there are both mental strategies, such as creating mental models of what is being read, and external strategies, such as note taking (Paris et al., 2001). One of the most cited categorizations, introduced by Weinstein and Mayer (1986), differentiates between rehearsal, elaboration, organizational, metacognitive, and affective strategies. Rehearsal strategies are generally associated with repetition, which aim to reproduce the material in some form. Rehearsal strategies could be activities such as creating acronyms, underlining information, or copying material. Elaboration strategies involve processes by which the learner tries to make the content more comprehensible, or attaches the new information into a personally meaningful context. Organizational strategies entail processes such as grouping information, organizing information into meaningful categories, and outlining a concept map. Affective strategies aim at affecting one's own internal states, such as preventing external disturbance or using thought stopping to keep the learning process focused. Metacognitive strategies are related to monitoring and managing one's own cognitive processes (Alexander, Schallert & Hare, 1991; Garner & Alexander, 1989). They may include, for instance, checking comprehension, self-questioning, evaluating the learning process, and monitoring the use of cognitive strategies. It is recognized that the types of strategies that learners use are highly dependent on contextual factors such as the quality of instructional tasks and embedded learning goals (Pintrich & Garcia, 1991). For instance, students use different strategies based on whether they read for learning, complete an essay, or study for an exam (Haldwin, Winne, Stockley, Nesbit, & Woszczyna, 2001). In this study metacognitive strategy is considered.

### **2.1.2 Learning Style**

A learning style is the method a person uses to learn. By knowing a student's learning style, a teacher can use teaching methods that maximize student learning. Students can use recognition of their individual learning styles to find what study methods, environment and activities help them learn best.

Learning is a complex lifelong educational process of how human absorbs information and experiences; memorizes and processes them to be further transformed into knowledge, skills, behaviour and attitudes. Nevertheless, with much emphasis given to the importance for an individual to gain education, the issue on whether students are learning

in the way they prefer is still debatable. Extensive research has documented that the way people learn differ in how they see, interpret, understand, and conceptualize information (Teele,2006; Zacharis,2011 & Kang,1999).The learning environment has changed to become more interconnected and learner-centred. The 21<sup>st</sup> century learners would have diverse requirements and references from their learning environment. They would have a particular learning preference and style due to their upbringing background (Bennett, Maton, and Kervin, 2007).

Learning style is a term generally used to describe an individual's natural or habitual pattern of acquiring and processing information in learning situations. There is no commonly accepted definition of learning styles. However, a core concept is that individuals differ in how they learn. The idea of individualized learning styles originated in the 1970s and acquired enormous popularity.

Keefe and Monk (1986) define learning styles as "...the characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment."

Humans have adapted to their environments throughout history. These adaptive patterns have allowed us to survive these environments. Although we have evolved as part of the adaptation process we, as humans, are different; and the concept of one size fits all is inadequate, especially regarding the way we learn or the learning process. The concept of learning styles is one such example. If instructors recognize students as being different, and if they assume, based on research regarding learning theories and learning styles, that each student has a preferred learning environment, determination of student learning styles could offer insight to instructors to help facilitate a more favorable learning environment for all students and potentially improve academic performance.

The following discussion of learning style models and instruments is however, fairly comprehensive and includes descriptions of most of the models at least referred to in recent and significant review papers.

### **2.1.2.1 Learning Styles Theories**

Learning style refers to learners' preferences in learning. It is a subset of a wider concept of personality. Experts define learning style in various ways. According to Pashler,

McDaniel, Rohrer, and Bjork (2008), the term “learning styles” refers to the concept that individuals differ in regard to what mode of instruction or study is most effective for them. Determining students’ learning style is important in order to facilitate students in identifying the most effective way for them to gain a deeper understanding on certain subjects and make the learning process easier for them. Felder and Silverman (1988) pointed out that, learners with strong preference for a specific learning style may have difficulties in learning if the teaching style does not match with their learning style.

The theories of learning style emerged in early 1900s. Wu (2014) explained that there are conflicting accounts concerning the ultimate origin of learning style. For instance, according to Buboltz et al. (2001, as cited in Wu 2014) traced the origin of learning or cognitive styles to Allport (1937). Fazarro, Pannkuk, Pavelock, and Hubbard (2009) on the other hand claimed that Thelen (1954) was the first to use the term ‘learning style’ in describing how people learn and interact in a certain environment. Nevertheless, the renewed interest in learning style research was said to begin since the last four decades. Cassidy, (2004) explained that there were two lines of renewed efforts in learning styles, which are: applied models of learning style, and strong preference for the cognitive style dimension. There have been a myriad of learning style models which have been proposed by scholars to describe learners’ learning styles. According to Wu (2014), one of the earliest models was the “Group Embedded Figures Test” (GEFT) developed by Witkin, Oltman, Raskin, & Karp (1971). Other models include David Kolb’s model (Kolb, 1976), Honey and Mumford’s model (Honey & Mumford, 2000), Neil Fleming’s VARK model (Fleming & Mills, 1992), and Felder-Silverman’s model (Felder & Silverman, 1988). These models may be classified into four categories based on whether they focus on external conditions or personality (Claxton & Murrell, 1987). They are instructional and environmental preference (such as Neil Fleming’s VARK model), Social interaction (such as Grasha-Reichmann Learning Styles’ model), Information processing (such as Kolb’s learning style inventory and Felder-Silverman’s Model), and Personality level (Myers-Briggs’s model).

#### **(i) Myers- Briggs model**

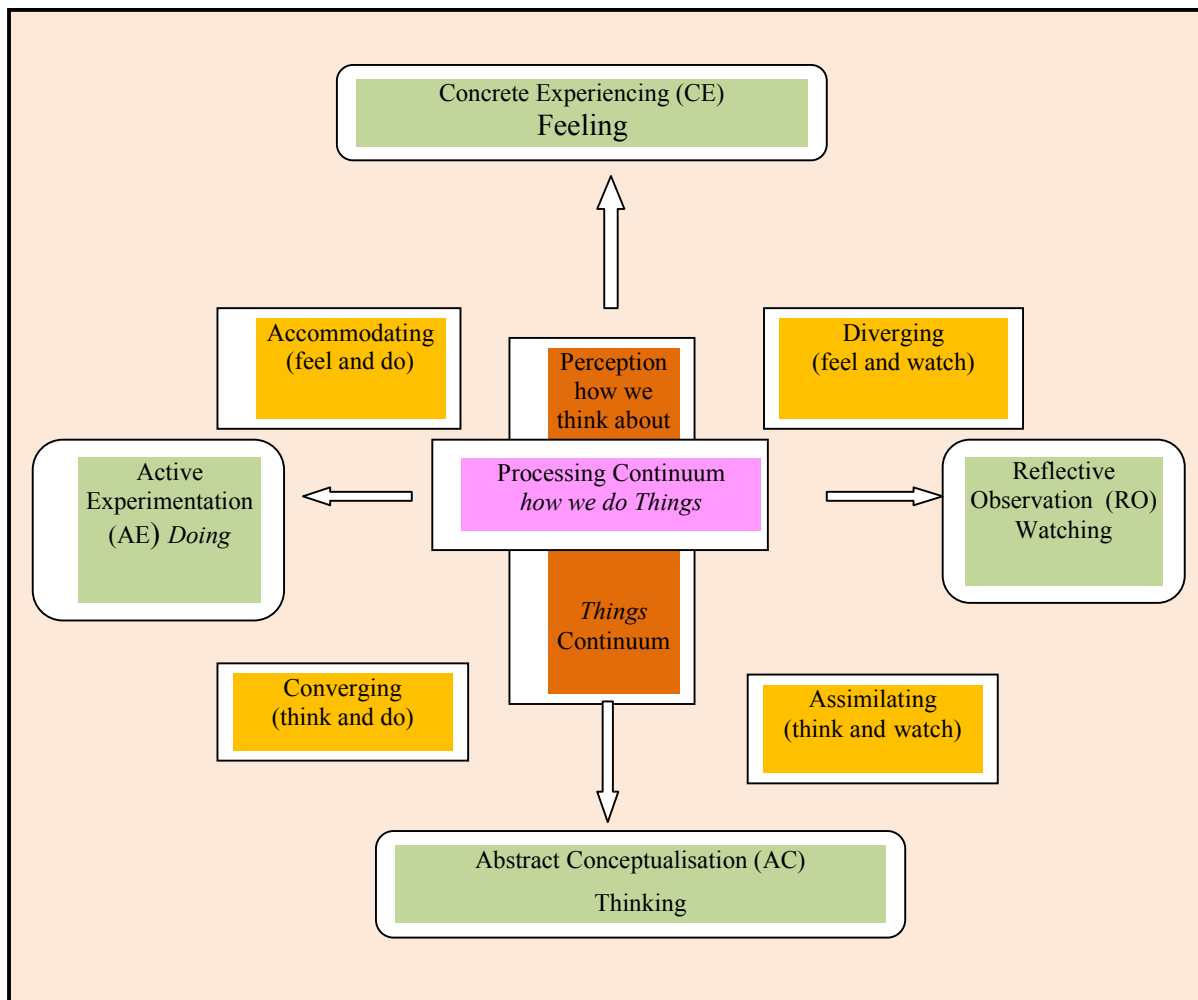
Jung’s theory of psychological types serves as the historical backbone for the learning styles model identified with the Myers Briggs Type Indicator (MBTI). One of the most commonly used instruments is the Myers-Briggs Type Indicator (MBTI) which is

based on a combination of traits found in personality type domains. These domains are: Introversion-Extraversion; Sensing-Intuitive; Thinking-Feeling; and Judging-Perceiving. Individual student's preferences in each of these categories can then be combined to form any of 16 different learning style types. These, like the sensory modalities, may include the learning preferences of the sight, auditory provisions and the use of motion. The results of the MBTI, classify students as extraverts or introverts, sensors or intuitors, thinkers or feelers, and judges or perceivers. While the MBTI is actually a personality assessment, the information that is gathered has often been related to how people think, learn, and make decisions.

**(ii) Kolb's Learning Styles**

Kolb (1984) has defined one of the most commonly used models of learning. It is based on two preference dimensions, giving four different styles of learning.

- a) Diverging (feeling and watching - CE/RO)** - People with a Diverging Learning Style have broad cultural interests and like to gather information. They are interested in people, tend to be imaginative and emotional, and tend to be strong in the arts. People with the diverging style prefer to work in groups, to listen with an open mind and to receive personal feedback. Kolb called this style 'Diverging' because these people perform better in situations that require ideas-generation, for example, brainstorming.
  
- b) Assimilating (watching and thinking - AC/RO)** - People with an assimilating learning style are less focused on people and more interested in ideas and abstract concepts. People with this style are more attracted to logically sound theories than approaches based on practical value. These people possess effectiveness in information and science careers.



**Figure 2.1** Kolb's learning styles

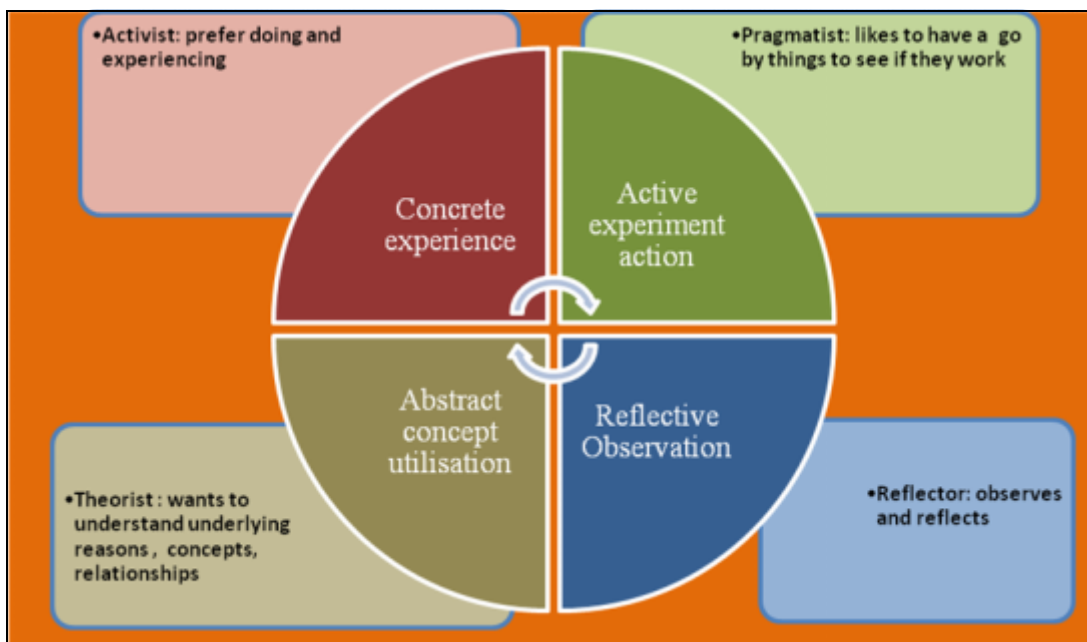
In formal learning situations, people with this style prefer readings, lectures, exploring analytical models, and having time to think things through.

**c) Converging (doing and thinking - AC/AE)** - People with a converging learning style can solve problems and will use their learning to find solutions to practical issues. They prefer technical tasks, and are less concerned with people and interpersonal aspects. They can solve problems and make decisions by finding solutions to questions and problems. People with a converging learning style are more attracted to technical tasks and problems than social or interpersonal issues.

**d) Accommodating (doing and feeling - CE/AE)** - The Accommodating Learning Style is 'hands-on', and relies on intuition rather than logic. These people use other people's analysis, and prefer to take a practical, experiential approach. They are attracted to new challenges and experiences, and to carrying out plans. They commonly act on 'gut' instinct rather than logical analysis. This learning style is prevalent and useful in roles requiring action and initiative. People with an accommodating learning style prefer to work in teams to complete tasks. They set targets and actively work in the field trying different ways to achieve an objective.

### (iii) Honey and Mumford model of Learning Style

According to Honey and Mumford (1992) each of us has predisposition to use a particular part of the learning cycle as our prime approach to learning. This gives four types of learner - Activists, Reflectors, Theorists and Pragmatists- corresponding roughly with the experiencing, reflecting, generalising and testing stages of the cycle. They do accept that style may vary according to the learning situation and also that some individuals may have a mixed strategy (thus, many academics are reflector/theorists rather than one or the other).



*Figure 2.2 Honey and Mumford model of learning styles*

**Activists favour:**

Teamwork, games and simulations, role-plays; brainstorming, unstructured discussions; project work; creative situations; problem-based learning and extrovert activities.

**Reflectors favour:**

Cerebral activities; passive situations like watching video.

**Theorists favour:**

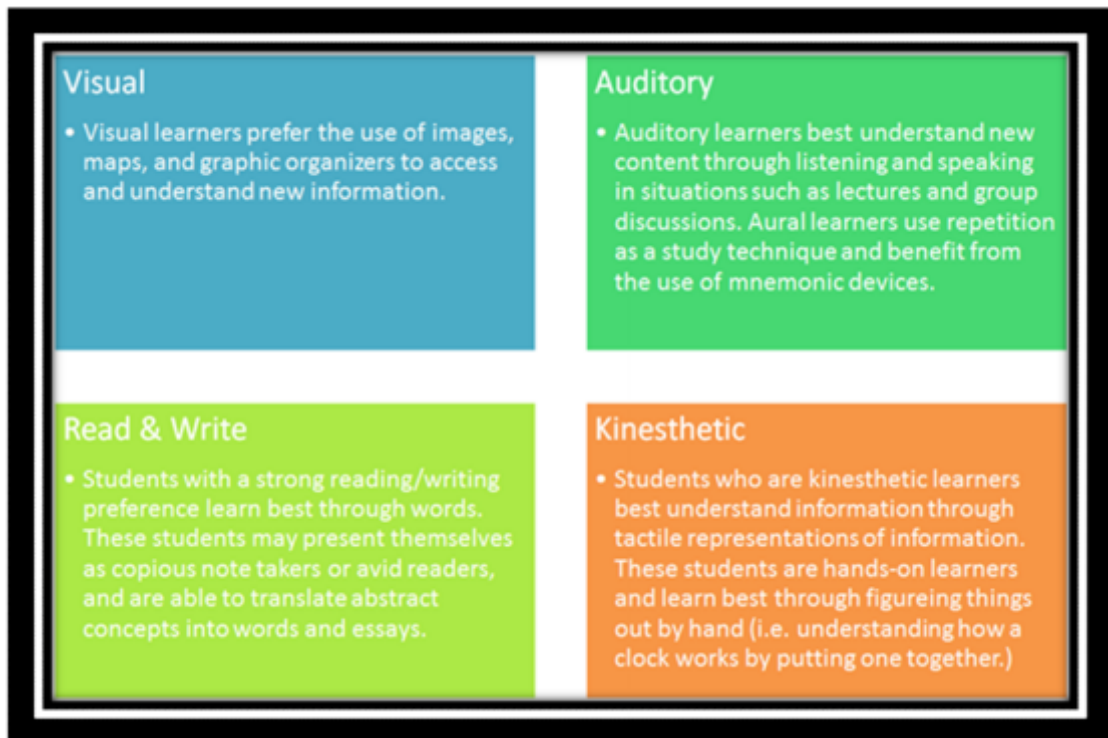
Learning set in a conceptual framework; structured situations with a clear purpose; listening to, or reading about, well-argued, logical ideas; being intellectually stretched; interesting notions even if they are not immediately relevant; understanding and participating in highly complex situations.

**Pragmatists favour:**

Learning where there is an obvious link between theory and practice; skills and techniques with obvious practical advantages; working with a credible expert; demonstrations, simulations, films etc with a practical bias; working with real problems, realistic case studies and knowledge with immediate and obvious application.

**(iv) Fleming's VARK model**

Fleming and Mills (1992) has devised a model of learning based on the principal sensory mode of learning. The acronym VARK stands for Visual, Auditory, Read/Write and Kinesthetic.



*Figure 2.3 Fleming's VARK model*

**(v) Grasha – Riechman Model of Learning Style**

Grasha and Riechman (1996) describes six types of learning style that they have used as the basis for their Student Learning Style Scale. They are

**Competitive students** learn material in order to perform better than others, they like to receive recognition for their accomplishments and prefer both teacher-centred instruction and also group tasks where they can lead or demonstrate their pre-eminence.

**Collaborative students** feel that they can learn by sharing ideas and talents, they like to cooperate with the teacher and to work with others. This leads to a preference for group work, projects, seminars and lectures that feature small group discussion.

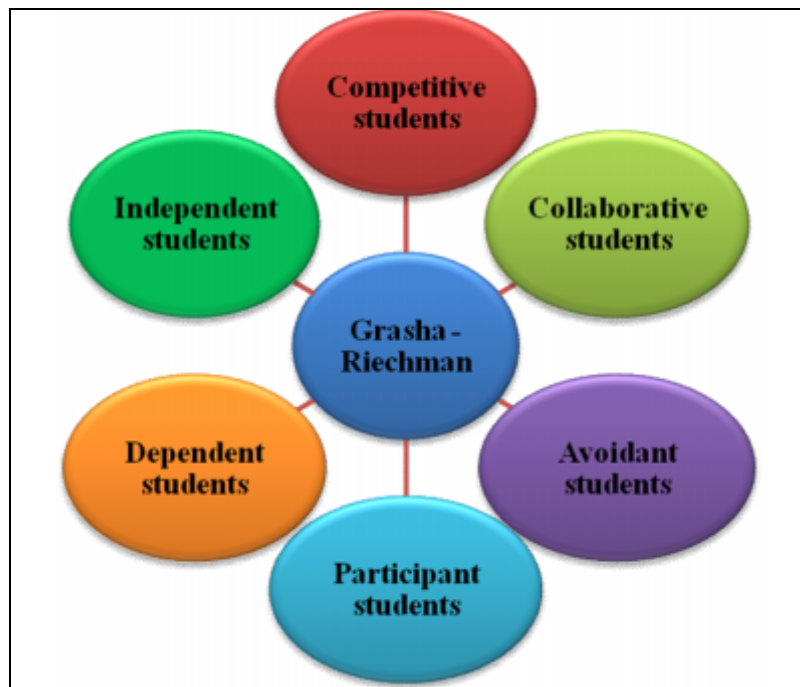
**Avoidant students** are uninterested in classroom learning and participate reluctantly. They prefer large group situations where they can remain anonymous and do not like enthusiastic teachers.

**Participant students** are good citizens and enjoy participating in as much as they can. Typically, they are eager to take all the options that they can and to fully meet all the

requirements. They prefer participative exercises, including lectures that allow student participation, informal discussions and reading assignments.

**Dependent students** show little intellectual curiosity and learn only what is required. They look for structure and specifics and prefer teacher-centred classroom situations, good handouts or notes to copy and clear deadlines and instructions for assignments.

**Independent students** like to think for themselves and are confident in their learning abilities. They often like to work alone and prefer student-centred methods, self-paced instruction and assignments that give students a chance to think independently.

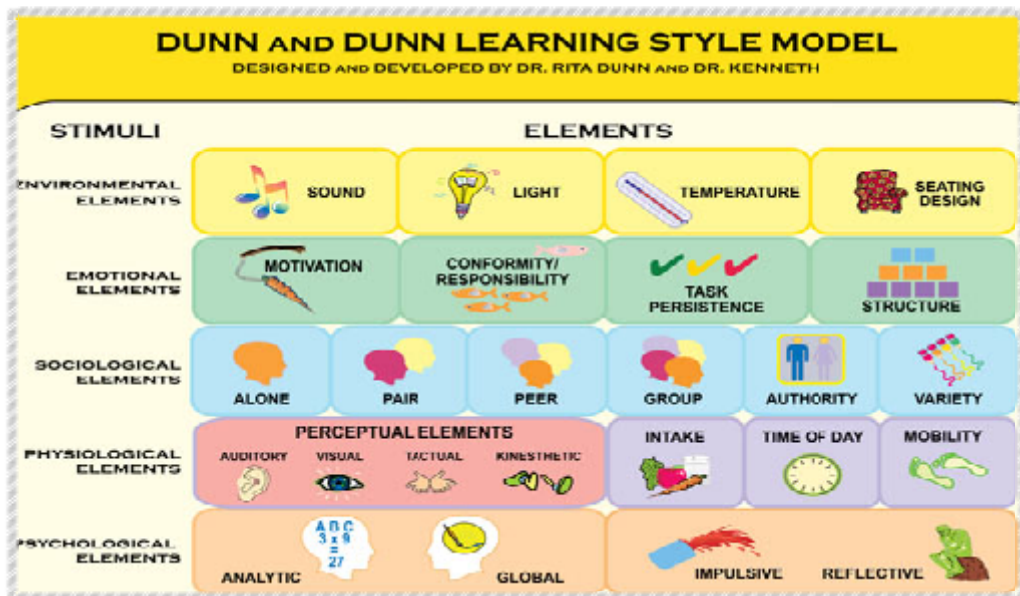


*Figure 2.4* Grasha – Riechman Model of Learning Style

#### (vi) Dunn and Dunn Model of Learning Styles

Foundational to this approach is the concept that intelligence is not definitively linked to talent or inborn capabilities (Denig, 2004; Dunn et al., 2001; Lovelace, 2005). Instead, perception, comprehension, adaptability, the acquisition of knowledge through experiences, and analytical problem solving and decision making skills are acceptable and valid demonstrations of intelligence (Denig, 2004).

As such, the learning style model considers elements that affect student learning and encompass the learner's environment, emotionality, sociological preferences, physiological characteristics, and psychological processing inclinations. Each of these broad categories is then broken down into the following specific elements: sound, light, temperature, seating design (environment); motivation, task persistence, responsibility, structure (emotionality); learning alone, in pairs, in a small group of peers, as part of a team, with an adult, with variety or routines (sociological preferences); perceptual strengths, time of day, need for intake, mobility while learning (physiological characteristics); and global/analytic, impulsive /reflective (psychological processing inclinations) (Dunn & Burke, 2006).



**Figure 2.5** Dunn and Dunn learning styles model

(Retrieved October 28, 2013, from [www.eton.edu.ph](http://www.eton.edu.ph))

**(vii) MAT Learning Styles**

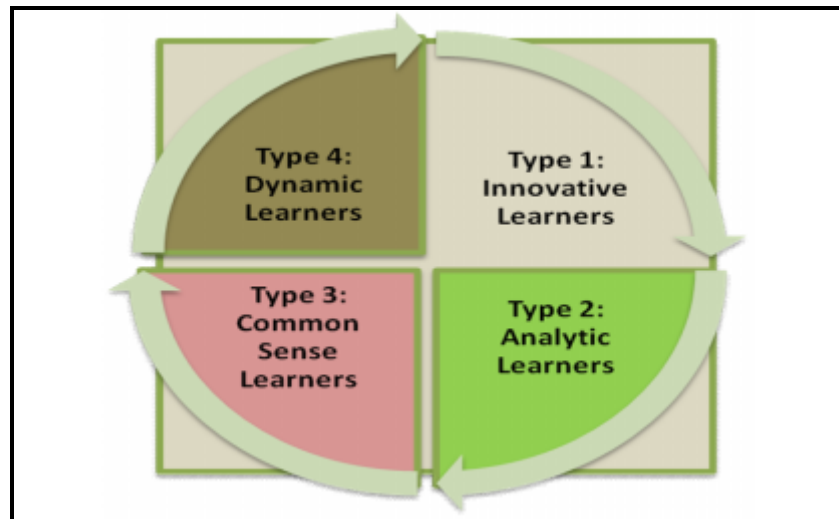
The four learning styles identified by McCarthy are:

**Type 1: Innovative Learners** who are primarily interested in personal meaning. They need to have reasons for learning--ideally, reasons that connect new information with personal experience and establish that information's usefulness in daily life.

**Type 2: Analytic Learners** who are primarily interested in acquiring facts in order to deepen their understanding of concepts and processes. They are capable of learning effectively from lectures, and enjoy independent research, analysis of data, and hearing what "the experts" have to say.

**Type 3: Common Sense Learners** who are primarily interested in how things work; they want to "get in and try it." Concrete, experiential learning activities work best for them--using manipulatives, hands-on tasks, kinesthetic experience, etc.

**Type 4: Dynamic Learners** who are primarily interested in self-directed discovery. They rely heavily on their own intuition, and seek to teach both themselves and others. Any type of independent study is effective for these learners. They also enjoy simulations, role play, and games.

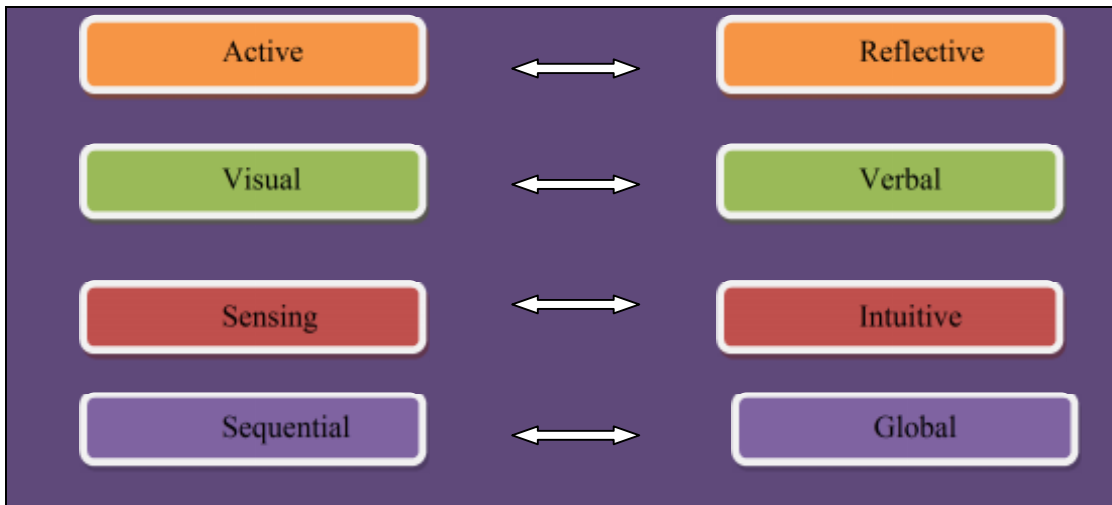


*Figure 2.6 MAT Learning Styles*

**(viii) Felder-Silverman Model of Learning Style**

There are several different learning style models in literature such as by Kolb (1984), Honey and Mumford (1986) as well as Felder and Silverman (1988), each proposing different descriptions and classifications of learning types discussed above. The present study focusses on the Felder-Silverman learning style model (FSLSM). Most other learning style models classify learners in few groups, whereas Felder and Silverman describe the learning style of a learner in more detail, distinguishing between preferences on four dimensions. Another main issue is that FSLSM is based on tendencies, saying that

learners with a high preference for certain behaviour can also act sometimes differently. According to Carver et al. (1999), “the Felder Model is most appropriate for hypermedia courseware” and it can also be seen that FLSM is used very often in research related to learning styles in advanced learning technologies. The four dimensions of learning style preference are active- reflective, visual- verbal, sensing- intuitive and sequential- global. Each learners is characterised by a specific preference for each of these dimensions.



**Figure 2.7 Felder-Silverman Learning Styles**

### **Active - Reflective**

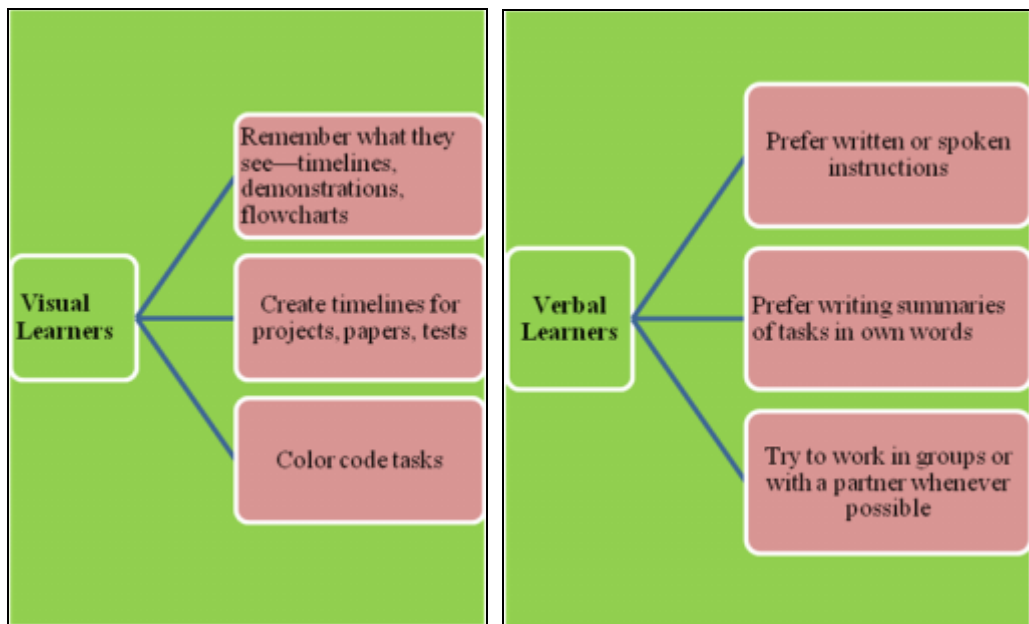
The first dimension distinguishes between an active and a reflective way of processing information. Active learners learn best by working actively with the learning material by applying the material and trying things out. Furthermore, they tend to be more interested in communication with others and prefer to learn by working in groups where they can discuss about the learned material. In contrast, reflective learners prefer to think about and reflect on the material. Regarding communication, they prefer to work alone or maybe in a small group together with one good friend.



**Figure 2.8: Characteristics of Active and Reflective Learners**

**Visual – Verbal**

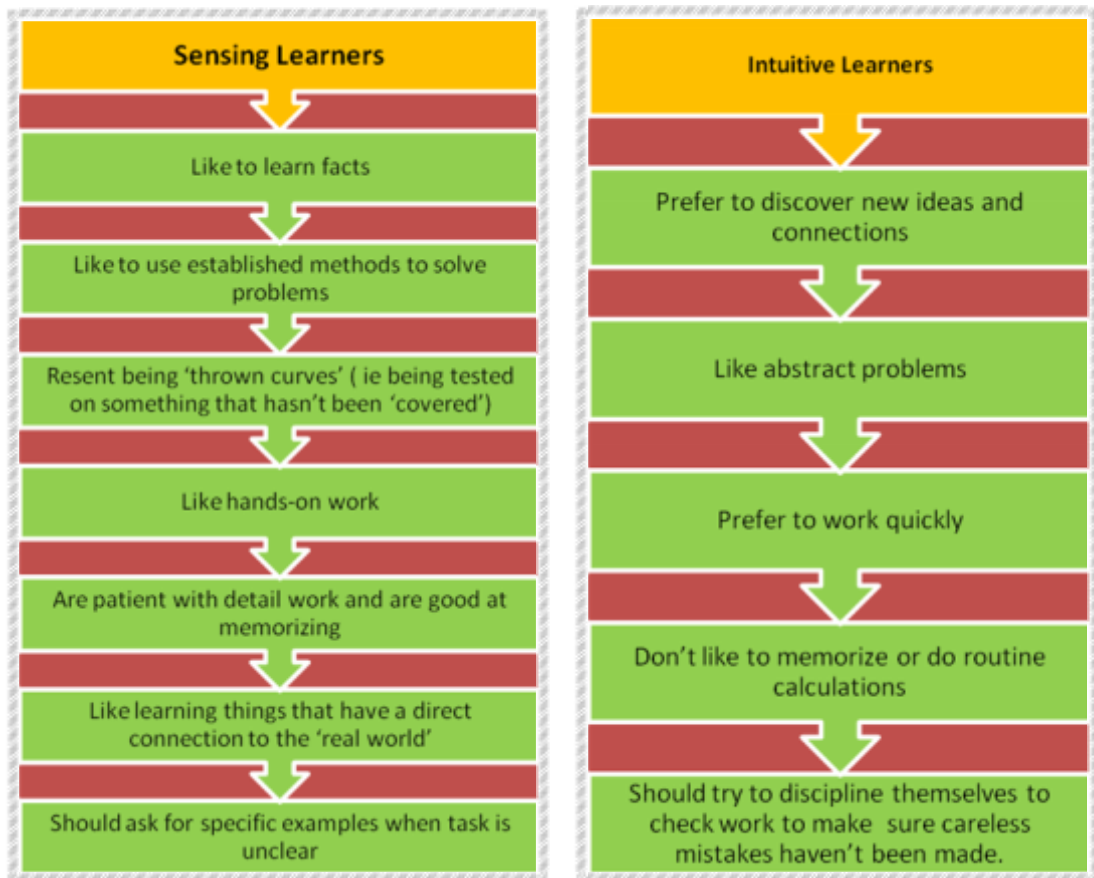
The second dimension, visual-verbal differentiates learners who remember best what they have seen, from pictures, diagrams and flow-charts, and learners who get more out of textual representations, regardless of the fact whether they are written or spoken.



**Figure 2.9: Characteristics of Visual and Verbal Learners**

## Sensing – Intuitive

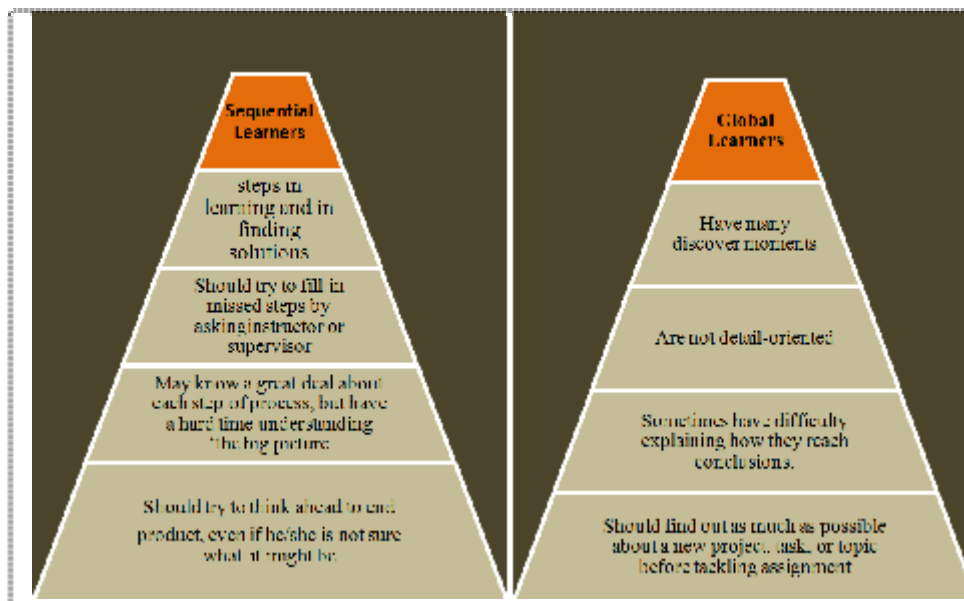
The third dimension covers sensing versus intuitive learning. Learners who prefer a sensing learning style like to learn facts and concrete learning material. They like to solve problems with standard approaches and also tend to be more patient with details. Furthermore, sensing learners are considered as more realistic and sensible; they tend to be more practical than intuitive learners and like to relate the learned material to the real world. In contrast, intuitive learners prefer to learn abstract learning material, such as theories and their underlying meanings. They like to discover possibilities and relationships and tend to be more innovative and creative than sensing learners.



*Figure 2.10* Characteristics of Sensing and Intuitive Learners

## Sequential – Global

In the fourth dimension, the learners are characterized according to their understanding. Sequential learners learn in small incremental steps and therefore have a linear learning progress. They tend to follow logical stepwise paths in finding solutions. In contrast, global learners use a holistic thinking process and learn in large leaps. They tend to absorb learning material almost randomly without seeing connections but after they have learned enough material they suddenly get the whole picture. Then they are able to solve complex problems, find connections between different areas, and put things together in novel ways but they have difficulties in explaining how they did it. Because the whole picture is important for global learners, they tend to be more interested in overviews and a broad knowledge whereas sequential learners are more interested in details.



**Figure 2.11** Characteristics of Sequential and Global Learners

(based on the Index of Learning Styles survey by Barbara Solomon and Richard Felder College of Charleston-center for student learning)

### 2.1.3 Metacognition:

Even before psychology was recognized as a separate discipline, scholars were fascinated by what we now call metacognition, because self-reflective knowledge (i.e., metacognition) was thought to symbolise a particular kind of consciousness unique to human beings. According to a number of thinkers, this kind of consciousness bears a

special connection to our 'self' or our knowledge of ourselves, as in the maxim, 'know thyself'. The idea is that whereas other species may have evolved adaptive characteristics such as the ability to fly, or, like the raptors, to see tiny movements many miles away, or, like the monarch butterfly, to eat foods that are poisonous to other animals, the human species has evolved as its unique adaptive strength of a particular form of consciousness. The most elementary component of this form of consciousness is metacognition.

There is monitoring and control at all levels of the human and the animal mind/brain system. Indeed, the entire brain can be thought of as a giant feedback system, with virtually every pathway having both feed forward and feedback connections, and multiple connections among different brain regions serving to allow the outcomes of one kind of processing to modulate other processes. So, if monitoring and feedback were all that was meant by metacognition it would be pervasive and there would be no question at all that most other animals also use such feedback. But it is not simple feedback from one level interacting with processing at another that, alone, characterizes metacognition.

Furthermore, it is not simply being able to make a discrimination or a judgment. It is not merely the production of a complex multi-step response, to get a reward. And it is not the combination of a multi-step response to a difficult discriminative judgment. Metacognition is a very special kind of judgment or commentary that involves a level of processing that we call representational, or cognitive (and that Nelson & Narens, 1990) and a higher level monitoring that we call metacognitive.

If a person just makes a judgment about something that they see or hear, or even about their own current fluency of processing, it is not metacognitive, since it is not a judgment about a mental representation. Metacognition must be a judgment about an internal representation.

#### **2.1.3.1 What is Metacognition?**

Metacognition is probably the most actively investigated cognitive process in contemporary research in developmental and instructional psychology (Tobias et al., 2009). Metacognition is a form of cognition, a second or higher order thinking process which involves active control over cognitive processes. It can be simply defined as thinking about thinking or as a "person's cognition about cognition" (Wellman, 1985).

Beyond dispute, the seeds for research programs and development in metacognition were planted and begun to germinate by Flavell, the pioneer of the field, who deserves great credit for highlighting the depth of his knowledge on metacognition in his landmark pioneering publications on the subject. Metacognition was characterized by Flavell (1979) as a “promising new area of investigation”. Thereafter, a multitude of empirical and theoretical researches have pursued an agenda on which metacognition was high.

Flavell of Stanford University is regarded as a foundation researcher in metacognition. He was influenced by the work of Piaget. Flavell (1971) used the term metamemory in regard to an individual's ability to manage and monitor the input, storage, search and retrieval of the contents of his own memory. He implied with his statements that metacognition is intentional, conscious, foresighted, purposeful, and directed at accomplishing a goal or outcome. These implications have all been carefully scrutinized in subsequent research, and in some cases have been the subjects of controversy among researchers in metacognition. Kentridge and Heywood (2000) argued that metacognitive processes need not operate in a person's conscious awareness.

Educational psychologists have long promoted the importance of metacognition for regulating and supporting student learning. More recently, the Partnership for 21st Century Skills has identified self-directed learning as one of the life and career skills necessary to prepare students for post secondary education and the workforce.

#### **2.1.3.2 Definition of Metacognition**

Flavell originally coined the term metacognition in the late 1970s to mean “cognition about cognitive phenomena,” or more simply “thinking about thinking” (Flavell, 1979). Subsequent development and use of the term have remained relatively faithful to this original meaning. Different definitions for metacognitive awareness were given by different authors.

Metacognition is the knowledge and control children have over their own thinking and learning Activities (Cross & Paris, 1988). Awareness of one’s own thinking, awareness of the content of one’s conceptions, an active monitoring of one’s cognitive processes, an attempt to regulate one’s cognitive processes in relationship to further learning, and an application of a set of heuristics as an effective device for helping people organize their methods of attack on problems in general (Hennessey, 1999).

As Kuhn and Dean (2004) explain, metacognition is what enables a student who has been taught a particular strategy in a particular problem context to retrieve and deploy that strategy in a similar but new context. The authors note that in cognitive psychology, metacognition is often defined as a form of executive control involving monitoring and self-regulation, a point echoed by other researchers (McLeod, 1997; Schneider & Lockl, 2002). Further, Schraw (1998) describes metacognition as a multidimensional set of general, rather than domain-specific, skills. These skills are empirically distinct from general intelligence, and may even help to compensate for deficits in general intelligence and/or prior knowledge on a subject during problem solving.

Metacognition consists of two components: knowledge and regulation. Metacognitive knowledge includes knowledge about oneself as a learner and the factors that might impact performance, knowledge about strategies, and knowledge about when and why to use strategies. Metacognitive regulation is the monitoring of one's cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies.

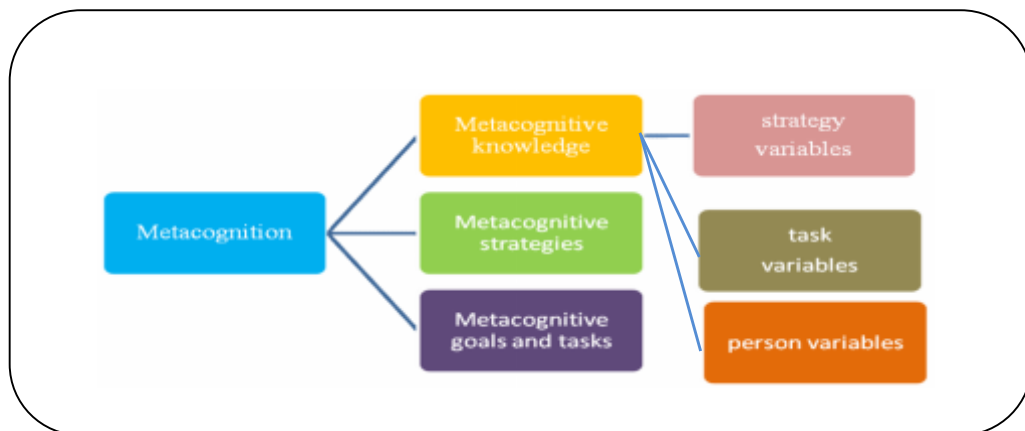
### **2.1.3.3 Theories on Metacognition**

Metacognition has two constituent parts: knowledge about cognition and monitoring of cognition (Cross & Paris, 1988; Flavell, 1979; Paris & Winograd, 1990; Schraw & Moshman, 1995; Schraw et al., 2006; Whitebread et al., 1990). Several frameworks have been developed for categorizing types of knowledge about cognition. Flavell recognized that metacognition consisted of both monitoring and regulation aspects. It was here that the term metacognition was first formally used in the title of his paper. He defined metacognition as follows: "In any kind of cognitive transaction with the human or non-human environment, a variety of information processing activities may go on. Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in service of some concrete goal or objective." Hacker (1998) offered a more comprehensive definition of metacognition, to include the knowledge of one's own cognitive and affective processes and states as well as the ability to consciously and deliberately monitor and regulate those processes and states.

### (i) Flavell's model of metacognition

In his 1979 paper, Flavell proposed a formal model of metacognitive monitoring which included four classes of phenomena and their relationships. The four classes were (a) metacognitive knowledge, (b) metacognitive experiences, (c) tasks and goals, and (d) strategies or actions. The first of Flavell's (1979) classes was metacognitive knowledge, which he defined as one's knowledge or beliefs about the factors that effect cognitive activities. The distinction between cognitive and metacognitive knowledge may lie in how the information is used, more than a fundamental difference in processes. Metacognitive activity usually precedes and follows cognitive activity. They are closely interrelated and mutually dependent.

Metacognitive knowledge can lead the individual to engage in or abandon a particular cognitive enterprise based on its relationship to his interests, abilities and goals. Flavell described three categories of these knowledge factors: Person variables, Task variables, and Strategy variables. These are the three categories in which Flavell proposed that individuals have metacognitive knowledge. The person category of knowledge includes the individual's knowledge and beliefs about himself as a thinker or learner, and what he believes about other people's thinking processes. Flavell gave examples of knowledge such as a person believing that he can learn better by listening than by reading.



**Figure 2.12 Formal model of metacognition by John Flavell**

The task category of metacognitive knowledge encompassed all the information about a proposed task that is available to a person (Flavell, 1979). This knowledge guides the individual in the management of a task, and provides information about the degree of

success that he is likely to produce. Knowledge about task difficulty and mental or tangible resources necessary for its completion also belong to this category.

The strategy category of metacognitive knowledge involved identifying goals and sub goals and selection of cognitive processes to use in their achievement (Flavell, 1979).

Metacognitive experiences (Flavell, 1979), the second class of phenomena included the subjective internal responses of an individual to his own Metacognitive knowledge, goals or strategies. These may be fleeting or length, and can occur before, during, or after a cognitive enterprise. As monitoring phenomena, these experiences can provide internal feedback about current progress, future expectations of progress or completion, degree of comprehension, connecting new information to old, and many other events. New or difficult tasks, or tasks performed under stress tend to provoke more experiential interaction, while familiar tasks may tend to provoke less Metacognitive experience can also be a “stream of consciousness” process in which other information, memories, or earlier experiences may be recalled as resources in the process of solving a current moment cognitive problem.

Metacognitive goals and tasks are the desired outcomes or objectives of a cognitive venture. This was Flavell's third major category. Goals and tasks include comprehension, committing facts to memory, or producing something, such as a written document or an answer to a math problem, or of simply improving one's knowledge about something. Achievement of a goal draws heavily on both metacognitive knowledge and metacognitive experience for its successful completion (Flavell, 1979).

Metacognitive strategies are designed to monitor cognitive progress. Metacognitive strategies are ordered processes used to control one's own cognitive activities and to ensure that a cognitive goal (for example, solving a math problem, writing an effective sentence, understanding reading material have been met. A person with good metacognitive skills and awareness uses these processes to oversee his own learning process, plan and monitor ongoing cognitive activities, and to compare cognitive outcomes with internal or external standards. Flavell (1979) indicated that a single strategy can be invoked for either cognitive or metacognitive purposes and to move toward goals in the cognitive or metacognitive domains. He gave the example of asking oneself questions at the end of a learning unit

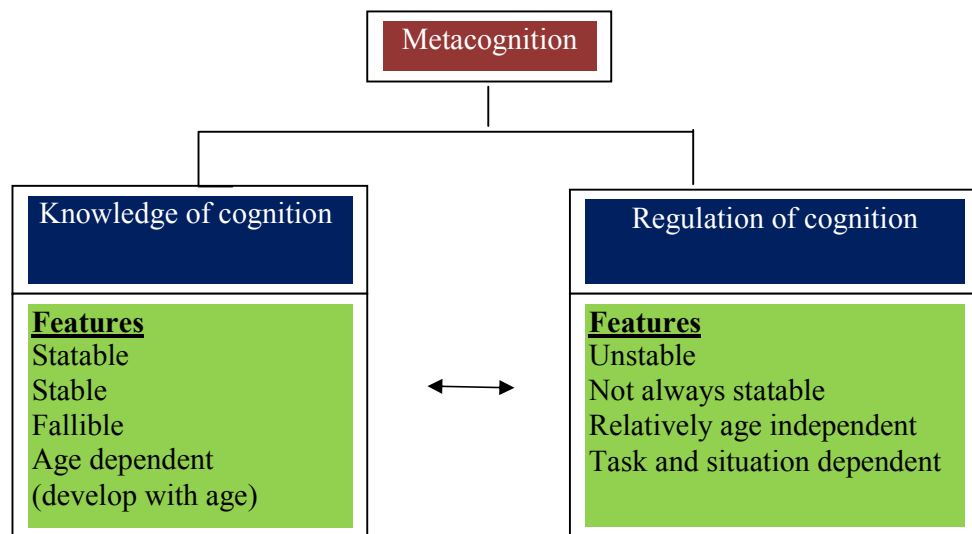
with the aim of improving knowledge of the content, or to monitor comprehension and assessment of the new knowledge. Subsequent metacognition researchers have offered a slightly different framework for categorizing cognitive knowledge. For example, several researchers have used the concepts of declarative and procedural knowledge to distinguish cognitive knowledge types (Cross & Paris, 1988; Kuhn, 2000; Schraw et al., 2006; Schraw & Moshman, 1995). Kuhn and Dean (2004) characterize declarative cognitive knowledge broadly as epistemological understanding, or the student's understanding of thinking and knowing in general. Schraw et al. (2006) portray declarative cognitive knowledge as knowledge about oneself as a learner and what factors might influence one's performance. Paris and Winograd (1990) discuss the process of self-appraisal as reflection about personal knowledge states to answer the question, "Do I know this?" Finally, Cross and Paris (1988) define declarative cognitive knowledge specifically within the context of reading as awareness of the factors that might affect reading ability. On the other hand, procedural knowledge involves awareness and management of cognition, including knowledge about strategies (Cross & Paris, 1988; Kuhn & Dean, 2004; Schraw et al., 2006). Schraw et al. (2006) also distinguish conditional cognitive knowledge, which is knowledge of why and when to use a given strategy. The other component of metacognition is monitoring of one's cognition, which many researchers have argued includes activities of planning, monitoring or regulating, and evaluating (Cross & Paris, 1988; Paris & Winograd, 1990; Schraw & Moshman, 1995; Schraw et al., 2006; Whitebread et al., 2009). Planning involves identification and selection of appropriate strategies and allocation of resources, and can include goal setting, activating background knowledge, and budgeting time. Monitoring or regulating involves attending to and being aware of comprehension and task performance and can include self-testing. Evaluation is defined as "appraising the products and regulatory processes of one's learning," and includes revisiting and revising one's goals (Schraw et al., 2006).

## **(ii) Brown's model of metacognition**

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

these two forms of metacognition are closely related, each feeding on the other recursively, although they can be readily distinguishable (see Figure 2.13).

**Knowledge of cognition** refers to the stable, storable, often fallible, and often late developing information that human thinkers have about their own cognitive processes as it required that learners step back and consider their own cognitive processes as object of thought and reflection; traditionally this has been referred to as knowing that (Brown, 1987).



**Figure 2.13: Brown’s model of metacognition.**

**Regulation of cognition** consists of the activities used to regulate and oversee learning. These processes included planning activities (predicting outcomes, scheduling strategies, and various forms of vicarious trial and error, etc) prior to undertaking a problem; monitoring activities (monitoring, testing, revising, and re-scheduling one’s strategies for learning) during learning; and checking outcomes (evaluating the outcome of any strategic actions against criteria of efficiency and effectiveness). It has been assumed that these activities are relatively unstable (although they are ubiquitously employed by adults on simple problems), not necessarily storable (knowing how to do something does not necessarily mean that the activities can be brought to the level of conscious awareness and reported on to others), and relatively age independent (i.e., task and situation dependent).

Additionally, Brown introduced the concept of “autopilot state”, arguing that expert learners (e.g. readers) monitor their comprehension and retention and evaluate their own

progress in the light of the purposes for which they are learning to the extent that these activities become automatic and learners proceed as if in “automatic pilot”. This concept tries to explain why metacognitive learners (i.e. those who apply metacognitive knowledge and skills in learning situations) some-times are not conscious of their strategies and cannot describe their metacognitive knowledge.

This model emphasizes the executive processes, stressing the importance of the control that people bring or fail to bring to cognitive endeavours. Moreover, Brown points to important characteristics of regulation of cognition, that have to be taken into account for those interested in the applications of these concepts into instructional research.

### **(iii) Tobias and Everson’s hierarchical model**

Similar to other researchers (Pintrich et al. (2000), for example) Tobias and Everson perceive metacognition as a compound of skills and knowledge - knowledge of cognition, monitoring of one’s cognitive and learning processes, and control of those processes. However, they organize these components into an hierarchical model, where the metacognitive skill of knowledge monitoring is a pre-requisite for activating other metacognitive skills as illustrated in Figure 2.14.



**Figure 2.14: Tobias and Everson’s hierarchical model of metacognition.**

They define knowledge monitoring (KM) as the ability of knowing what you know and knowing what you don’t know. In their recent research report they affirm. They

believed that monitoring of prior learning was a fundamental or prerequisite metacognitive process. If students cannot differentiate accurately between what they know and do not know, they can hardly be expected to engage in advanced metacognitive activities such as evaluating their learning realistically, or making plans for effective control of that learning. Learners who accurately differentiate between what has been learned previously and what they have yet to learn are better able to focus attention and other cognitive resources on the material to be learned.” (Tobias and Everson, 2002). Therefore, those who accurately distinguish between what they have already learned and what is yet to be acquired have an important advantage, since they can refrain from studying material that has already been mastered, or merely review it briefly. They assert that these students devote most of their time and energies to new, unfamiliar materials. In contrast, they argue that those students with less effective knowledge monitoring processes are likely to allocate their time and resources less effectively and spend valuable time studying what they already know at the expense of unfamiliar material and, consequently, have greater difficulty mastering new subjects (Tobias et al., 1999).

Tobias and Everson (1999) have investigated largely the monitoring aspect of metacognition, based on the assumption that accurate monitoring is crucial in learning and training contexts where students have to master a great deal of new knowledge. They have performed a series of empirical studies to investigate the aspect of metacognition and its relationship to learning from instruction in different domains, focusing on issues such as domain specificity of knowledge monitoring, measurement concerns, and the relationship of knowledge monitoring to academic ability.

They adopted the model of metacognition, building our computational framework based on the vision that promoting conscious development of knowledge monitoring, would lead to increasing of attention focus and appropriate allocation of cognitive resources and would, consequently, improve the other components of metacognition, that are placed on the top of Tobias and Everson’s pyramid. This model is particularly suitable for this research because it enables us to focus on specific metacognitive skills relevant for problem solving and provides an assessment instrument for one of these skills (i.e., knowledge monitoring).

#### **(iv) Schraw and Dennison Model**

The present study is based on the conceptual framework of metacognition of Schraw and Dennison's definition, as it is comprehensive and operationally measurable. Schraw, (1998) described two aspects of metacognition, knowledge of cognition and regulation of cognition, and how they are related to domain-specific knowledge and cognitive abilities. Schraw argue that metacognitive knowledge is multidimensional, domain-general in nature, and teach-able. Four instructional strategies are described for promoting the construction and acquisition of metacognitive awareness. These included promoting general awareness, improving self-knowledge and regulatory skills, and promoting learning environments that were conducive to the construction and use of metacognition.

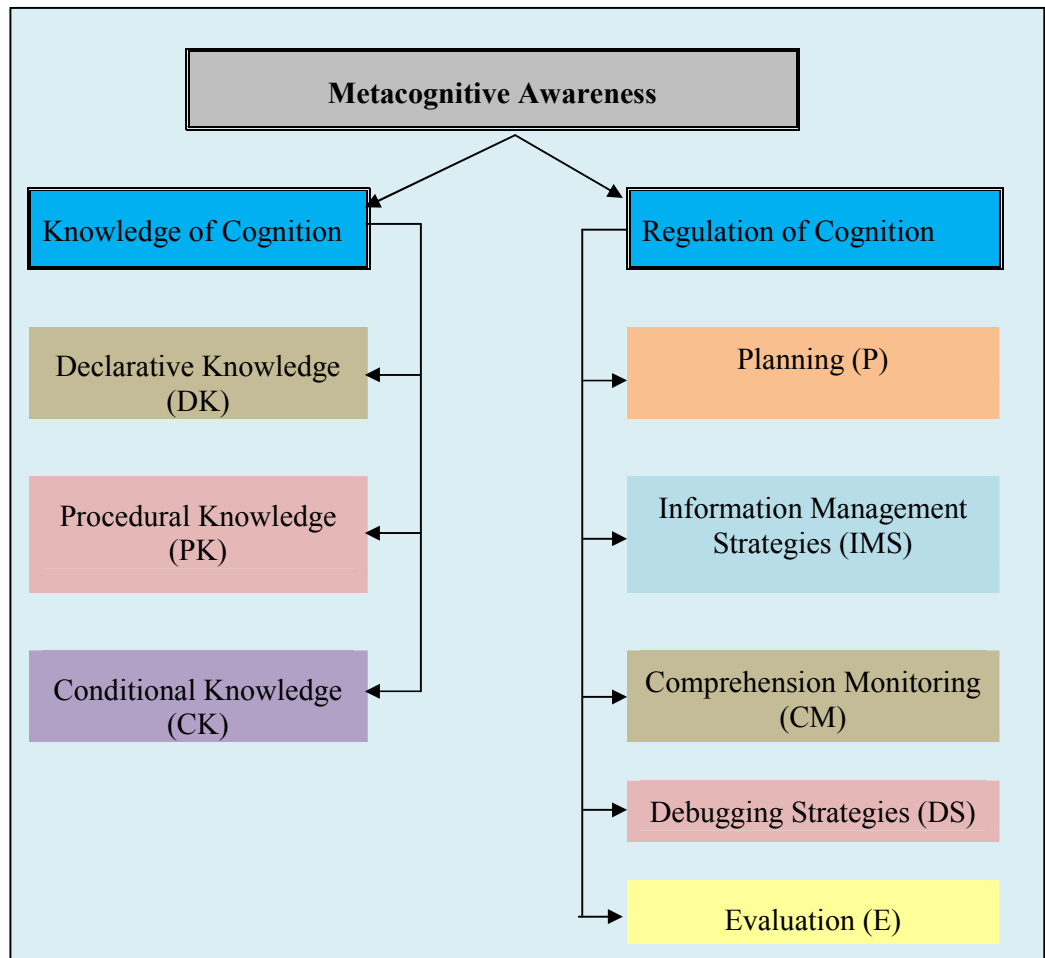
Schraw (1998) provided explicit instruction in cognitive and metacognitive strategies. Further, Schraw emphasizes that such strategy training needs to emphasize how to use strategies, when to use them, and why they are beneficial. Schraw recommends providing explicit prompts to help students improve their regulating abilities. He suggests using a checklist with entries for planning, monitoring, and evaluation, with sub questions included under each entry that need to be addressed during the course of instruction. Such a checklist, he argues, helps students to be more systematic and strategic during problem solving. Knowledge of cognition includes three sub-scales: declarative knowledge, procedural knowledge, and conditional knowledge. Regulation of cognition includes five sub-scales: planning, information management strategies, comprehension monitoring, debugging strategies and evaluation. The different components and sub components of metacognitive Awareness Inventory by Schraw and Dennison (1998) is depicted in Figure 2.15.

##### **(a) Knowledge of Cognition:**

Knowledge of Cognition is how learners know about themselves as a learner, and resources before beginning the task. Knowledge of Cognition has three sub-components namely declarative knowledge, procedural knowledge and conditional knowledge.

***Declarative Knowledge:***

It is how learners know about themselves as a learner, about their own weaknesses and strengths, and about their relationships with the tasks that they want to accomplish, such as learning or problem solving.



***Figure 2.15 Schraw and Dennison model***

***Procedural Knowledge:***

It is to know how and what strategies learners can use to accomplish their tasks.

***Conditional Knowledge:***

It is to know when and under what conditions learners can use a particular strategy to achieve their goals.

### **(b) Regulation of Cognition:**

Regulation of Cognition is to control the cognition. It consists of five subcomponents: such as Planning, Information Management Strategies, Comprehension Monitoring, Debugging Strategies, and Evaluation.

#### ***Planning:***

Planning, goal setting and allocating resources prior to learning.

#### ***Information Management Strategies:***

It includes skills to process information, such as organizing, elaborating etc.

#### ***Comprehension Monitoring:***

It entails assessing one's comprehension and learning process, whether the reading materials make sense or not.

#### ***Debugging Strategies:***

It is to look for help when encountering difficulties.

#### ***Evaluation:***

It is to assess oneself to see whether he or she has accomplished his/her jobs.

## **2.2 Learning Styles and Academic Achievement**

Learning styles constitute important component in the learning environment. Experts affirm that individuals enjoy various learning styles. In many cases what was being taught has a less impact on learners' achievement than the way materials were presented. It was also found that the high, moderate and low achievers have a similar preference pattern of learning in all learning styles. Moreover, the learning styles framework does not change with subjects, where it actually plays an important role across all the subjects. There have been many attempts made to enhance students' academic achievement. It has always been the main concern of teachers and parents that their students and children be as much successful as possible. In relation, many teachers were convinced that students need the positive attitude to succeed academically. Often, one's learning style was identified to determine strengths for academic achievement. Dunn, Beaudry and Klavas (1989) assert that through voluminous studies, it has been indicated

that both low and average achievers earn higher scores on standardized achievement and attitude tests when they were taught based on their learning styles.

Most students favour to learn in particular ways with each style of learning contributing to the success in retaining what they have learnt. As such, studies carried out conclude that students retain 10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, and 90% of what they say as they do something (Cheng, 1988). These facts revealed that each learning style has its own strengths and weaknesses. Some students learn in many ways, while others might only favour one or two. Those students with multiple learning styles tend to gain more and obtain higher scores compared to those who rely solely on one style (Dunn, Beaudry & Klavas 1989). Additionally, the differences in learning styles have also been reported between gifted and the under achievers; between the learning disabled and average achievers; among different types of special education students; and among secondary students in comprehensive schools and their counterparts in vocational education and industrial arts (Dunn & Dunn 1986). Some special students favour kinesthetic instruction, such as experiential, active and hands-on, while many others are more auditory and visually oriented (Dunn 1991). Dunn and Dunn (1986) also believed that low achievers tend to have poor auditory memory. Although they often want to do well in school, their inability to remember information through lecture, discussion, or reading causes their low achievement especially in traditional classroom environment where teachers dominated and students mostly listen or read. It was not only the low achievers learn differently from the high achievers, they also vary among themselves. Impulsive students for instance, when compared to reflective ones, show poor academic achievement (Kagan and Kagan, 1970). Other studies show that Field Independent students achieve more than Field Dependent ones (Chapelle 1995). Studies also reveal that matching teaching and learning styles can significantly enhance academic achievement at the primary and secondary school levels (Smith & Renzulli 1984). According to Felder (1995), students learn more when information was obtainable in a variety of approaches than when only a single approach is applied. Much experiential research indicated that learning styles can either hamper or increase academic performance in several aspects even though not much research has been conducted on the relationship between instructional design of learning materials and learning styles (Riding & Cheema 1991). Research findings indicate that

when students are taught in relation to their learning styles, it results in better academic success.

### **2.3 Metacognitive awareness and academic achievement**

Many researchers have examined metacognition and how it relates to academic achievement. Metacognitive skills were measured in terms of metacognitive regulation, metacognitive knowledge or both of these components. However, these components were measured differently within the literature. Some researchers used self report inventories assessed metacognitive skills and relate them to achievement measures (Schraw and Dennison, 1994; Sperling et al., 2004). Other researchers examined metacognitive judgments in the form of monitoring accuracy as a measure of metacognitive regulation on various tests (Everson and Tobias, 1998; Nietfeld et al., 2005; Schraw, 1994). Monitoring accuracy was measured in terms of what was considered calibration of performance. Calibration of performance judgments were made at the local and global levels. Local judgments were made after each item on a test. Local monitoring accuracy was determined to be the average difference between the actual answer of each test question and the students' judgment of how well they answered each question. Global judgments were made after the entire test was completed. Students were to judge how well they think they did on the test as a whole. Global monitoring accuracy was determined to be the difference between the overall test score and the students' judgment of how they did on the test. Local monitoring accuracy was measured of ongoing metacognitive regulation during testing and global monitoring accuracy was measured of cumulative metacognitive regulation (Nietfeld, et al 2005).

Research conducted by different investigators on correlation of metacognition with academic achievement measures indicated that when regulation of cognition was measured by having students estimate their performance on either a local or global level, regulation of cognition was related to test performance, domain specific GPA scores and overall GPA scores (Everson and Tobias, 1998; Nietfeld et al, 2005; Schraw, 1994). It appears that when metacognition was assessed through calibration of performance measured there was support for the relationship between metacognitive skills and measures of academic achievement. Unfortunately, determining monitoring ability and monitoring accuracy at the local and global level to assess metacognitive knowledge and regulation skills is a labor intensive endeavor. This situation was especially true for students who were assessed

in their actual college classes and not a laboratory or contrived setting. Students monitoring their accuracy on a local and global level must take the time to answer the test questions and then respond to how confident they were about their performance on each question. The process can be a time consuming and possibly stressful task for students while taking tests that will count toward their end of course grades (Nietfeld, 2005). It was important to assess students in a less intrusive manner in order to ascertain their metacognitive awareness and skill level. A less intrusive assessment such as a questionnaire, will allow instructors to quickly identify struggling students early on and assist them in developing effective metacognitive skills.

Schraw and Dennison (1994) developed the Metacognitive Awareness Inventory (MAI) as a quick and easy means to assess metacognitive awareness, and they found that the MAI correlated with reading comprehension, test performance, and of academic achievement, only on the knowledge of cognition factor. In general, it is accepted that the learners can improve their performance if they can monitor their own learning process (Dowing, 2010). Plenty of studies (Mevarech and Fridkin, 2006; Vrugt and Oort, 2008) show that metacognitive strategies are highly related to academic achievement and higher achievers know how to make use of metacognitive strategies better than the lower achievers.

## **2.4 Review of Related Studies**

Studies conducted in India and abroad in the field of learning style, metacognition and academic achievement have been reviewed in this section. These studies have been given under various subheadings.

### **2.4.1 Studies Related to Learning Style**

The studies relating to Learning Styles and achievements have been reviewed. The details have been presented below.

Verma and Sharma (1987) studied Academic Achievement in Relation to Learning Styles of Adolescents. The objectives of the study were to compare academic achievement of adolescent students possessing independent and dependent learning styles and to ascertain the effects of competitive and collaborative learning styles on academic achievement of adolescent students in hindi, english, mathematics, general science, social

studies and total area of study. The sample selected for the study comprised 120 adolescent students of both the sexes studying in secondary class in two Higher Secondary Schools of Bharatpur city. The tools used for measuring general intelligence and learning styles were, the Group Test General Mental Ability (Hindi version): Jalota (1972) and Student Learning Styles Questionnaire: Anthony and Riechmann (1975). Normative survey method of research was followed. The study revealed that, the group of students with dependent learning style was significantly better than the group of students with independent learning style so far achievement in Social Studies was concerned and there was no significant difference between mean scores of achievement in hindi, english, mathematics and general science, social studies and total area of study in respect of competitive and collaborative learning style group.

Kumar and Sudheesh (1997) examined the effect of learning style on achievement in biology of students of secondary school. The objectives of the study were to construct and standardize a multi dimensional learning style inventory and to assess the effect of learning style on achievement in biology. The sample of the study consisted of 329 boys, 321 girls, thereby making it 650. The tools used to collect the data included Learning Style Inventory and an Achievement Test in Biology by Kumar. The research was survey type in nature. It was found that the learning style of girls had significant effect on achievement in biology. But in the case of the sub sample boys, no significant main effect of learning style on achievement in biology was found.

Kopsovich (2001) conducted a study on correlations between learning styles of students and their Mathematics Scores on the Texas Assessment of Academic Skills Test". The research questions of the study were, is there a positive correlation between students' learning styles and their achievement test scores in mathematics? and is there a positive correlation between specific sub group's and gender's learning styles and their achievement test scores in mathematics? The data was collected from 500 fifth grade students attending a North Texas Intermediate school. The Learning Style Inventory by Dunn, Dunn and Price were used for data collection. The data was analyzed by the Pearson Product Moment Correlation coefficient and the Point-biserial correlation technique. The study used survey type research method. The findings of the study was that learning style preferences of all students in the area of persistence had significant impact on their mathematics achievement scores. Gender and ethnicity were mitigating factors in the findings.

Dasari (2006) analysed the influence of matching Teaching and Learning Styles on the achievement in science of grade six learners. The objectives of the study were to determine if there is a significant difference in the academic achievement of grade six science students when teaching strategy is matched to their learning styles, at educating learners in the process, how to identify conditions suitable to their optimal learning and take advantage of the study. The sample comprised 87 grade six students between ages of 11-13 years. The data were collected by Learning Style Inventory and Science Teaching Programme on units Alkynes and Electricity. The experimental pre-test, post-test control group design was used in the study. The investigator found that there was a significant difference in science achievement of 6<sup>th</sup> grade learners when teaching style was matched to learning style.

Graf et al. (2006) observed that when the learning styles are more and more incorporated in technology it enhanced learning and a lot of research work is done in this area. The aim of the study was to analyse data about learning styles with respect to the Felder-Silverman Learning Style Model (FSLSM), in order to provide a more detailed description of the learning style dimensions. Therefore, investigators used linear discriminant analysis in order to detect the most representative characteristics of learning styles as represented in the gathered data. Furthermore, investigators analysed how representative these characteristics are for the specific learning style dimensions. To investigate the learning style of students, investigators performed a case study where 207 students participated. 122 students were from Massey University of New Zealand and 85 from Vienna University of Technology in Austria. To measure the learning styles of the students, they completed a questionnaire developed by Felder and Soloman (1997). Each learning style dimension was divided in semantic groups and analysed the impact of each group for each learning style. A hybrid approach was used for detecting interesting features. The results obtained were social behaviour as well as the preference for trying things are important for the active-reflective dimensions, for sensing-intuitive dimension preference for concrete materials was the most representative characteristics, regarding the visual-verbal dimension, it was seen that questions from verbal point of view (i.e) about written text and spoken words were important for verbal learners and for visual learners the only characteristics to learn best is from what they see. Questions relating to sequential learning and relationship to other areas as a whole were preferred by the sequential-global

learners. The results showed a more accurate descriptive of Felder Silverman Learning Style Model.

Malathi and Malini (2006) studied the Learning Style of Higher Secondary Students of Tamil Nadu. The objectives of the study were to find out the learning style of students in classes XI and XII, to find out the relationship of learning style with achievement of students and to analyse the learning style of higher secondary students in terms of their sex, class and types of school. The sample consisted of 160 higher secondary students from private and government schools. The tool used in the study for data collection were Felder's Learning Style Inventory. Cronbach's alpha test, and 't'-test was used for data analysis. The findings of the study were that the learning style of higher secondary students was found to have no significant difference in terms of their class and types of school. There was significant difference in the learning style of boys and girls studying in higher secondary schools and the correlation were higher between learning style and achievement which indicates that higher the achievement scores, the better the selection of learning style among higher secondary students.

Mayya and Rao (2006) tested the association between leaning style preference and performance in the examination of medical students. The objectives of the study were: to estimate the perceptual learning style preference (auditory, visual and tactile) distribution in medical students and to compare the learning style preference score based on university examination marks of the students. Learning style inventory was used to collect data on learning style. The items of the inventory were grouped into 3 scales; each contained 8 items, to assess individual's auditory, visual and tactile performances in learning situations. Students' response to each item was scored on a 3 point scale. University examination marks were collected from office of the controller of examinations, Manipal Academy of Higher Education. The findings of the study showed significant negative correlation between tactile preference score and the percentage of marks in the university examination. Traditional teaching methods favor the auditory and visual learning styles. It was the tactile learner who was at a disadvantage at the university level. Mayya and Rao suggests that in order to provide a compatible educational environment for all students, it was important that teachers understood their own teaching style and adjust their teaching styles.

Tamimi and Shuib(2009) suggested that learning styles are important as they can give educators new directions for making changes in their classrooms. With this in mind a study was conducted to investigate Universiti Sains Malaysia (USM) English majors' learning styles. More specifically, the study identified the type of information these students preferentially perceive, through which sensory channel external information was most effectively perceived, how they prefer to process information, and how they progress toward understanding. The Index of Learning Styles (ILS) questionnaire developed by Felder and Soloman (2004) was adopted. The ILS questionnaire was based on Felder and Silverman's (1988) model, reported to be valid, reliable and suitable in identifying learners' learning styles (Felder and Spurlin,2005). The Index of Learning Styles (ILS) questionnaire was administered to Sixty final year students majoring in English in the academic year 2006-2007 at the School of Humanities, USM. A convenience sampling technique was used for sample selection. The study findings indicated that USM English majors have certain learning styles that should be considered by USM staff members in preparing their materials, curriculum and teaching methods. From the result, the scores of the subjects which ranged from only one subject has a very strong preference for the active dimension, only a small number of the subjects (i.e.12%) were intuitive learners, 5% of the subjects have a moderate preference on the verbal dimension, most of these subjects (i.e. 27 out of 45) have a mild preference in the sequential dimension.

Chen (2009) investigated the relationships between grade level, perceptual learning style preferences, and cognitive strategies among Taiwanese English as Foreign Language students in grades 7 through 9. Three hundred and ninety junior high school students participated in the study. The instruments for data collection were the Perceptual Learning Style Preference Questionnaire and the Strategy Inventory for Language Learning. Results showed that statistically significant relationships were found to exist between grade level and kinesthetic learning style preference, tactile learning style preference and individual learning style preference. Results also showed that statistically significant relationships were found to exist between grade level and the use of memory strategies, cognitive strategies, meta-cognitive strategies, affective strategies and social strategies. Implications are that it is critical for classroom teachers to be more aware of the differences in their students and ensure that their courses present information that appeal to students in different grade levels.

Holtbrugge and Mohr (2009) investigated the relationship between cultural values and the learning style preferences of students. By linking Kolb's model of learning style preferences to the cultural differences of individual learners they developed hypotheses that are tested against data collected from 953 students from 74 different national backgrounds enrolled in management courses at universities in Germany, UK, USA, Russia, Ireland, Spain, the Netherlands, Poland, China and the UAE. Findings of this study showed that learning style preferences differ across countries and that these preferences were affected by a number of cultural values. They also found important differences in the learning styles of male and female students and between local and exchange students. The results were important to teachers and managers active in the education and development of individuals from different cultural backgrounds and for researchers interested in the influence of cultural values on learning style preferences.

Ozpolat and Akar (2009) conducted a study based on automatic detection of learning styles for an e-learning system. The purpose of the study based on e-learning system is to provide the learner the most appropriate information based on his requirements and preferences. It can be achieved by capturing and utilizing the learner model. Learner models can be extracted based on personality factors like learning styles, behavioral factors like user's browsing history and knowledge factors like user's prior knowledge. The investigators addressed the problem of extracting the learner model based on Felder-Silverman Learning Style Model. The target learners in the problem were the ones studying basic science. Using NB Tree classification algorithm in conjunction with Binary Relevance classifier, the learners were classified based on their interests. Then, learners' learning styles were detected using these classification results. Experimental results were also conducted and evaluated the performance of the proposed automated learner modeling approach. The results showed that the match ratio between the obtained learner's learning style using the proposed learner model and those obtained by the questionnaires traditionally used for learning style assessment was consistent for most of the dimensions of Felder-Silverman learning style.

Soylu and Buket (2009) studied the Effect of Learning Styles on Achievement in Different Learning Environments. The study investigated the effect of learning styles on students' achievement in different learning environments which were designed according to principles of Generative Theory of Multimedia Learning. Research was conducted in the

framework of single group repeated measures experimental design model and three different learning environments (text based, narration based and computer mediated (narration + music + text + static picture) were planned and study group studied in these environments at different times. Students' achievement test and Kolb's Learning Style Inventory, were used to collect data for the study. Pretest-post test design was used. The result, clarified that the type of the learning style was not significantly effective on students' achievement in different learning environments.

Naimie et al. (2010) examined that students from English program in Iran were demotivated, confused and looked tired in class. One solution was to use new teaching styles in the class to overcome such problems, as learners learn in different ways such as hearing, seeing, taking notes, imagining and visualizing, among many others. To obtain the data, the Index of Learning Styles was used together with observations and interviews. The participants were 4 lecturers and 310 students in an English major program in Iran. The findings from the study suggested that it was crucial for teachers to have knowledge about learner preferences in their classes considered in their teaching design. The students showed a positive response and higher achievement when their learning preferences and needs were accommodated by their lecturers. Based on findings, it was hypothesized that the different learning styles dimensions have their own preferences in terms of teaching and technology usage.

Strang (2010) conducted an interdisciplinary empirical study of international university students on global culture, learning style and academic outcome. The study examined 2500 business degree students from 21 countries, enrolled at an Australian university, and used a survey to assess learning style, which was integrated into global culture taxonomy. The research hypothesis was that academic outcome could be explained through an interdisciplinary model, by integrating proven theories from educational psychology (learning style) and anthropology (culture). The literature review included interdisciplinary and rival theories to make the research useful for global practitioners. Technical discussion was minimized, focusing on the pedagogical implications of a generalized least squares regression model, which was statistically significant. Four factors dominated the model in predicting higher multicultural student academic outcome: collectivist and risk-taking cultures, along with visual-input and active-processing learning styles.

Abidin et al. (2011) studied the relationship between learning styles and overall academic achievement. Representative samples of 317 upper secondary class students were selected for the study. These students were consistent in their learning style patterns and all were Malay boys and girls with an average of 16 years of age. Survey method of research was followed. The Learning Styles Survey (LSS) instrument which was based on Joy Reid's Perceptual Learning-Style Preference Questionnaire (1987) was used. The result indicated a significant relationship between overall academic achievement and learning styles. It was also found that the high, moderate and low achievers have a similar preference pattern of learning in all learning styles. Moreover, the learning styles framework does not change with subjects, where it actually plays an important role across all the subjects.

Wilson (2012) analysed the extent to which learning styles influenced the educational process as well as the outcome of elementary-age students in terms of academic achievement. Participants for the study included students taken from a sample of 308 fourth grade students from thirteen classes in three school districts in north western South Carolina. The study examined potential relationships between the degree of match (as determined by comparing learning style preferences of students with instructional strategies of teachers) and the academic achievement of fourth grade students as shown by Palmetto Assessment of State Standards scores in the academic content areas of english language, arts, mathematics, science, and social studies. The study identified need for empirical data concerning the influence of learning styles on academic achievement, a quantitative approach with a correlational research design was appropriate for the study. The results of the study demonstrated a lack of significant correlation between variables.

Hemalatha (2013) in her study on learning style and their influence on academic achievement found the influence of learning styles over academic achievement of students studying in selected colleges of Chennai district. Learning styles were the cognitive, affective and psychological ways learners perceive, interact with, and respond to the learning environment. Students differ in the ways they approach learning. The way in which the students approach the learning tasks and the behavior in learning situations determines their learning style. The study was ex-post facto research with 1 x 1 designs. The sample of the study was 600 college students enrolled in chemistry who were selected at random. Learning Style Inventory was the tool used. Based on the four learning styles

identified, the investigator performed the study to find the influence of learning styles on academic achievement of college students. A strong positive correlation, was found between learning styles of students and their academic achievement.

Oriab and Ameerh (2014) examined if the learning styles (concreteness, reflectiveness, abstractness and experimentation) predict meta-cognition (knowledge of cognition, regulation of cognition and cognition processing). Participants of the study consisted of 715 students (males and females) selected randomly from different faculties of Albalaq'a Applied University. Two questionnaires on learning styles and meta-cognition were administered to members of the sample during academic year 2013-2014. Regression and correlation analyses were used for data analysis. Results indicated that there was a significant positive correlation between the dimensions of learning styles and meta-cognition. Results also indicated that learning styles significantly explain and predict all sub-dimensions of metacognition.

Learning styles varied according to the individual and the diversity was fundamental in terms of teaching as curricula must respond adaptively to the various learning styles of pupils. Aljojo and Alkhouli (2015) conducted an Empirical Investigation on the relationship between Learning Styles based on an Arabic version of the Felder-Silverman Model. Study focused on the interpretation of data derived from the Arabic form of the Index of Learning Styles (ILS) to establish correlations between the learning styles of 1024 female students drawn from two specific departments at the King Abdul-Aziz University in Saudi Arabia. The findings, generated by Multiple Correspondence Analysis and cross-validated by correlation analysis, demonstrated a definite link between certain learning styles from opposing dimensions that are considered to be contradictory within the same dimension of learning. The validity and reliability of the Arabic scale was established and compared to the examples reported in the literature. Findings showed comparable reliability and factor analysis supports the interdependences between dimensions and perhaps the constructs they intended to assess. The results of this study had implications for the design of e-learning tools, materials and sessions in order to adapt to the relationships between learning styles and had a positive impact on the learners themselves and their learning experience.

Babu (2015) studied the preferred ways of learning of 600 students of class IX of Hyderabad and Ranga Reddy districts of Telangana state in India. The Learning Style considered were figural, verbal, enactive, reproducing and constructive and the tool used was Learning Style Inventory by Misra (2012). The analysis revealed that 84% of students were seen to be moderate and good in figural learning,  $\frac{3}{4}$  of the students appeared to be moderate in verbal learning, 80% of the sample were moderate and good in enactive learning, 83% of the students appeared to be good and moderate in reproducing learning and 73% of students were good and moderate in constructive learning.

Shuib and Azizan (2015) investigated individuals preferentially process information in different ways. It included the varied learning style preference of the individuals in any study program, including English as a Second Language (ESL). However, one of the major concerns was, do the ESL students have different preferred way to learn? Past studies have given mixed results including Malaysian students. The study sought to identify whether there were differences in learning style preferences between male and female students who undertook ESL courses in the Universiti Sains Malaysia (USM). To achieve the study objective, Felder-Silverman Learning Style Model (FSLSM) was selected to gather data on the respondents' learning style preference due to its validity, widespread use and suitability to the scope of the study. The responses gathered from FSLSM were tallied and assessed for gender difference in LSP. Results indicated that, there is a strong representation of visual learners from both male and female respondents. On the other hand, the respondents, irrespective of the gender difference, are well-balanced in the dimensions of sensing/intuitive, active/reflective, and sequential/global. In addressing the gender difference, it was found in the study that there is no significant difference between male and female ESL students in their preferred learning styles on each of the FSLSM dimension. Thus, this study revealed that, gender does not help differentiate students' learning preferences. The findings lend support to several past studies on learning style preference.

#### **2.4.2 Studies Related to Metacognition:**

Studies related to metacognition and its components have been reviewed and presented here under.

Romainville(1994) conducted an exploratory research project on first-year university students' meta-cognition. Using data from structured interviews, the investigator examined the way university students describe, judge and justify their cognitive strategies. The paper explored in particular the relationship between students' meta-cognition and their academic performance. In a sample of 35 economics students, a relationship was found between performance and some students' meta-cognitive knowledge characteristics. In particular, it was found that high achieving students seem to be aware of more cognitive rules and to evoke meta-cognitive knowledge about cognitive processes and cognitive results more frequently. Their meta-cognitive knowledge also seemed more structured and hierarchically organized; for instance, high achieving students describe more frequently their cognitive strategy as a complex sequence including several relationships.

Schraw (1994) was interested in the relationship between metacognitive knowledge and metacognitive regulation. He measured metacognitive knowledge by asking students to rate how well they thought they could monitor their accuracy on a series of multiple choice reading tests. He measured metacognitive regulation at both the local and global levels by having students rate accuracy for each question then rate their accuracy after completing the tests. Based on the results of the study, Schraw suggested that adult students may differ not so much in their metacognitive knowledge skills but in their metacognitive regulation skills. He further suggested that metacognitive knowledge may develop independently of metacognitive regulation. Finally, Schraw found that actual test performance was significantly correlated with judgments of test performance made before testing, a measure of metacognitive knowledge. Test performance was also correlated with metacognitive regulation in that he found correlations between performance and local and global judgments.

Albaili (1998) examined the relationships among goal orientations, the use of cognitive strategies and academic achievement of 234 undergraduate college students at the United Arab Emirates University. Results showed that students who scored higher on learning goal orientation scale were more likely to be cognitively engaged in the use, elaboration and organizational strategies. In contrast, students who scored higher on performance goal orientation scale were more likely to use rehearsal strategies and somewhat less likely to use elaboration and organizational strategies. Simple one-way

ANOVA followed by post hoc Scheffe test indicated that high GPA students scored significantly lower than the middle and low GPA students on the performance goal orientation and the use of rehearsal strategy scales. Unexpectedly, no significant differences were observed among the three GPA groups on learning goal orientation scale. Subsequent path analysis suggested that performance goal orientation has a negative direct effect on GPA, while the learning goal orientation had a positive indirect effect mediated by both elaboration and organizational strategies.

Everson and Tobias (1998) were interested in knowledge monitoring accuracy. The skill was involved in metacognitive regulation. They developed a means to assess students' Knowledge Monitoring Ability (KMA) by examining the difference between students' estimates of their knowledge in the verbal domain and their actual knowledge as determined by performance on a standardized verbal test. They found the greatest relationship to be between the KMA and students' end of course grade in English, then the humanities and the students' overall GPA. They also found that the measure of metacognitive regulation, the KMA, was related to academic achievement in college and it was a good predictor for success in college.

Martin and McNerney (1998) explored the relationships between middle school students' multiple motivational goal orientations and their use of multiple cognitive and meta-cognitive strategies with a focus on relations between these motivational and cognitive variables and students' academic achievement in two curriculum areas. Participants were 602 middle school students from 4 high schools in the Sydney (Australia) metropolitan area. In the study, a dual approach combining cognitive and motivational variables were used. Students' mastery goals were most strongly associated with their strategy use. The findings validate the salience, for Australian middle school students, of various motivational goals, cognitive strategies, and meta-cognitive strategies identified in international research.

Kwang (2000) established the extent to which metacognitive training plays a part in Singapore primary students' word problem solving in a computer environment. The study involved 142 Singapore 11 to 12-year-old students from two primary schools. The study adopted a two-phase design, combining a quasi-experimental design and a case study design. For the quasi-experimental design, analysis of students' mathematical achievement

test data was used to investigate the relationship between metacognitive training, students' level of mathematical achievement and their mathematical word problem solving performance. For the case study design, analysis of the think aloud protocol data during word problem solving of eight pairs of students was used to explore the role of metacognition in mathematical word problem solving in a computer environment. In addition, student questionnaire and teacher interview data provide descriptive accounts of students' metacognitive knowledge during mathematical word problem solving. The findings from the analysis of mathematical achievement test and think aloud protocol data reveal that metacognitive training results in improvement in mathematical word problem solving performance, and that low achievers appear to show the full benefit from metacognitive training only after a period of time. The findings of the think aloud protocol data also reveal that, generating metacognitive behaviours, and knowing when and how to use them during word problem solving are important determinants for successful word problem solving, and students have distinctive progressions of word problem solving activity which can be represented by five types of cognitive-metacognitive word problem solving models. These progressions of word problem solving activity seem to relate to students' success in word problem solving. It is also proposed that there is a relationship between affect, students' ability to develop metacognitive awareness, and word problem solving. In addition, effective pair collaboration is influenced by students' mathematical beliefs, and how students are paired according to their metacognitive knowledge.

Kramarski et al.(2002) investigated the differential effects of cooperative-learning with or without metacognitive instruction on low and high achievers' solutions of mathematical authentic tasks. Participants were 91 seventh graders who studied in three classrooms. Data were analyzed by using qualitative and quantitative methods. Results indicated that students who were exposed to the metacognitive instruction within cooperative learning (COOP+META) significantly outperformed their counterparts who were exposed to cooperative learning with no metacognitive instruction (COOP). The positive effects of COOP+META were observed on both authentic and standard tasks. In addition, the findings showed the positive effects of COOP+META method on low and high achievers.

Sperling et al. (2004) determined college students metacognitive awareness, found a significant correlation between the knowledge of cognition factor and the regulation of

cognition factor. They also were interested in whether the MAI would be correlated with other measures of academic achievement such as SAT scores and high school average. They found no relation between scores on the MAI and measures of academic achievement. They were surprised to find a negative correlation between SAT math scores and the MAI scores.

Nietfeld et al. (2005) examined metacognitive regulation by measuring monitoring accuracy at the local and global level on a series of multiple choice tests given as a part of a semester long course. They found that monitoring accuracy remained stable across tests throughout the semester. They also found that students were more accurate in their global predictions than their local predictions. They found that student performance on the tests was related to local monitoring accuracy.

Annevirta and Vauras (2006) investigated the development of metacognitive skills (MS) of 43 children from preschool to the 2<sup>nd</sup> grade (6-8 years of age) in a problem-solving situation. The children's skill to direct, guide, and monitor their performance in a play-like problem-solving context was evaluated in 3 experimental groups of preschool children with high, average, or low metacognitive knowledge (MK). The development of MS was further compared with the development of general MK of the same children. The results showed that children with initially high MK had better MS in problem-solving tasks during the first 2 school years, whereas the self-guided behavior of children with lower MK resembled more the type of adult-dependent behavior typical of young children as late as the 2<sup>nd</sup> grade. However, there was no clear developmental relationship between MK and MS.

Zulkipli (2006) discussed metacognition is thinking about one's own thinking, and its relationship to students academic performance. The paper also reports on a study investigating the relationship between students academic achievement and metacognitive awareness, which has been done in a private secondary school in Kuching. An established instrument by Shraw and Andersons Metacognitive Awareness Inventory was used for the study. Specifically, the study examined the relationship between students academic performance and each of the five components of metacognition regulation namely planning, information management strategies, comprehension monitoring, debugging strategies and evaluation. It also examined metacognition awareness in students across

gender and different academic years. Overall, the findings revealed a significant positive relationship between students academic performance and metacognitive awareness, a significant difference in metacognitive awareness between Form 2 and Form 5 students, and no significant difference in metacognitive awareness between male and female across all academic years. Some suggestions to develop metacognition in students were discussed, and possible directions for research on metacognition in learning process were proposed.

Countinno (2007) focused on how students learn with a view to improve learning tactics for students and encourage effective teaching practices by teachers. The study examined the relationship between three variables – achievement goal orientation that orient students towards a focused on mastering information or performing well, metacognition was the learner’s monitoring of how well he or she was learning, and academic success was reflected in class grades accumulated over the college tenure. These variables have been studied with elementary and secondary school students but not college students. College students were a different group from elementary and secondary students and may have different learning patterns that are based on their goals to finish college or acquire skills for a job. The learning variables used in the study have not been studied in this combination. Both reasons provided support for conducting the study. Relationships between these variables have implications for student learning, and can help students become better learners and apply their knowledge to academic and non-academic settings. The data was collected through survey encompassing goal orientation scale, metacognition scale and demographic information. The data was analysed by using correlation analysis. The results showed that there was a moderate relationship between metacognition, academic achievement and goal orientation but a weak relation between metacognition and academic achievement.

Hoffman and Spatariu, (2008) used a regression design to test the unique and interactive effects of self-efficacy beliefs and metacognitive prompting on solving mental multiplication problems while controlling for mathematical background knowledge and problem complexity. Problem-solving accuracy, response time, and efficiency (i.e. the ratio of problems solved correctly to time) were measured. Students completed a mathematical background inventory and then assessed their self-efficacy for mental multiplication accuracy. Before solving a series of multiplication problems, participants

were randomly assigned to either a prompting or control group. They tested the motivational efficiency hypothesis, which predicted that motivational beliefs, such as self-efficacy and attributions to metacognitive strategy use are related to more efficient problem solving. Findings suggested that self-efficacy and metacognitive prompting increased problem-solving performance and efficiency separately through activation of reflection and strategy knowledge.

Mevarech & Amrany (2008) analysed the immediate and delayed effects of meta-cognitive instruction on regulation of cognition and mathematics achievement. The study addressed two research questions: whether the students who were exposed to meta-cognitive instruction were able to implement meta-cognitive processes in a delayed, stressful situation, namely matriculation exam and whether students preparing themselves for the matriculation exam in mathematics, attain a higher level of mathematics achievement and meta-cognitive awareness (knowledge about cognition and regulation of cognition) as a result of being exposed to meta-cognitive instruction. Participants were 61 Israeli high school students who studied mathematics for four-point credit on the matriculation exam (middle level). About half of the students ( $N = 31$ ) were assigned to meta-cognitive instruction, called IMPROVE, and the others ( $N = 30$ ) studied with no explicit meta-cognitive guidance (control group). Analyses included both quantitative and qualitative methods. Results indicated that IMPROVE students outperformed their counterparts on mathematics achievement and regulation of cognition, but not on knowledge about cognition. Furthermore, during the matriculation exam, IMPROVE students executed different kinds of cognitive regulation processes than the control students.

Shannon (2008) studied about use of Metacognitive Strategies and Learning Styles to Create Self-Directed Learners. The purpose of this action research project was to help students become self-directed learners by determining what metacognitive strategies would be the most effective for a student's specific learning style. Students were surveyed using the Perceptual Modality Preference Survey and determined their dominant learning styles. Students were then introduced a new metacognitive strategy each week and asked to apply the strategy to their daily learning processes. Students were asked to reflect on which metacognitive strategies best fit their learning styles. The study took place at a high school in a Midwestern Class C-1 school district. The district's enrollment was approximately

282 students in grades nine through twelve; with a 27% free/reduced lunch population and 14% of students receiving special education services. For the study, a total of 40 students participated in the action research project within the three chemistry classes. After analyzing the data from student lab journals and metacognitive forms, four themes were apparent and they included the connection between learning styles and metacognitive strategies, self-assessment, and student motivation. First, the connections between a student's learning styles and preferred metacognitive strategies, as determined by students. Next, the concept of motivation, related to metacognition and the self-directed learner was addressed. It was seen that 73% students had kinesthetic learning style and they preferred selecting strategies in which they had direct involvement. 45% of students were interactive and they preferred critiquing and revising and the 38% haptic learners preferred strategies which allowed them to have hands-on contact with material. Visual learners (30%) preferred self-questioning and print learners (15%) preferred self-assessing and 10% of learners were aural learners who preferred questioning by teacher. It was also seen that irrespective of the learning style preference all learners were continuously evaluating their performance and progress.

Vrugt and Oort (2008) designed a model of effective self regulated learning, based on effort expenditure they discerned effective self-regulators and less effective self-regulators. The model comprised achievement goals (mastery, performance- approach and-avoidance goals), metacognition (metacognitive knowledge, regulation and experience), study strategies (metacognitive, deep cognitive, surface cognitive and resource management strategies) and academic achievement. The relationships in the model were tested with controlling for intellectual ability, gender and age. First-year psychology students (N=952; 652 female and 300 male) cooperated in this study, participating in a number of collective test sessions within the framework of study obligations. The mean age was 21 years (SD=4.3). The MSLQ devised by Pintrich and Garcia (1991) was used to assess the students' study strategies. The results showed that effective self-regulated learning involved two pathways: a metacognitive and a strategy pathway. The first pathway involved a positive relationship of mastery goals and a negative relationship of performance-avoidance goals with metacognition. Metacognition positively affected the use of the four study strategies. The strategy pathway involved

positive effects of mastery and performance-approach goals on the use of metacognitive and deep cognitive strategies. Further, performance-approach goals positively affected the use of surface cognitive and resource management strategies. The use of metacognitive and resource management strategies had a positive and the use of surface cognitive strategies had a negative effect on exam scores.

Young and Fry (2008) developed a Metacognitive Awareness Inventory (MAI) to determine how it relates to broad and single measures of academic achievement among the college students. Correlations were found between the MAI and cumulative GPA as well as end of course grades. Scores on the MAI significantly differ between graduate and undergraduate students.

Bannert et al. (2009) studied the effects of a metacognitive support device in learning environments. It is based on metacognitive activities which have to be performed and constantly monitored during learning. Research revealed that many learners have difficulties in performing such metacognitive activities spontaneously, which most probably results in lower learning outcomes. The aim of the study was to experimentally analyse the effects of a metacognitive support device combined with a paper-based prompting scheme. With the support device, students were instructed to activate their repertoire of metacognitive knowledge and skills which should further enhance learning and transfer. University students of the experimental group 29 were instructed by means of a metacognitive support device why metacognitive activities are useful and how to apply them during learning. Students of the control group 27 were not instructed why and how to use metacognitive activities, and furthermore, they were not prompted during learning to apply these metacognitive activities. Rather, they were instructed by a computer device, so all groups were treated in a similar way. The students' learning task was to learn about "psychological theories of using pictures in multimedia learning environments" within 60min. Immediately afterwards, learning outcome was measured with a test. Altogether, 56 university students participated, counter balanced according to their prior knowledge as well as metacognitive knowledge. At last the students of the experimental group showed better transfer performance compared with the control group.

Kaberman and Dori (2009) investigated the ways by which the metacognitive strategy affected students' skills to pose complex questions and to analyze them according

to a specially designed taxonomy. The study focused on guided question posing while using a metacognitive strategy by 12th grade honors chemistry students. The learning unit, Case-based computerized laboratories, emphasizes learning through chemical case studies, accompanied by tasks that call for posing questions to which the answer cannot be found in the text. Teachers equipped their students with a metacognitive strategy for assessing the quality of their own questions and characterizing them according to three-component taxonomy: content, thinking level, and chemistry understanding levels. The participants were 793 experimental and 138 comparison chemistry students. Research instruments included interviews and case-based-questionnaires. Interviews with students revealed that using the metacognitive strategy the students had been taught, they were capable of analyzing the questions they generated with the taxonomy. The questionnaires showed that students significantly improved their question posing skill, as well as the complexity level of the questions they posed. A significant difference was found in favor of the experimental group students. Stimulating students to generate complex questions with a metacognitive strategy in mind enabled them to be aware of their own cognitive process and to self-regulate it with respect to the learning task.

A metacognitive teaching approach was implemented in a special education class with five children, aged 12 to 13 years by Marco and Hessels (2009). One day per week, the regular school activities were enriched with a metacognitive intervention with curriculum-unrelated tasks during the morning hours and curriculum-related tasks during the afternoon. The children first worked in dyads, after which the tasks were discussed in the whole class. The discussions served indirectly to teach cognitive and metacognitive strategies and to develop metacognitive awareness in an indirect manner. In the afternoon, the learned strategies were applied to the curriculum related task to foster transfer. In addition, a strategy of the day was defined in the final discussion of both types of exercises, and children were encouraged to use these on other school days. The application of the strategies and the children's metacognitive knowledge were evaluated through self-report questionnaires (both general and task specific), observation of their behavior and verbalizations, and their performance in the various tasks. Children progressed in cognitive and metacognitive strategy used in both types of tasks as well as in their overall performance on the tasks, but their evaluations in the general metacognitive questionnaire

decreased. The latter was interpreted as a metacognitive adjustment in the children, who, after repeated reflection on their behavior in different types of tasks, were evaluated their cognitive and metacognitive behavior.

Menderes (2010) tested the relationship between the meta-cognitive learning strategies and academic achievement of university students. The data of the study were gathered from randomly chosen undergraduate students who have been studying at Ahi Evran University which was the restricted universe of the study, in the first term of 2009-2010 academic years. Randomly chosen 230 students from different departments of Ahi Evran University were included in the sample of the study. The higher level of students' awareness, the more successful they are in courses. Considering the results of the research, it was suggested that the meta-cognitive awareness and strategies of students in universities should be identified. In case the students have lower level of meta-cognitive strategies, some guidance and counselling should be provided by arranging some activities such as meetings, conferences or seminars.

Nbina and Viko (2010) examined the effect of instruction in metacognitive self assessment strategy on senior secondary school students' Chemistry self-efficacy and achievement. The study also explored the interaction effect of instruction in metacognitive self assessment strategy and gender in their Chemistry self-efficacy and achievement. The study was guided by five research questions and four hypotheses. A non-equivalent control group pretest and posttest design involving one treatment and one control group was adopted. A total of 192 Senior Secondary students from Port Harcourt Education zone were used for the study. The Self Assessment Instructional Programme (SAIP) was developed, validated and used for the study. Three instruments: Chemistry Achievement Test (CAT), Self Assessment Scale (SAS) and Chemistry Self-efficacy Scale (CSS) were adopted, validated and used for data collection. The results suggested that instruction in the metacognitive self assessment strategy improved the students' chemistry achievement and self-efficacy.

Ndidiama (2010) studied the relationship between mastery goals, performance goals, metacognition and academic success. The study adopted an analytical survey involving 179 undergraduates (87 females, 92 males) of the Alvan Ikoku Federal College of Education, Owerri. The instruments for data collection were the metacognitive

awareness inventory, the mastery goal items and performance goals. Findings of the study showed that mastery goals were related to GPA whereas performance goals were unrelated to GPA performance. Metacognition is also related to academic success and students with good metacognition have good GPAs. Mastery goals influence GPAs through metacognition as students with mastery goals may have superior metacognitive skills and strategies that they use to master information. The researcher recommends that teachers adopt teaching techniques that present information to students in a way that encouraged the use of mastery goal and metacognitive strategies.

Rahman (2011) conducted a study to see nature of metacognition using metacognitive awareness inventory. The instrument was administered to students of grade X. The age group of the students ranges between 15-16 years. The data analysis indicated that metacognition was not a single variable but was highly multivariate. The approach was considered as factor analysis of the response patterns of the students which showed no underlying structure at all. They undermined the claims of the original authors of the inventory but, more importantly, suggests that metacognition was not a single variable or even the eight variables that were derived from the original survey. The study recommended that there was a need to explore the nature of metacognition through further research.

Sendurur (2011) investigated the pre-service teachers levels of metacognitive awareness and comparison of sub-awareness scores, and explored the relationships among metacognitive awareness factors and other independent variables including gender, GPA, course grades, and graduated high school type. The data were collected during “Computer Applications in Education” course in Spring-2010. 49 students completed the “Metacognitive Awareness Inventory (MAI)” developed by Schraw and Dennison (1994). There are 52 items loaded into 2 factors which are ‘knowledge of cognition’ and ‘regulation of cognition’. High reliability coefficients were found for these factors (from 0.91 to 0.97). Students’ scores on MAI were calculated and used to find out relations with other descriptive factors. The findings revealed that metacognitive awareness scores of pre-service teachers were not too low, but mean differences between knowledge of cognition and regulation of cognition factors were found significant. The correlational analysis revealed that overall academic success was related to regulation skills and also the

pre-service teachers evaluation skills was highly correlated to their academic achievement scores.

Sperling et al. (2012) studied the predictive ability of metacognition in middle school learners. The study examined relations among components of metacognition from varying theoretical perspectives, explored the psychometric characteristics of known measures of metacognition, and examined the predictive strength of measures of metacognition for both science and overall academic achievement in 97 seventh-grade students. Findings indicated expected significant correlations between two measures of metacognition, the Junior Metacognitive Awareness Inventory and open-ended version of Swanson's (1990) metacognition measure and a significant correlation between the Swanson measure and general science teacher ratings of students' metacognition. Student measures demonstrated sound psychometric properties and both were significant predictors of science achievement.

Wong (2012) analysed how university students in Hong Kong self-regulate their academic learning. Two factors were investigated for their self-regulation: the use of metacognitive skills and the punctuality for learning. Three hundred and fourteen students from two universities participated in the study by filling out a self-administered questionnaire, which consists of three instruments measuring metacognitive awareness, procrastination, and academic performance. The results showed that high metacognitive awareness and low procrastination tendency are two positive elements for academic learning. For analysis purposes, the data were divided into four categories by using the mean scores of each variable: students with high level of metacognitive awareness and high level of procrastination; students with low level of metacognitive awareness and low level of procrastination; students with high level of metacognitive awareness but low level of procrastination; students with low level of metacognitive awareness but high level of procrastination. The results showed that the students without any of these positive elements were significantly lower in GPA, than students from the other three groups; however, it was surprised to find that the students who have two positive elements do not get a higher GPA than those who have only one of these positive elements.

Amzill(2013) assessed the effect of metacognitive intervention on college students' reading performance and metacognitive skills. The goal of the study was to

investigate the impact of a metacognitive intervention, with explicit training in monitoring and control on college students' reading performance and metacognitive skills. The intervention was five sessions long used an instructional design that combines reflective dialogue, modeling, and group-practice. Effects were contrasted with an active control group who received strategy training in reading comprehension. Results showed that the experimental group gained in metacognitive skills and reading performance while the control group did not show any change from pretest to posttest. Finally, researcher found that within the experimental group high achievers as measured by GPA showed greater gains in reading than low achievers.

Aurah (2013) investigated the effect of self-efficacy Beliefs and Metacognition on Academic Performance among high school students using a mixed method approach. A total of 2,138 form four (12<sup>th</sup> grade) students participated in the study. The mixed-method study consisted of a quasi-experimental approach and in-depth interviews. Quantitative data were collected from Self Efficacy Questionnaire (SEQ), Biology Ability Test (BAT), Genetics Problem Solving Test (GPST) and Metacognitive Prompting Questionnaire (MPQ). Qualitative data were collected using in-depth interviews. Quantitative data were analysed using both descriptive and inferential statistics (hierarchical linear regression and factorial ANOVA). Qualitative data were coded, categorized and reported thematically. Regression analysis indicated that self-efficacy was a strong predictor of academic performance. ANOVA analysis displayed statistically significant differences in metacognition in form of metacognitive prompts between groups. Subsequent qualitative data suggested that highly efficacious students did better on the tests than less efficacious students. The metacognitive prompting experience provided a rich environment for the development of metacognitive strategies that promoted problem solving skills among high school students.

Bergstresser (2013) discussed the effect of metacognitive training sessions on students' calculus retention. This study involved 27 students ranging in age from 17 to 18 in two separate senior calculus classes in a private religious high school. There were 10 boys and 21 girls, 5 African American students, 1 Middle Eastern student, and 25 Caucasian students. Students in two high school classes participated. The students in both classes were given lessons on a chapter without metacognitive training and lessons on a subsequent chapter with training in a set of metacognitive skills. After the latter chapter

students scored higher on a post-test and expressed desire to incorporate the skills they learned into their other classes.

Eluemuno (2013) investigated the effect of metacognitive skills on academic performance of senior secondary school students in Anambra state, Nigeria. The study examined the relationship between metacognitive skills and academic performance among senior secondary school students. A sample of 144 participants' were randomly selected from three senior secondary schools for the investigation. The schools were randomly assigned two intervention conditions (metacognitive training strategies) and control group. Questionnaire and achievement test was employed to generate data for the study. To guide the study, two research hypotheses were formulated. The hypotheses were tested using descriptive statistical method, analysis of covariance (ANCOVA) and Pearson product moment correlation coefficient statistics. The study revealed a positive relationship between metacognitive skills and academic performance such that developing metacognitive skills of a student will lead to the improvement of his/her academic performance in English Language. Thus, the investigator concluded that there is a need to inculcate the development of metacognitive skills in the school curriculum. This is considered important because of its impact in improving academic performance of students in English Language. The findings of the study can assist educators in developing instructional objectives for a better understanding of the effects of metacognitive skills on academic performance of senior secondary school students.

Ersozlu & Yıldırım (2013) investigated the relationship between the metacognitive awareness of university students and their solutions to the similar mathematical problem types. Participants were 97 freshmen from department of mathematics at a state university in Turkey. Two different scales were used for data collection: Metacognitive Awareness Inventory and Mathematical Problem Types Test. The results showed that there was a significant positive correlation between the students' metacognitive awareness levels and their problem solving levels regarding routine and non-routine problems. There was no significant linear correlation between university students' metacognitive awareness levels and their problem solving levels for separation, combining, and multiplication in routine problems. Multiple regression analysis was used to test if the metacognitive awareness significantly predicted participants' levels of problem solving. The results of the regression

indicated that metacognitive awareness significantly predicted problem solving levels and both predictors explained 45 percentage of the total variance.

Narang (2013) studied the impact of metacognition on academic performance of rural adolescents (13-16 years). The study was carried out in rural schools of block-I, Ludhiana District. The sample comprised of 240 rural adolescents equally distributed over four grades (7th, 8th, 9th and 10th grade), two sexes and two socio-economic groups i.e. middle and low socio-economic group. Metacognitive skills of the subjects were assessed using a self-structured Questionnaire adapted from Metacognition Inventory and Metacognitive Awareness Inventory. To assess the academic performance of the subjects, the aggregate percentage of marks obtained by them in the last school examination was procured from the concerned teachers. Results revealed that the major proportion of subjects with high level of metacognition also performed above average in academics. Further, analysis depicted that both the components of metacognition viz. 'Knowledge of Cognition' and 'Regulation of Cognition' significantly contributed towards the academic performance of the adolescents.

Rani (2013) explored the relationship of metacognition of undergraduate students with demographic variables like gender, place of living, academic achievement and parents' education. The study was conducted on the sample of 313 undergraduate students of Aligarh District. The metacognitive inventory (MCI) developed by Govil was used as the tool for assessing metacognition of students. 't' test and analysis of variance have been employed to analyse the data. The findings of the study revealed that gender has no significant impact on the metacognition of undergraduate students on the other hand the metacognitive level of urban students differs significantly from their rural counterparts. The high and low achieving undergraduate students differ significantly on their metacognitive level. Moreover, fathers' educational qualification was found to have no significant impact on metacognition of the students under study while mothers' education has significant impact on it. The study suggested learners to understand and regulate their own thinking process to resolve the real life complexities. Further the study also recommended some strategies for parents and teachers to facilitate learning among students at college level.

Said (2013) investigated the prediction of academic performance of 32 female college students as measured by observed study behaviors and test scores in a mock study session. The predictors of interest were: executive functions, academic self-efficacy, self-reported study strategies, and metacognitive skills. Unexpectedly, executive functions, self-efficacy and self-reported study strategies did not predict academic performance, nor did the two measures of academic performance (test score and observed study behaviors) correlate with each other. However, hierarchical regression analysis demonstrated that the metacognitive skill of procedural knowledge and the study strategy of time management predicted 39% of the variance in test performance; whereas, the metacognitive skills of planning and information management predicted 22% of the variance in observed study behaviors.

Zhang and Seepho (2013) conducted a study to find out the relation between the metacognitive strategies of English major students and academic reading at Guizhou University in China. It was known that metacognitive strategies are important for successful second/foreign language readers. All of the participants were third-year English majors. The data were collected by means of a Metacognitive Strategy Questionnaire (MSQ), a semi-structured interview and a reading comprehension test. The results revealed the overall metacognitive strategy use in academic reading comprehension of Chinese EFL (English as a Foreign Language) students with both high and low proficiency. The in-depth analysis of their differences was also illustrated. The results indicated that there was a significant positive correlation between metacognitive strategy used and English reading achievement. The study bears crucial pedagogical implications in the teaching of reading for EFL learners.

Gomes et al. (2014) investigated the role of specific and general metacognitive ability on specific and general academic achievement, controlling for the effects of intelligence. Four hypotheses were elaborated and empirically tested through structural equation modelling. The sample was comprised 684 students (6th to 12th graders) from a private Brazilian school, who answered to three intelligence tests and three metacognitive tests. The modeled hypotheses presented a good data-fit ( $\chi^2= 51.18$ ;  $df = 19$ ;  $CFI = 1.00$ ;  $RMSEA = 0.05$ ), showing that the general metacognitive ability explained general academic achievement rather than intelligence, but did not explain specific academic achievement. On the other hand, specific metacognitive ability explained specific academic

achievement rather than intelligence, but did not explain general academic achievement. The predictive power of the general metacognitive ability was greater than fluid intelligence in the explanation of general academic achievement. In the same line, specific metacognitive ability had a greater predictive power than intelligence and specific knowledge in the explanation of specific academic achievement. Finally, a new structural model of metacognition and its role in academic achievement were proposed.

Serhat (2014) examined the effect of metacognition on one's academic locus of control. The study's sample group consists of 451 university students enrolled in various programs at Sakarya University, Turkey. In the study, the Metacognitive Awareness Inventory and the Academic Locus of Control Scale were used. The correlations and path analysis were examined. The hypothesis model was tested through path analysis. The findings of the path analysis revealed that an internal academic locus of control was predicted to have a positive relation with metacognition, an external academic locus of control was predicted to have a negative relation. In conclusion, the research indicated that metacognition affects academic locus of control in that students whose internal academic locus of control was high are more likely to adopt metacognition than are students whose external academic locus of control was high. Therefore, the current findings act to increase our understanding of the different relationships between metacognition and academic locus of control.

Shetty (2014) conducted a study titled 'Metacognition levels of student teachers on the basis of their Learning Styles'. The study investigated whether metacognition and Learning styles were significant factors which influence learning. Metacognition is the awareness of one's own patterns of thinking. Metacognitive awareness helps a learner to be self directed and self regulated. Learners exhibit different learning styles that influence the way they make sense of the learning experiences. The study aimed at finding out the learning styles that showed higher levels of Metacognition. The Descriptive Survey Method was adopted for the study. A sample of 172 student teachers were administered the Metacognitive Awareness Inventory (Schraw and Dennison-1994) and The Myers-Briggs Type Indicator (MBTI -1977). The data collected was analyzed using the t-test to compare the Mean scores on Metacognition of student teachers having different learning styles. The results showed that the combination that emerged the highest among student teachers was ESFJ (Extraversion, Sensing, Feeling and Judging). However student teachers with the

learning styles Introversion and Thinking were found to be significantly higher in Metacognition as compared to student teachers with the learning styles Extraversion and Feeling.

Abdellah (2015) examined the relationship between metacognitive awareness and academic achievement, and its relation to teaching performance of pre-service female teachers in Ajman University in United Arab of Emirates. The sample consisted of 75 pre-service Professional Diploma Female Students in Ajman University in UAE. The tools used in the study were the Metacognitive Awareness Inventory (MAI) and Teaching Performance Checklist. Findings assert the importance of metacognition in learning as there was a positive relationship among metacognition, academic achievement and teaching performance. The study recommended that college professors have to adopt teaching technique and strategies in presenting information to students in a way that encourage use of metacognitive skills that has an effective impact on the academic achievement and teaching performance.

Hassan et al. (2015) conducted a study during 2014-2015 in Jazan University-KSA. The aim of the study was to verify impact of metacognitive strategies on academic descriptive statics methods. Questionnaire was used as the tool for data collection, Study group was formed from special education students, and 26 students were selected randomly from study group as a sample. The data was analysed by using SPSS program, the results were following: the availability of metacognitive strategies among special education students was positive (high than normal), the availability of metacognitive strategies namely planning strategy and monitoring strategies among special education students was positive. Metacognitive strategies namely evaluating strategy among special education students was normal, and the metacognitive strategies were found to influence academic achievement.

Sadati et al. (2015) explored the extent to which second/foreign (L2) learners used metacognitive and self-regulated learning strategies. Additionally, they investigated the relationship of metacognitive and self-regulated learning strategies with L2 learners' language learning achievement. To these ends, 49 English as a foreign language (EFL) learners, including 8 male and 41 female EFL learners, from several language institutes participated in the study. To collect the data, Metacognitive Strategy Questionnaire by Item Type (MSQIT), Self-Regulated Learning Strategy Questionnaire (SRLSQ), and Final

English Achievement Test were used. The data were analyzed descriptively and inferentially using Pearson product moment correlation procedures. The results revealed the high and medium use for metacognitive and self-regulated learning strategies, respectively, among Iranian intermediate-level EFL learners. Moreover, there was a positive relationship between metacognitive and self-regulated learning strategy use with L2 learning achievement. The findings suggested that L2 teachers should gain better understanding of L2 students' weaknesses and strengths regarding metacognitive and self-regulated learning strategies and make modifications in their teaching methods to provide opportunities for their students to promote L2 learning achievement.

Sajjadi et al. (2015) aimed to find out relationship among achievement self efficacy, metacognition and academic success among high school students of Bandar Abbas. All high school students of high schools of Bandar Abbas, comprised the population of the study. Stratified sampling technique was used to collect data. The data was collected through survey encompassing self-efficacy scale, metacognition scale (MAI) and demographic information. The data was analyzed by using correlation analysis. The results showed that there was a strong relationship between metacognition and self-efficacy and academic achievement and self efficacy but moderate relation was found between metacognition and achievement.

Sawhney (2015) explained metacognition is an individual's knowledge of their own cognitive processes and their ability to control these processes by organizing, monitoring and modifying them as a function of learning. Students who succeed academically often rely on being able to think effectively and independently in order to take charge of their learning. These students have mastered fundamental but crucial skills such as keeping their workspace organized, completing tasks on schedule, making a plan for learning, monitoring their learning path, and recognizing when it might be useful to change course. Learning cognitive and metacognitive strategies offers students the tools to "drive their brains." Being metacognitive can be likened to being more conscious, reflective, and aware of one's progress along the learning path. The investigator undertook the study to find out the relationship between metacognitive awareness and academic achievement of undergraduate students. The sample of the study comprised of 100 undergraduate students from various colleges of Chandigarh. Metacognitive Awareness Inventory (MAI) by Schraw & Dennison (1994) was used to measure the metacognitive

awareness. The findings revealed a significant difference in academic achievement of undergraduate students with high and low scores in metacognitive awareness.

Richmond et al. (2015) investigated how metacognitive beliefs may predict prevalence or susceptibility to psychological and educational misconceptions. A total of 430 participants completed six online measures to gauge their susceptibility to common misconceptions and their level of metacognition. Results indicated that a higher level of metacognition was negatively correlated with susceptibility to psychological and educational misconceptions. The study demonstrated that there are varying levels of misconceptions on psychological and educational topics in the college student population. Therefore, it is important that instructors know how to prime and teach metacognitive strategies to their students to help overcome misconceptions.

### **Conclusion**

Based on the literature review, it is sensible to suppose that metacognition, learning style preference and academic achievement are related. It can be tentatively assumed that learners with a high metacognitive awareness would perform better academically. From the review of literature it becomes clear that metacognition is a multifaceted topic of research. The investigator would therefore prefer to go ahead and statistically analyse the relationship among these three variables.