Chapter 2

METACOGNITION: AN OVERVIEW

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METACOGNITION: AN OVERVIEW

Education is the process of all round development of an individual. Education is the main tool to develop the innate potentialities of an individual. It makes one to not only realize his/her potentialities but also enables one to use them for the development of oneself and the society. Around the world, major changes in the design of curricula and the methodologies for teaching learning have been driven by the need to adopt learner centered approaches to education with the view that learners would emerge empowered, capable of autonomous, life long learning skills. Such initiatives have also attempted to bridge the gap between ‘knowing what’ and ‘knowing how’ a dichotomy which was seen to be a fundamental weakness of teacher centered approaches stems from one aim: It is to make student learning possible. In recent years, higher education has begun to accommodate this aim as evidenced by the focus on the use of constructivist learning environment (Jonassen, 1999), open ended learning environments (Land and Hannafin, 1996), microworlds and anchored instruction (cognition and technology group, 1992), problem based learning (Savery and Duffy, 1995) and goal based scenarios (Schank and Cleary, 1995).

Students at almost any age are capable of taking charge of their own learning. Self Regulated Learning is a fairly new construct in research on student performance and achievement in classroom settings. Recently, several scholars have suggested that SRL skills (Self Regulated Learning Skills) are important not only for students in traditional te’tè – a tete classroom setting but also for the students participating in a web-based learning environment / online education.

Self-regulated learners know how to plan and control the time and effort to be used on tasks, and they know how to create and structure favourable learning environments, and direct their mental process towards the achievement of personal goals i.e. Metacognition. They are able to put into play a series of volitional strategies, aimed at avoiding external and internal distractions in order to maintain their concentration, effort and motivation while performing academic tasks. They are flexible and analyze reasons why learning did not occur as planned and then revises the approach to circumvent the problem. They are initiators of the learning process.
and accept greater responsibility for their achievement, choose cognitive strategies
that have higher payouts they seek to understand ideas and material rather than just
memorize and recall.

Therefore, it is necessary to promote self regulated learning skills among the
children to make new and useful adaptations to the emerging challenges in our global
environment. So the focus is on examining the conceptual foundations of
metacognition, metacognitive skills and metacognitive strategies.

2.1 Conceptual Evolution of Metacognition

Metacognition is one of the latest buzz words in educational psychology. It
refers to higher order thinking which involves active control over the cognitive
processes engaged in learning.

Cognition is the mental processing of information, which is the function of
human mind that allows perceptions to grow into conceptions. When we have control
over our own cognitive functions that is termed as metacognition. It is the combined
monitoring and regulation of one’s own thinking processes. It is a conscious
verification of one’s personal cognitive status that allows a person to develop and
expand upon new knowledge. Metacognitive Skills predict success in academic
endeavours and other areas of life. It plays an important role in communication,
reading comprehension, language acquisition, social cognition, attention, self control,
memory, self-instruction, problem solving and personality development (Cooper,
1999).

Metacognition is a broadly defined concept incorporating any knowledge or
cognitive process that refers to monitors or controls any aspect of cognition, it is now
seen as a central contributor to many aspects of cognition including memory,
attention, communication, problem solving and intelligence with important
applications to areas like education, ageing, neuro-psychology and eyewitness
testimony.

The conceptual bases of Cognition and Metacognition were considered by
James (1911) as he began to describe the mechanics of the mental machine. American
Novelist Henry, also described early concepts of cognition as a choosing activity or selective attention.

The notion of a learner, as a personal creator and constructor of knowledge was suggested by U.S. Philosopher and educator Dewey in 1859. Dewey (1902) expressed that ‘Learning is an active process’. It involves reaching out of one’s mind. It involves organic assimilation from within.

The inductive vision of learning through observation is a prime component of Dewey and was exhibited in his book, ‘how we think’. He was one of the first educators to take a scientific look at thinking from a metacognition viewpoint. He proposed two-distinct metacognition phases of reflective thought.

1. A conscious recognition of doubt where desired knowledge is obscured in some way causing a state of perplexity.

2. The active thinking process required relieving this difficulty as an act of searching, hunting, inquiring, to find material that will resolve the double settle and dispose of the perplexity (Dewas, 1900).

Dewey recognized and described the cognitive processes of self monitoring, and self regulation, and provided an early conceptual design of metacognition.

Most references directed to the nascent studies of metacognition, single out from the work of Piaget (1980-1996), a Swiss psychologist and philosopher. His initial studies illustrated early metacognitive activity in children. According to him, the young is directing cognition, but is not yet conscious of the evolving thought processes, which he/she displays. Some of Piaget’s later research with older children described an evolving ability on the part of these learners to verbalize the actual step by step processes utilized to complete assigned tasks. Piaget termed this awareness and narrative ability as, “consciousness of cognizance”, which we call metacognition for this function.

During the period of early research, another provocative cognitive researcher, the Russian psychologist Vygotsky (1896-1934) involved in the area of conceptual
development. Vygotsky observed that children naturally make sense of any task with the use of speech as a tool, first verbalizing a situation to make sense of it and then internalizing this speech as part of self regulated thought. An individual continues to use his/her private inner language to think, which Vygotsky (1933) labelled as one’s “inner voice”. People often talk to themselves to reinforce their own concrete experiences and or to link their experiences to those of others. This cognizant use of inner speech to direct personal learning is a primary criterion of what could be labelled as the Vygotskian, metacognitive theory and it clearly resembles the cognitive psychology of executive control.

U.S. Researchers, such as Flavell and Wellman (1977), Borkowski (1979) realized that the learners could demonstrate previously undisclosed and unexplored control processes of learning and thinking. Both the cognitive researchers and computer programmers emphasized an information processing model of learning and they applied the term ‘executive process’ when they describe the strategic control of thinking process. Neiser (1967) was one of the first psychologists who attempted to illustrate the concept of an executive thinking ability. Executive process is a control mechanism used to organize cognition, to harness and orchestrate the various cognitive skills, such as memory, the recognition of icons and verbal cues etc., which is a metacognitive process. The executive process is multifaceted and can be considered as inseparable element of a more expansive thinking activity that comprehensively monitors, evaluates, and regulates the information flow of the human cognitive system.

Flavell (1970) a cognitive researcher, professor of psychology, introduced the term, metacognition. Flavell (1977) was the first to recognize that specific strategies for remembering, categorizing and recalling, needed information, which can be consciously directed by learners. Metacognition is defined as “cognition about cognition or knowing about knowing”. In Flavell’s words metacognition refers to one’s knowledge concerning one’s own cognitive processes or anything related to them eg:- the learning - relevant properties of information or data. For example, I am engaging in metacognition if I notice that I am having more trouble learning A than
B; if it strikes me that I should double check C before accepting it as fact (Begum & Mohan, 2007).

2.2 Components of Metacognition

Metacognition is often simply defined as, “thinking about thinking”. In actuality, defining metacognition is not that simple. Although the term has been part of the vocabulary of educational psychologists for the last couple of decades, and the concept for as long as humans have been able to reflect on their cognitive experiences, there is much debate over exactly what metacognition is. One reason for this confusion is that there are several terms currently used to describe the same basic phenomenon (eg:- self regulation, executive control), or an aspect of that phenomenon (eg:- meta memory), and these terms often used interchangeably in the literature. While there are some distinctions between definitions, all emphasize the role of executive processes in the overseeing and regulation of cognitive processes.

Metacognition is classified into 3 components

2.2.1. Metacognitive Knowledge or Metacognitive Awareness

It is what individuals know about themselves and others as cognitive processes, knowledge that can be used to control cognitive processes. Flavell further divides Metacognitive Knowledge into 3 categories: Knowledge of Person variables, Task variables, Strategy variables.

**Knowledge of Person variables** refers to general knowledge about how human beings learn and process information, as well as individual’s knowledge of one’s own learning processes.

**Knowledge of Task variables** include knowledge about the nature of the task as well as the type of processing demands that it will place upon the individual.

**Knowledge of Strategy variables** include knowledge about both cognitive and metacognitive strategies, as well as conditional knowledge about when and where it is appropriate to use such strategies.
Metacognitive Awareness involves 3 kinds of content knowledge.

**Declarative Knowledge** is the factual information that one knows; it can be declared, spoken or written. An example is knowing the formula for calculating momentum in a physics class (Momentum = Mass times velocity)

**Procedural Knowledge** is knowledge of how to do something, of how to perform the steps in a process. For example, knowing the mass of an object and its rate speed and how to do the calculation. Monitor the selection and application as well as the effects of solution processes and regulate the stream of solution activity that represents, according to Kluwe (1982). Metacognitive Procedural Knowledge, Kluwe uses the term executive processes to denote this kind of Procedural Knowledge. Executive processes involve both monitoring and regulating other thought processes, and therefore correspond with Flavell’s (1979) Metacognitive Strategies and Brown’s (1978) Metacognitive Skills. Executive monitoring processes are those that are “directed at the acquisition of information about the person’s thinking processes they involve one’s decisions that help.

- to identify the task on which one is currently working
- to check on current progress of that work
- to evaluate that progress
- to predict what the outcome of progress will be. Executive regulation processes are those that are “directed at the regulation of the course of one’s own thinking”. This involve one’s decisions that help
- to allocate his or her resources to the current task
- to determine the order of steps to be taken to complete the task
- to set the intensity
- the speed at which one should work the task

Thus the general distinction between Procedural and Declarative Knowledge and the finer distinctions between what is and is not metacognitive within which each kind of knowledge has helped to further define metacognition and cognitive monitoring.

**Conditional Knowledge** is knowledge about when to use a procedure, skill or strategy and when not to use it; why a procedure works and under what conditions;
and why one procedure is better than another. For example, students need to recognize that an exam word problem requires the calculation of momentum as part of its solution. In Anderson’s Act Theory, however, Conditional Knowledge is regarded as an intrinsic part of Procedural Knowledge, which is represented by condition-action rules.

This notion of three kinds of knowledge applies to learning strategies as well as course content when they study; students need the Declarative Knowledge that (1) all reading assignments are not alike; for example, that a history textbook chapter with factual information differs from a primary historical document, which is different from an article interpreting or analyzing that document. They need to know that stories and novels differ from arguments. Furthermore they need to know that there are different kinds of note taking strategies useful for annotating these different types of texts. And (2) students need to know how to actually write different kinds of notes (Procedural Knowledge), and (3) they need to know when to apply these kinds of notes when they study (Conditional Knowledge).

2.2.2. Metacognitive Regulation

Metacognitive Experiences involve the use of Metacognitive Strategies or Metacognitive Regulation (Brown, 1987). Metacognitive strategies are sequential processes that one uses to control cognitive activities, and to ensure that a cognitive goal (eg:- understanding a text) has been met. These processes help to regulate and oversee learning, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities. Thus metacognitive regulation is the regulation of cognition and learning experiences through a set of activities that help people control their learning.

For example, after reading a paragraph in a text, a learner may question herself about the concepts discussed in the paragraph. Her cognitive goal is to understand the text. Self questioning is a common Metacognitive Comprehension Monitoring Strategy. If she finds that she cannot answer her own questions, or that she does not understand the material discussed, she must then determine what needs to be done to ensure that she meets the cognitive goal of understanding the text. She may decide to
go back and reread the paragraph with the goal of being able to answer the questions she had generated if, after rereading through the text she can now answer the questions, she may determine that she understands the material. Thus, the Metacognitive Strategy of self questioning is used to ensure that the cognitive goal of comprehension is met.

2.2.3. Metacognitive Experiences

Metacognitive experiences are those experiences that have something to do with the current, ongoing cognitive endeavour. Metacognitive experiences usually precede or follow a cognitive activity. They often occur when cognitions fail, such as the recognition that one did not understand what one just read. Such an impasse is believed to activate metacognitive processes as the learner attempts to rectify the situation.

Metacognition, or the ability to control one’s cognitive processes (self regulation) has been linked to intelligence (Borokowski et al., 1987, Brown, 1987, Sternberg, 1984, 1986). Sternberg refers to these executive processes as “Metacomponents in his triarchic theory of control, other cognitive components as well as receive feed back from these components. According to Sternberg, Metacomponents are responsible for “figuring out how to do a particular task or set of tasks, and then making sure that the task or set of tasks are done correctly” (Sternberg, 1986). These executive processes involve planning, evaluating, monitoring and problem solving activities. Sternberg maintains that the ability to appropriately allocate cognitive resources, such as deciding how and when a given task should be accomplished is central to intelligence.

Flavell (1979) offered a model of Metacognition with four components.

- Metacognitive knowledge
- Metacognitive experience
- Goals (tasks)
- Actions (strategies)
Metacognitive Knowledge refers to the personal perspectives of one’s own learning abilities as well as others.

Metacognitive knowledge refers to one’s stored world knowledge that “has to do people as cognitive creatures and with their diverse cognitive tasks, goals, actions and experiences. It consists of one’s knowledge or beliefs about three general factors: his or her own nature or nature of another as a cognitive processor, a task, its demands, and how those demands can be met under varying conditions; and strategies for accomplishing the task (cognitive strategies that are involved to make progress toward goals and metacognitive strategies that are invoked to monitor the progress of cognitive strategies). Metacognitive knowledge may influence the course of cognitive
enterprises through a deliberate and conscious memory search or through unconscious and automatic cognitive processes. Metacognitive knowledge may lead to a wide variety of Metacognitive experience, which Flavell describes a conscious cognitive affective experience that accompany and pertain to an intellectual enterprise.

**Metacognitive experience** is the conscious consideration of intellectual experiences that accompany any success or failure in learning.

**Metacognitive goals or tasks** of metacognition are the actual objectives of cognitive endeavour, such as reading and comprehension of a passage.

**Metacognitive actions or strategies** refer to the utilization of specific techniques that may assist in understanding.

**Metamemory** involves two processes, the first process monitors progress as an individual learns and the second makes changes and adopts various strategies if a person believes that they are not doing well (Nelson and Narens, 1994; Ridley, et al., 1992).

According to Martinez, to give a sense of the breadth of Metacognitive functioning identified 3 Major categories of Metacognition

- Metamemory
- Metacomprehension
- Problem Solving
- Critical Thinking

**Metamemory**

One component of metacognition, is about one’s memory capabilities and strategies that can aid memory, as well as the processes involved in memory self monitoring. This self awareness of memory has important implications for how people learn and use memories. When studying, for example, students make judgments of whether they have successfully learned the assigned material and use these decisions, known as “Judgments of learning” to allocate study time.
So, Meta-memory refers to learner’s awareness of and knowledge about their own memory systems and strategies for using their memories effectively. Meta-memory includes,

(a) Awareness of different memory strategies

(b) Knowledge of which strategy to use for a particular memory task

(c) Knowledge of how to use a given memory strategy most effectively

**Metacomprehension**

This term ‘refers to the learners’ ability to monitor the degree to which they understand the information being communicated to them, to recognize failures to comprehend, and to employ repair strategies when failures are identified.

Learners with poor Meta-comprehension Skills often finish reading passages without even knowing that they have not understood them, on the other hand learners who are more adept at Meta-comprehension will check for confusion or inconsistency, and undertake a corrective strategy, such as rereading, relating different parts of the passage to one another looking for topic sentences or summary paragraphs or relating the current information to prior knowledge (Harris, et al.,1988).

Metamemory and Metacomprehension skills help the learner to make adjustments in their own learning processes in response to their perception of feedback regarding their current status of learning. This concept is known as “self regulation”. Its focus is on the ability of the learners themselves to monitor their own learning (without external stimuli or persuasion) and to maintain the attitudes necessary to invoke and employ these strategies on their own. To learn most effectively, students should not only understand what strategies are available and the purposes these strategies will serve, but also become capable of adequately selecting, employing, monitoring and evaluating their use of these strategies, (Hallahan et al.,1979; Harris, 1992; Harris, 1989,1993).

This concept involves - **self appraisal and self management of cognition.** Self appraisal is people’s personal reflections about their knowledge states and
abilities and their affective states concerning their knowledge, abilities, motivation and characteristics as learners. Such reflections answer questions about “what you know, how you think, and when and why to apply knowledge or strategies” (Paris & Winograd, 1990). Self management refers to “Metacognition in action”, that is, mental processes that help to “orchestrate aspects of problem solving”. Focusing on self appraisal and self management helps in the conceptualization of learners as individuals who need to be actively involved in the orchestration of their knowledge construction.

**Problem Solving**

This almost exclusively human pursuit is a significant category of cognitive activity. Problem solving is exercised daily, often continuously, especially in a complex society where following established rules and procedures is not enough to succeed. Problem solving can defined simply as the pursuit of a goal when the path to that goal is uncertain.

In other words, it’s what you do, when you don’t know what you are doing. Problem solving certainly involves cognition. But more is required: constantly stepping back mentally to appraise and rework plans by asking such questions as, what am I trying to accomplish? What are the most promising pathways? Is my strategy working?

**Critical Thinking**

Like problem solving, critical thinking encompasses a lot of what human beings do or at least potentially can do while problem solving and critical thinking are distinct functions they can be seen as complementary. Critical thinking is evaluating ideas for their quality, especially, judging whether or not they make sense. There are many metacognitive standards that apply to thinking critically, for example, when evaluating ideas or messages, we can ask:

- Is the idea stated clearly?
- Does one idea follow logically from another?
Is the message logical, rational and coherent? Or does it contradict itself or make unwarranted inferences or unsupported generalizations?

Critical thinking can take very specific forms. In fact, the methods of inquiry used in science and those used in other domains can be viewed as specialized tools developed over many years to focus on a more basic and general orientation to critical thinking.

![Diagram of Metacognitive Functioning]

Figure 2.2 Michel E. Martinez’s Model of Metacognitive Functioning

2.3 Metacognitive Skills

Metacognitive skillfulness is often distinguished from Metacognitive Knowledge. The latter concept refers to the Declarative knowledge one has about the interplay between personal characteristics, task characteristics and the available strategies in a learning situation (Flavell, 1979). Metacognitive knowledge, however, does not automatically lead to appropriate execution of Metacognitive skills.

Metacognitive skills concern the Procedural knowledge that pertains to the actual regulation of, and control over one’s cognitive processes and learning
activities. They are occasionally referred to as Executive Skills (Kluwe, 1987). These skills can be acquired and eventually executed implicitly though some argue that awareness of their metacognitive nature is pre-requisite. Metacognitive skills are important organizers of all of the tasks that we perform. They enable planning, setting goals, initiating work, sustaining future - oriented problem solving activities, monitoring and managing progress on tasks to detect and correct errors, and keeping track of the effect of one’s behaviour towards others.

Metacognitive Skills appear to be highly interdependent, by means of thorough orientation of a task, a metacognitively skilled student is likely to focus on relevant information given in the task assignment necessary for building an adequate task representation. Consequently, goals and directions for subsequent learning activities, such an elaborate action plan entails the possibility of process control during task performance. Working systematically according to that plan may enable the student to keep track of the progress being made. Evaluation or monitoring activities, which are necessary for detecting faulty procedures and mistakes, are more fruitful within the frame work of such an action plan. Finally, elaboration activities like drawing conclusions, recapitulating, and generating explanations are more helpful if they are based on a clear trace of activities (Veenman et al., 1997).

**Metcognitive skills are**

- Task Analysis
- Planning
- Monitoring
- Checking or evaluation
- Recapitulation
- Reflection

These skills include taking conscious control of learning, planning and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies and changing learning behaviours and strategies when necessary.
2.3.1 Task Analysis involves the following

- To identity the task on which one is currently working.
- Consciously identify what you already know
- Define the learning goal
- Consider your personal resources (eg: text books, access to library, access to a computer workstation or a quiet study area)
- Consider the task requirements
- Determine how your performance will be evaluated
- Consider your motivational level
- Determine your level of anxiety

2.3.2 Planning

- Estimate the time required to complete the task
- Plan study time into our schedule and set priorities
- Make a checklist of what needs to happen when
- Organize materials
- Take the necessary steps to learn by using strategies like outlining, mnemonic, diagramming etc.

2.3.3 Monitoring and Reflection

- Reflect on the learning process, keeping track of what works and what doesn’t work for you
  - Monitor your own learning by questioning and selftesting
  - Provide your own feedback
  - Keep concentration and motivation high

The act of Reflection involves an examination of stems of cognition, an examination which includes analysis, evaluation of progress in terms of plans, monitoring and modification of cognition.
2.3.4 Evaluation

Evaluation means checking one’s own solution to the problem against the standard procedure of solving strategy.

2.3.5 Recapitulation

To obtain feedback and to make adjustments regarding their effective use of the process. It enables them to transfer the process to new situations beyond those in which it has already been used.

Learners with good metacognitive skills are able to monitor and direct their own learning processes. When learning a metacognitive skill, learners typically go through the following steps.

- They establish a motivation to learn a metacognitive process. This occurs when either they themselves, or someone else, help them to know how to apply the process.
- They focus their attention on what is, that they or someone else does that is metacognitively useful. This proper focusing of attention puts the necessary information into working memory sometimes this focusing of attention can occur through modeling. Sometimes it occurs during personal experience.

- They talk to themselves about the metacognitive process. This talk can arise during their interactions with others. But it is their talk to themselves that is essential. This self talk serves several purposes,
  - It enables them to understand and encode the process
  - It enables them to practise the process
  - It enables them to obtain feedback and to make adjustments regarding their effective use of the process
  - It enables them to transfer the process to new situations
  - Eventually they begin to use the process without being aware that they are doing so
2.4. Metacognitive Strategies

Taylor (2002) defines metacognition as “an appreciation of what one already knows, together with a correct apprehension of the learning task and what knowledge and skills it requires. Combined with the ability to make correct inferences about how to apply one’s strategic knowledge to a particular situation and to do so efficiently and reliably”.

The more students are aware of their thinking processes as they learn, the more they can control such matters as goals, dispositions, attention (Marzano et al., 1988).

![Figure- 2.3 Metacognition- The Central Process](image)

Student who possess metacognitive skills are more likely to learn effectively than those who lack these skills. Through certain metacognitive strategies we can develop these skills among students.
Planning

1. **Advance organizers**: It is previewing of main ideas and concept of the material to be learned. It is carried out by skimming the concepts behind at the physical principle ideas for the organization of the learning material.

2. **Directed Attention**: It involves deciding in advance to attend in general a learning task and to ignore irrelevant distracters. It clearly diverts students’ attention towards a particular concept, principle or idea.

3. **Functional planning**: For relating respective formula is necessary to carryout solving strategy, it involves visualization of the concept using simple diagrams relating the known to the unknown.

4. **Selective Attention**: It involves deciding in advance to attend a specific skill which involves solving a problem. This is done by searching the physical terms, deriving units etc.

5. **Self management**: means management of or by oneself. It means taking of responsibility for one’s own thinking process and directing one’s own knowledge.

Monitoring

6. **Self monitoring**: means checking one’s own level of understanding and planning process for problem solving during the treatment.

7. **Regulating**: It involves regulating one’s own thinking process during the planning and organizing procedure.

8. **Orchestrating**: It consists of planning and adjusting for problem solving i.e. arranging or directing the elements of a situation to produce a desired effect.

Evaluating

9. **Self evaluation**: It is checking one’s own solution to the problem against the standard procedure of solving strategy (Flavell, 1979).
Metacognitive Orientation & Enhancement of Learning Process:

**Metacognitive Orientation**
- Awareness of one’s cognitive process to meet the demands for a given task

**Advanced Organizer**
- Acquisition of knowledge & initial prediction about the problem
- Reflection in action
- Awareness of one’s thinking
- Developing the plan of action
- Developing logical thinking

**Metaattention**
- Motivating to respond
- Attending stimuli of the task

**Metamemory**
- Knowing one’s memory systems

**Metacomprehension**
- Comprehending the problems
- Acquisition of new knowledge
- Developing logical reasoning

**Orchestration**

**Self –monitoring**
- Selection of appropriate strategies to the given problem
- Knowing the progress towards the solution
- Perceiving the difficulty

**Self-Regulation & Self-Management**

- Fostering creativity to allocate resources to the current task
- Developing heuristic attitude
- Reduction of anxiety

**Evaluation**

- Regulation of cognitive and affective status to attain the solution
- Setting intensity and speed to work with the problem

**Perceived Self-Efficiency**

**Reflection on action**

- Developing strategic competency
- Promoting self confidence
- Originality
- Appreciation
- Interest in problem solving
2.5. Importance of Metacognitive strategies.

As students become more skilled at using metacognitive strategies, they gain confidence and become more independent as learners. Independence leads to ownership as students realize that they can pursue their intellectual needs and discover a world of information at their fingertips. The task of educators is to acknowledge, cultivate, exploit and enhance the metacognitive capabilities of all learners. One general aspect of metacognition is the periodic appraisal of one’s thinking. It is useful for teachers and students alike because it is reflection on the dynamics of teaching and learning, the core of education and a first step to change or revise one’s approach. The following figure depicts how metacognitive strategy promotes deep learning through metacognitive skills.
Children appear to develop and use increasing metamemory skills and various other kinds of metacognitive skills. These skills involve the understanding and control of cognitive processes. Examples are monitoring and modifying one’s own cognitive processes while one is engaged in tackling cognitive tasks. A major difference between the memory of younger and older children (as well as adults) is not in basic mechanisms, but in learned strategies, such as rehearsal (Flavell & Wellman, 1977). Thus, young children appear to lack not only the knowledge of strategies, but also the inclination to use them when they do not know about them. Older children understand that to retain words in short term memory they need to rehearse. Younger children do not have this understanding. In a nutshell, younger children lack metamemory skills.

Another aspect of metamemory skill involves cognitive monitoring. In monitoring, the individual tracks and as needed, readjusts an ongoing train of thought. Cognitive monitoring may consist of several related skills (Brown, 1978). For instance, you are realizing “what you know and what you do not know”, you learn to be aware of your own mind and the degree of your own understanding (Holt, 1964). Other work on the development of cognitive monitoring proposes a distinction between self monitoring and self regulation strategies (Nelson and Narren, 1994). Self monitoring is a bottom up process of keeping track of current understanding involving the improving ability to predict memory performance accurately. Self regulation is a top-down process of central executive control over planning and evaluation. Children benefit from training in using such cognitive monitoring processes to enhance their use of appropriate strategies.

Metacognition is our understanding and control of our cognition (Schunk and Nelson, 2003). It provides one of our best aids in language learning. As adults, we have a great advantage in learning languages. Now, we have greater familiarity with the structure of languages than we had when we were young. The extent to which metacognition helps, however, depends on how similar a new language is to the language or languages we already know.
2.6. **The Problem Solving Cycle**

We engage in problem solving when we need to overcome obstacles to answer a question or to achieve a goal. If we quickly can retrieve an answer from memory, we do not have a problem. If we cannot retrieve an immediate answer, then we have a problem to be solved. Problem solving cycle includes the following.

**Problem Identification**

As odd as it sounds, identifying a situation as problematic is sometimes a difficult step. We may try to recognize that we have a goal. Or we might fail to recognize that our path to a goal is obstructed or we might fail to recognize that the solution we had in mind does not work.

**Problem Definition and Representation**

Once we identify the existence of a problem we have to define and represent the problem well enough to understand how to solve it. If inaccurately define and represent the problem we are much less able to solve it.

**Strategy Formulation**

Once the problem has been defined effectively, next step is to plan a strategy for solving it. The strategy may involve,

**Analysis**- breaking down the whole of a complex problem into manageable element

**Synthesis**- putting together various elements to arrange them into something useful. As in most dichotomies, one must be careful of drawing too much of a distinction (Kotovsky, 2003). People use analysis to help in synthesizing information. They may also use synthesis to help in analysis.

**Divergent thinking** – generates a diverse assortment of possible alternative solutions to a problem,

**Convergent thinking** – narrows down the multiple possibilities to converge on a single best answer. In solving real life problems, we need both analysis and synthesis.
and both divergent and convergent thinking. There is no single ideal strategy for addressing every problem. Instead the optimal strategy depends on both the problem and the problem solvers’ personal preferences in problem-solving methods.

**Organization of Information**

In this stage we try to integrate all of the information that will need to effectively do the task at hand. It might involve collecting references or even collecting your own ideas. Sometimes, people fail to solve a problem not because they cannot solve it, but because they do not realize what information they have or how it fits together. Once a strategy has been formulated we are ready to organize the available information in a way that enable us to implement the strategy. Through out problem solving cycle, we are constantly organizing and reorganizing the available information.

**Resource Allocation**

In addition to our other problems, most of us face the problem of having limited resources. These resources include time, money, equipment and space. Some problems are worth a lot of time and other resources. More over we need to know when to allocate which resources. Studies show that expert problem solvers (and better students) tend to devote more of their mental resources to global planning than do novice problem solvers. By spending more time in advance deciding what to do, effective students are less likely to fall prey to false starts, winding paths, and all kinds of errors. When a person allocates more mental resources to planning on a large scale he or she is able to save time and energy and to avoid frustration later on.

**Monitoring**

Good problem solvers check up on themselves all along the way to make sure that they are getting closer to their goal. If they are not, they reassess what they are doing. They may conclude that they have made a false start, that they got off track somewhere along the way, or even that they see a more promising path if they take a new direction.
Evaluation

Just as we need to monitor a problem while we are in the process of solving it, we need to evaluate the solution. Through evaluation, a new problem may be recognized. Moreover, the problems may be redefined, and new strategies may come to light. New resources may also become available or existing ones may be used more effectively. Hence the cycle is completed when it leads to new insights and beginnings.

Figure 2.5  Sternberg’s Problem Solving Cycle

So metacognition refers to a level of thinking that involves active control over the process of thinking that is used in learning situations. Planning the way to approach a learning task, monitoring, comprehending and evaluating the progress towards the completion of a task. These are skills that are metacognitive in nature. The theory of metacognition has a critical role to play in successful learning means it
is important that it can be demonstrated both by students and teachers alike. The following figure depicts the process, components and skills of metacognition.

![Diagram of Taxonomy of Metacognition Components]

**Figure 2.6 Taxonomy of Metacognition Components**