Chapter 3

REVIEW OF RELATED LITERATURE

3.1. Studies related to Metacognition and Academic Improvement
3.2. Studies related to Metacognition and Attitudinal change
3.3. Studies related to Metacognition and Problem solving
3.4. Studies related to Teaching and Learning Metacognitive Skills
REVIEW OF RELATED LITERATURE

The review of empirical studies is considered as an important aspect of any research. It is a fact that review of past knowledge and studies will help us equip ourselves for the present. A review of related studies helps the Investigator to eliminate the duplication of what has been done so far, review of literature is an essential component of a research process. Review of related literature helps the researcher to build on existing work; he or she should understand what is already known on a topic (Polit and Hungler, 2003). The present study was intended to develop and validate a learning package based on Metacognitive Process and to ascertain the relative effectiveness of this package with existing Activity Oriented Method of Instruction on enhancing metacognitive skills and achievement in Biology of secondary school students. The Investigator had done an extensive review in the field related to metacognition. Flavell (1979) coined the term, metacognition as a regulatory system that includes knowledge, experiences, goals and strategies. Metacognition is a broadly defined concept incorporating any knowledge or cognitive process that refers to, monitors or controls any aspect of cognition. Many psychologists and professional educators interpret the term metacognition in different ways and studied its importance in improving learning and performance outcomes.

There is a vast body of literature pertaining to metacognition, much of it written by educators for educators offering practical applications of the theory in classroom instructions, with a view to improving student’s performance. This may include an extensive coverage of the theory of metacognition, components of metacognition and its applications in the field of education.

For the purpose of the study, the literature regarding metacognition has been reviewed to ascertain whether metacognitive process has been found to be associated with improved student outcomes in the secondary school setting. Hence the Investigator reviewed the research studies as well as scholarly works and classified them as follows

3.1. Studies related to Metacognition and Academic Improvement
3.2. Studies related to Metacognition and Attitudinal change

3.3. Studies related to Metacognition and Problem solving

3.4. Studies related to Teaching and Learning Metacognitive Skills

3.1. Metacognition and Academic Improvement

Wright (2011) reported that pedagogies that features metacognition and problem solving tend to involve students in higher order thinking, and support them to retain learning long after they first meet new content and concepts. Through such practices, students are encouraged to talk, pose questions, take risk, experiment, reflect and share ideas when student develops metacognitive and critical thinking skills, becomes active creators of information through using web services.

Shun (2010) conducted a study on the task and self regulated pathways to deep learning and also on the mediating role of achievement goals, classroom attentiveness and group participation. The study concluded that the task and self regulated pathways on the basis of metacognitive strategy promotes students to learn.

Andrew (2010) undertook a study on the Influence of cognitive and metacognitive strategies on deep learning and concluded that metacognitive strategies help children of all ages to develop highly critical cognitive functioning ability, which results in deep understanding and develop problem solving skills.

Myrtle (2009) studied the effect of metacognitive co-operative learning approach on Mathematics achievement of 65 higher secondary school students. The results of the study shows that there is a positive effect on the Metacognitive co-operative Learning approach, is significantly more effective than traditional method on the achievement in mathematics with respect to low achievers.

Darling et al. (2008) investigated the effectiveness of metacognitive strategies on students learning by

a) Predicting outcome which helps student to understand how to solve a problem successfully
b) Evaluating work which help to determine where their strengths and where their weakness lie when they study

c) Questioning by teachers also help to rethink their learning. It was concluded that the first two could be used in higher classes

The study concluded that metacognitive strategies are very effective in problem solving ability among higher students

**Martin (2008)** in the study on the use of cognitive strategies by high school social studies students reveals that cognitive strategy increases student’s knowledge and motivation. Furthermore it suggests that teachers need to stress the relevance of cognitive strategies to students and use more high level thinking on class work and exam.

**Christopher (2007)** conducted a research on metacognition which points out the crucial role of online methods when endeavoring to conduct valid assessment of metacognitive skills. Thus the aim of this study is to quasi-experimentally analyze the effects of 2 on line verbalization method on Learning Performance by means of the thinking aloud method students in one experimental group(n = 24) was used as a sample. The study concluded that the crucial role of online methods in developing metacognition.

**Cromley & Azevedo (2006)** developed a Direct and Inferential Mediation (DIME) model. This model was tested through hierarchical regression analysis in which reading comprehension was the dependent variable. The sample consisted of ninth grade students. There were five predictors: (a) background knowledge (related to the topic of the texts of reading comprehension test), (b) strategies (measured with multiple-choice questions on the use of reading strategies), (c) word reading (d) vocabulary and (e) inference drawing. The strategies factor had an indirect effect on reading comprehension mediated by the inference drawing factor. This implies that metacognition in the form of awareness of strategy use may be important as the previous knowledge.
Mark (2005) concludes that self-regulated learning involves learning strategies and mental processes that learners deliberately engage into help themselves learn and perform better academically. The results of this study provide empirical support for the theoretical relationship among cognitive evaluation theory, achievement goal theory, and self-regulated learning strategies in the context of the classroom. Superficial learning strategies were linked to extrinsic motivation, while intrinsic motivation determined deep cognitive and metacognitive strategy usage. Findings suggest that active application oriented experience delivered by enthusiastic facility, who provide high interaction, support feedback and clear goals will increase intrinsic motivation and the use of self-regulated learning strategies.

Sreevindra (2004) surveyed on the impact of various learning styles and metacognition up on the methods of teaching especially in secondary school students. She used a questionnaire as the tool, which is related to teaching styles and learning styles. The survey conducted at urban, rural, govt. and private schools, appropriately among 5000 students, revealed that the learning styles which are thought-provoking influence the students positively. The students are also in favor of such learning styles. These styles are appropriate and enough to make education a success.

Reddy & Santhakumari (2004) tried to identify the level of Metacognitive Awareness of Higher Secondary Level with the following objectives:

1. To develop diagnostic tools to identify the Language Learning Difficulty of second language learners (English) at Higher Secondary Level, and
2. To develop Metacognitive Awareness (questionnaire) (MCAQ) and to find out the difference between LLD (Language Learning Difficulties) students and normal students in their metacognitive awareness. The study arrived at the findings that at HSC Level, the students having LLD are in huge proportions and there are close link between language learning difficulties and metacognitive strategic deficits. The study underlined the need for language intervention programmes with metacognitive strategic orientation.

Kramarski (2004) incorporated metacognition into mathematics instruction (specifically graph interpretation). This study highlights an important point:
metacognition looks different in different contexts. The critical factor is to help students learn to think about what they are doing, believing, and thinking, and why they are doing, believing, and thinking those things.

**DuBois et al. (2004)** found a negative correlation between SAT math scores and metacognition. This may be in part due to a small sample size, and the traditional mathematics pedagogical methods of rote memorization which leaves little room or advantage for metacognition. Additionally, the questionable correlation between metacognition and achievement may be attributable to developing metacognitive abilities, which are not yet fully mature or reliably applied.

**Aleven & Koedinger (2002)** conducted an experimental study using the computer based cognitive tutor for geometry. The result of the study demonstrated the superiority of the experimental group on the post task. In this study the gain on the problem solving task was only marginally significant, for the experimental group. However, their performance on the questions requiring a deeper understanding of the concepts was significantly better than the control group while the control group performed better on those questions need only shallow knowledge.

**Schunk & Swanson (2000)** pointed out that there is not at all differences in metacognitive abilities, have to do with age or maturation. There is great variability even among students of the same developmental level, but these differences do not appear to be related to intellectual abilities. In fact, superior metacognitive skills can compensate for lower levels of ability, so these metacognitive skills can be especially important for students who have trouble in school.

**Santhakumari (1999)** also proved that incorporation of metacognitive strategies in the learning process promoted the following cognitive skills among low achievers; when they learn second language,

1) Recalling
2) Associating
3) Correlating concepts
4) Inference
5) Exploring
6) Incorporating

Burning et al. (1999) stated that metacognition involves three kinds of knowledge-declarative knowledge about yourself as a learner, the factors that influence your learning and memory and the skill, strategies what to do, procedure knowledge or knowing how to use the strategies and conditional knowledge to ensure the completion of the task knowing, when and why to apply the procedures and strategy.

Kraayenoord’s & Schneider’s (1999) research was conducted among third and fourth graders. It aimed at determining the predictors of reading comprehension. Four main independent variables were selected as predictors: (a) grade (whether third or fourth), (b) motivation, (c) metacognition, and (d) decoding skills. The study showed that reading comprehension was predicted by decoding skills as well as by metacognition. Metacognition was measured with the Index of Reading Awareness questionnaire which taps metacognitive knowledge about reading. Motivation had only indirect effects on reading comprehension. The indirect effects were mediated by both metacognition and decoding skills. Similarly, pupils’ grade (whether third or fourth) had a relatively low impact on reading comprehension and this effect was mediated also by decoding skills and metacognition.

Gloria (1997) investigated the effect of teaching metacognitive strategies to remedial reading among college students. The purpose of the study was to investigate the impact of direct teaching of metacognitive skills on the reading performance of college level remedial reading students at a historical black liberal arts college. The findings showed that there was no significant difference between the two groups control and experiment, in the use of metacognitive strategies.

Kramarski (1997) proved that multi-level metacognitive training was more effective than other instructional strategies in mathematical reasoning.

Kalyani (1996) studied cognitive styles in children. It attempt to study the incidence of different cognitive styles in children. It observed that a majority of the children are impulsive in the field. The study revealed that practicing metacognitive skills
consciously could make the learner independent in learning and could regulate their own learning.

**Surendar et al. (1996)** studied metacognition and achievement through co-operative learning. This study is undertaken to investigate the effectiveness of metacognitive process and achievement through co-operative learning.

**Bielaczyc et al. (1995)** divided their participants into 2 groups. Both group received lisp training but the control group received none of the strategy training developed for the experimental group. The two groups were balanced up on Lisp programming performance levels. The experimental group become familiar with asking “Why” questions, summarizing the main ideas, and were given self monitoring questions (such as do I understand this? and what is the purpose? of such and such) Therefore, the experimental group was trained in techniques that identified and elaborated on the relations between the main ideas in the text, looked at the examples in order to determine the form of the code and then explicitly connected the concepts between the text and the examples studied. After a verbal protocol analysis of the pre and post programming lessons it was determined that the experimental group performed significantly better than the control group by producing fewer errors, making more monitoring comprehension statements and clarifying a greater number of comprehension failures. This study did not monitor metacognitive abilities in planning or evaluation directly.

**Bielaczyc & Brown (1995)** identified a set of metacognitive strategies used by high performers in previous studies which included monitoring their comprehension, learning activities and clarifying and addressing their comprehension failures.

**Alexander & Schwanenflugel (1995)** examined the relationship between giftedness and metacognition. The study stated that metacognition is positively correlated with learner’s awareness of thinking and learning.

**Cams (1994)** studied the effects of learning style up on the metacognitive behaviour of reading awareness in elementary children. The purpose of the study was to explain the relationship between metacognitive reading behaviours and learning style of the
students. The findings shows that learning style may function as either an academic advantage or disadvantage and hence may serve as an important diagnostic tool for education.

**Jausovec (1994)** looked at average students, taught them about types of problems, strategies for each problem and when the strategy should be applied. Jausovec demonstrated that “performance of “average” students can significantly improve, especially on well-defined, or closed tasks.”

**Mukerjee (1993)** stressed the need in using cognitive strategies to attain the mastery of learning. He also established that linguistic competency is directly proportional to strategic competence.

**Scheid (1993)** studied that metacognitive strategy instruction is an instructional approach, which emphasis the development of thinking skills, and processes as a means to enhance learning. The objective of metacognitive strategy instruction is to enable students to become more strategic, self-reliant, flexible and productive in their learning endeavors.

**Ridley (1992)** studied that “Metacognitive 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 behaviors and strategies when necessary.”

**Baker (1991)** pointed out that metacognitive skills are applicable not only to reading, but also to writing, speaking, listening, problem-solving and any other domain requiring cognitive process.

**Volet (1991)** showed how metacognitive training can improve exam grades, grades in classes, retention and student’s satisfaction

**Franks et al. (1982)** used metacognitive learning techniques to train fifth graders in remembering. They were able to improve retention as well as give the students control over their learning processes and which strategy is best for difficult passages.
3.2. Metacognition and Attitudinal change

Brinol & Marree (2012) assumed that metacognition has a prominent role in social judgement became our thoughts about our thoughts can magnify, attenuate or reverse the impact of primary cognition. Metacognition thought can also produce changes in thought, feeling and behavior, and thus are critical for a complete understanding of human behavior.

Muhammad (2011) conducted a study on “The Impact of Using Metacognitive Learning Strategies on Al-Hussain Bin Talal University Students’ Achievement in and Attitudes towards Health Concepts in "Tenet of Worship" Course”. This quasi experimental study aims at investigating the impact of a Meta Cognitive Learning Model (MCLM) on the achievement of Al-Hussein Bin Talal University students and their attitudes towards health concepts included in the course "Tenet of Worship". The total sample of the study (# 120 students at Al-Hussein Bin Talal University) was selected purposively; then divided into two groups: a control group and an experimental group.

Two instruments were used to achieve the aims of this study: a) written test on the health concepts in "Tenet of Worship"; and b) attitude scale towards healthy concepts included in the course "Tenet of Worship". The findings of the study indicated:

- a significant difference between the mean scores of the experimental and control groups in the achievement test on the health concepts in " Tenet of Worship", in favours of the experimental group.

- a significant difference between the mean scores of the experimental and control groups in the students' attitudes towards the health concepts in " Tenet of Worship" in favors of the experimental group. The study concludes that it is vital to design the learning material in accordance with this model; and to carry out training courses for instructors of the health concepts in the course" Tenet of Worship" to enable them to apply this strategy.

Teasdale et al. (2010) pointed out that, metacognitive awareness is a cognitive set in which negative thoughts/feelings are experienced as mental events, rather than as the
Review of Related Literature

self. The authors hypothesized that (a) reduced metacognitive awareness would be associated with vulnerability to depression and (b) cognitive therapy (CT) and mindfulness-based CT (MBCT) would reduce depressive relapse by increasing metacognitive awareness. They found (a) accessibility of metacognitive sets to depressive cues was less in a vulnerable group (residually depressed patients) than in nondepressed controls; (b) accessibility of metacognitive sets predicted relapse in residually depressed patients; (c) where CT reduced relapse in residually depressed patients, it increased accessibility of metacognitive sets; and (d) where MBCT reduced relapse in recovered depressed patients, it increased accessibility of metacognitive sets. CT and MBCT may reduce relapse by changing relationships to negative thoughts rather than by changing belief in thought content.

Ray & Smith (2010) arguing that EC- Effortful Control the efficiency of executive attention” correlated with interpersonal skills and motivation which predicts kindergarten students future reading and maths abilities.

Ozsoy et al. (2009) investigated the relationship between fifth grade students’ metacognition levels, and their study habits and attitudes. Participants of the study consist of 221 students, 125 female and 96 male, enrolling to six public primary schools in Turkey. The results revealed that there is a medium positive relationship between metacognitive knowledge and skills and study habits ($r = .351, p < .05$), study attitudes ($r = .415, p < .05$) and study orientation ($r = .434, p < .05$). Additionally, the results of the study showed that there is no significant relationship between metacognition and study habits and attitudes for low and medium achievers but, there is a significant relationship for high achievers.

Schoenfeld’s (2009) study with math students illustrates ways that students can be taught to monitor and evaluate their performance on maths problems. Students are required to pause frequently during problem solving and ask themselves questions, such as "what I am doing now?”. Learning is both an active and a reflective process. Though we learn by doing, constructing, building, talking, and writing , we also learn by thinking about events, activities, and experiences. Self-reflective activities encourage students to analyse their performance, their attitude, contrast their actions
to those of others, abstract the actions they used in similar situations, and compare their actions to those of novices and experts. So, when students are engaged in metacognitive activities, such as self-assessment, self-explanation, help-seeking, monitoring, or revising, their learning is enhanced.

**Nelson & Conner (2008)** studied the influence of metacognition on various stages of learning. It was concluded that the main struggles that the students face in trying to develop an understanding of metacognition is the lack of awareness to their learning process. Students even at the rudimentary level, have some basic understanding of their own knowledge and thinking.

**Estell (2008)** undertook a study to understand the relationship between peer discussions and self regulated learning. 88 first year high school students answered questions from the Motivated Strategies for Learning questionnaire and reported the perceived frequency of discussions with peers both inside and outside the classroom regarding self regulated learning. The results of the study suggest that differences exist between the frequency of self regulation, discussions with peers from inside and outside the classroom especially for discussions concerning motivation.

**Lajoie & Azevedo (2006)** attempted to identify “how computer learning promote metacognition”. The study revealed that computer and technology rich environments afford the learner richer opportunities for the type of interaction that would support metacognition, self regulation and self regulated learning. Technology rich environments can be designed with cognitive tools that model human behaviour or provide complex simulations that learners can attend to and learn.

**Marcantonio (2006)** demonstrated that metacognition as a mediator of the effect of test anxiety on surface approach to studying. The following scales were completed by 109 undergraduate Social Science students: Approach and study skill inventories, Meta questionnaire, Test anxiety scale were developed for the study, and it was observed that there is a correlation between test anxiety and surface approach. Significant correlation was also found between four of the 5 dimensions of Metacognition and a surface approach to studying.
Steven (2005) conducted a study on “using metacognitive strategies and learning styles to create self directed learners”. After analyzing the data from student lab journal and metacognition forms 14 themes were apparent and included the connection between learning styles, metastrategies, self assessment and student motivation. Firstly the connection between students’s learning styles and preferred metacognitive strategies were determined. Finally the concept of motivation revealed to metacognitive and the self directed learner were determined.

Gama (2004) pointed out that metacognition is a higher order thinking process responsible for active control over cognitive process. He put forth a metacognition instruction model, named Reflection Assistant (RA) that focuses on the following metacognitive skills: (1) Problem understanding and monitoring, (2) Selection of metacognitive strategies and (3) Evaluation of the learning experience. An Empirical study conducted with 27 under graduate students showed that students who performed the reflective activities sent more time on tasks and give up on fewer problems. More over this group answered significantly more problems correctly than the control group. The result showed a positive effect of RA on the learning process. This RA model was beneficial in developing positive attitude towards learning among students.

Hallahan & Kauffman (2003) evaluated that some individual differences in metacognitive abilities are probably caused by biological differences or by variation in learning experiences. Students can vary greatly in their ability to attend selectively to information in their environment. In fact, any students diagnosed as learning disabled actually have attention disorders.

Veron & Mishra (2002) studied the cognitive and metacognitive aspects of learning styles of prospective secondary teachers in relation to teaching aptitude and self esteem. Findings of the study (1) The teaching aptitude and self esteem do influence some cognitive and metacognitive strategies of learning of prospective secondary teachers in an independent manner(2) No. interaction effect of the two variables found on any cognitive and metacognitive strategy of learning.
Casteel & Jordan (2000) discussed the importance of transactional strategies to bridge the gap between what is read and the ability of students to strategically transact with the text, peers and teachers as reading takes place. Assessment is more authentic with transactional strategies, and is done through anecdotal notes, audio and video taping, conferencing, check lists and journal writing. This helps develop and improve the students metacognition as he or she reflects on the comprehension of the text.

Perner (2000) advocates that metacognitive skills such as planning, monitoring and evaluating can be helpful in tasks that are challenging and too difficult. These processes are not necessarily conscious, especially in adults. We may use them automatically without being aware of our efforts.

Conati & Vanlehn (2000) devised a student model that integrates information about the students' actions with a model of correct self-explanations and the students' domain knowledge. In this way, the SE-Coach system (self explanation) assesses students' understanding of examples from reading and self-explanation actions and scaffolds improvements in self-explanation and attitude towards learning.

Halpern (1998) studied, about metacognitive strategy instruction based on the assumption that there are identifiable cognitive strategies, previously believed to be utilized by only the test and brightest students, which can be taught to most students.

Perry (1998) found that asking students two questions helped them become more Metacognitive. The questions were “what did you learn about yourself as a reader/writer today”? and “what did you learn that you can do again and again “? When teachers asked these questions regularly during class even young students demonstrated fairly sophisticated levels of metacognitive understanding and action.

Winn & Snyder (1998) metacognition is an important concept in cognitive theory. It consists of two basic processes occurring simultaneously; monitoring your progress as you learn, and making changes, and adopting new strategies if you perceive you are not doing so well. So it is about self-reflection, self-responsibility and initiative, as well as goal setting and time management.
Flavell et al. (1997) gave, meaning to the concept of metacognition by identifying self-monitoring and self-regulating activities as two aspects of metacognition. The thinking operation related to knowing on knowing is called metacognition. Metacognition, thereafter, is awareness about how thinking occurs, how strategies are used, and the effectiveness of one’s own cognitive activities.

Cardelle (1995) showed how low-achieving students can improve maths skills with metacognitive training. In fact, a 50% increase of improvement was recorded as well as a better attitude towards math.

Puntambekar (1995) developed a metacognitive model. It’s design follows a process-based intervention and uses collaboration, reflection, and questioning as tutorial strategies to facilitate students' planning and monitoring skills. Metacognitive inventory strategy model was rather simple from a computational point of view, but demonstrated success in bringing about some changes to the learning attitude of students.

Gullnick & Chinn (1994) stated that problems that students have in the classrooms learning are the result of lack of metacognitive skill. Many students have little cognitive prompting and monitoring. They suggested the following, which help teachers to capitalize of the difference among their students.

1) Place the student at the centre of the teaching and learning process
2) Believe that all students can learn.

Roberts & Erdos (1993) used cognitive strategies to help an individual achieve, a particular goal (eg: Understanding a text) while metacognitive strategies are used to ensure that the goal has been reached (eg: Quizzing oneself to evaluate one’s understanding of that text). Metacognitive Experiences usually proceed or follow a cognitive action. They after occur where cognitions fail, such as the recognition that one did not understand what one just read. Such an impression is believed to activate metacognitive processes as the learner attempt to rectify the situation.
**Temur (1990)** described metacognition in maths education as self-management, reflected in the plans that learners make before tackling a task, in the adjustments they make as they work, and in the revisions they make afterwards.

**Paris & Winograd (1990)** arguing that affective realm is an inevitable element of metacognition, because as students monitor and appraise their own cognition, they will become more aware of strengths and weakness.

**Cross & Paris (1988)** noted that metacognition includes affective and motivational states of the learner.

**Garner & Kraus (1982)** examined the reading abilities of VII grade students in the dual contexts of metacognitive knowledge and experience. Students' interviews revealed that in regulating one's own metacognitive strategies poor comprehenders were unable to uncover text inconsistencies; they never questioned inaccurate text information.

**Brown's (1978)** research interests include cognitive developments, transfer of learning, instructional design and metacognition with extensive inquiries into the cognitive process of reading-comprehension. Brown specified definitive executive processes with regard to efficient thinking and reading, such as predicting, planning, checking and monitoring. This implicate the role of metacognition as an important and practical instructional concept for classroom teachers.

**Markman (1977)** investigated verbal comprehension abilities and determined that reasonable understanding was dependent on a sufficient amount of constructive processing of information, self monitoring of comprehension, a pertinent element of metacognition, is missing among the poor readers. He concluded from the studies that direct instruction of metacognitive strategies regarding monitoring and reflection would be an effective intervention with elder students.

### 3.3. Metacognition and Problem solving

**Tingley (2012)** conducted a study using Talking Aloud Partner problem Solving (TAPPS) which is a teaching/learning strategy has increased the speed and
effectiveness of partner problem-solving, has little to do with the monitor and much to
do with the problem solver’s own behaviour.

Liu & Feng (2011) conducted an ‘Empirical study on the Relationship between
Metacognitive strategies and online-learning Behaviour & Test Achievements”. By
using Wen Qiufang’s Questionnaire on English Learning Strategies, 93 students from
thirteen different majors in Beijing university of Technology were surveyed about
their use of metacognitive strategies and online learning behaviour & test
achievements is analyzed with suggestion for strategy training and ability
development. Study concluded that metacognitive learning strategies function in
student’s online learning behaviour and test achievements.

Whitebread et al. (2009) found that children as young as 3-5 years old exhibited both
verbal and nonverbal metacognitive behaviour during problem solving, including
articulation of cognitive knowledge, cognitive regulation and regulation of emotional
and affective states.

Shen & Song (2008) claimed that learning strategies especially metacognitive
strategies are important for online self learning for facing the, vast amount of learning
resources, learner’s need, the ability to plan, monitoring and evaluation in order to
acquire learning efficiency and develop self learning ability.

Martinez (2006) argues that metacognition entails the management of affective states
and that metacognitive strategies can improve persistence and that metacognitive
strategy can improve persistence and motivation in the face of problem solving
situations.

Veenman (2006) attempted to correlate intelligence with metacognition yielded the
result that intelligent people usually have high metacognition, but some
metacognitively advanced students do not score as having high intelligence. While
there is a strong correlation between the two, it is far from predictive.

Kymes (2005) conducted a study related to the unique challenges in education and
need for metacognition. Students were taught to use “think alouds” a process in which
they verbalize their thoughts surroundings, several questions designed to keep them
focused and evaluating the usefulness and applicability of portions of their research. These questions were scripted and provided for the students but this is a unique application derived from the similar process used in reading and writing education. The result of the study reveals that metacognitive training improve students’ reading as well as writing performance.

**Veenman (2004)** examined the ways in which metacognition correlates with intelligence, as well as the effects that time pressures have on learning of texts and found several interesting things. First, there seems to be an element of metacognition that is not domain specific. While the specific questions may be different in different disciplines, there are self-maintenance questions (why do I think that? what should I do next? why was that conclusion drawn? etc.) which apply to any intellectual task. This is the advantage that metacognitively advanced learners have; they are able to use learned skills to guide their future learning, thereby greatly reducing the amount of time and effort required to learn skills in the new domain.

**Wong et al. (1997)** reported that weaker students benefit even more than stronger students from metacognitive strategic instruction.

**Neto & Valentine (1997)** compared the relationship between metacognitive strategy & problem solving. The only high school metacognitive study in the domain of physics was conducted by them. In this study the authors taught one high school class a metacognitive strategy for solving problems while the other was a conventional physics class. The metacognitive group also studied more difficult problems thus possibly allowing for the development of enhanced problem solving processes due to the complexity of the problems and not solely due to the metacognitive strategy. The metacognitive group did outstanding performance compared to the traditional class on both qualitative and quantitative problems sets. They did not look directly at the metacognitive abilities used via, think aloud protocols; but, only obtained a sense of student usage of metacognitive strategies by a questionnaire administered about the usage of such techniques.
McLeod (1997) points out that metacognition have been observed even in pre school aged children in the form of planning and monitoring progress toward goals and persistence at challenging tasks.

Coetta (1996) studied about the metacognitive processing. It seems that talking through a problem helps to sustain attention on the problem content, and lowered the process what you are doing to solve the problem. In other words talking through the problem may facilitate a person’s ability to solve problems by expanding their level of awareness in a sense allowing them to observe the particular steps that they are talking to solve problems. This process has been termed metacognitive processing.

Metcalf & Shimamura (1994) reported that metacognition literally means cognition about cognition –or Knowledge about knowing and learning. This metacognitive knowledge is used to monitor and relate cognitive processors such as reasoning, comprehension problem-solving, learning and so on.

Shraw & Dennison (1994) pointed out that metacognitive awareness enables individuals to plan, sequence and monitor their learning in a way that directly improves performance.

Davidson et al. (1994) claimed that metacognitive activities in interactive learning environments improved many aspects of students learning i.e. academic competence and fostering knowledge about the self as a learner.

Schoenfeld (1992) reported that heuristics should be taught in the context of a metacognitive strategy that supports the leaner in selecting the right one to solve a problem.

Garner & Alexander (1989) suggested that metacognitively aware learners are more strategic and perform better than unaware learners.

3.4. Teaching and Learning Metacognitive Skills

Eisenberg (2012) argues that EC- Efficiency of executive attention or Effortful Control is directly related to academic success through motivation. Eisenberg explains the relationship as follows: children high in EC are more likely to behave in
productive, pro-social ways; they are more socially competent and are generally rated as having higher quality interactions with others.

**Lorenzo & Catherine (2011)** undertook a study to develop metacognitive skills through collaborative model. Through their study they provided a platform for constructing common vocabulary and shared understandings. Then they introduced the model of metacognitive skill and described difficulties in learning and executing the skill. Based on this model, they also proposed a learning support environment where learners develop their metacognitive skills.

**Dignath et al. (2010)** meta-analyzed 48 studies investigating the effect of training in self-regulation on learning and use of strategies among students in first through sixth grades. The most effective metacognitive strategies included the combination of planning and monitoring and the combination of planning and evaluation both of which were more successful than teaching any of the skills in isolation or teaching a combination of all three metacognitive skills (planning, monitoring, and evaluation). In studies where the intervention also included instruction designed to promote student metacognitive reflection, the most effective type of instruction emphasized a combination of knowledge about strategies as well as specific benefits of those strategies.

**Schneider (2008)** followed 174 children from the ages of 3 to 5, investigating the relationship between Theory of Mind (ToM) and subsequent development of metamemory. Schneider also examined the role of language ability in the development of metamemory. He found that both ToM and language ability increased steadily with age. Further, there was a strong relationship between language ability and both ToM and metamemory. Strong language ability at age 3 was a salient predictor of metamemory at age 5. Knowledge and vocabulary in young children, arguing that "early ToM competencies can be considered as a precursor of subsequent metamemory". Although results suggest that declarative metacognitive knowledge tends to increase with age, developmental trends for procedural metacognitive knowledge, particularly as it relates to monitoring task demands in relation to abilities, were less clear.
Schraw et al. (2006) emphasizes that providing explicit instruction in cognitive and metacognitive strategies motivate students to use them strategically and independently. He pointed out that small group work should involve peers at a similar developmental level, because they can provide examples within the learner’s Zone of Proximal Development. Further, they observe that collaborative learning works especially well when students have been explicitly taught how to collaborate.

Sungur & Tekkaya (2006) suggested that problem based learning environments may enhance metacognitive skills relative conventional instructional environments.

Winston & Fouad (2006) undertook a study and found that metacognitive skills are learned and applied more effectively in supported active learning contexts than in direct instructional contexts.

Dresel & Haughwitz (2005) urged that gifted learners, have been found to employ fewer metacognitive strategies than less gifted students.

Mathan & Koedinger (2005) reported that students receiving intelligent feedback acquire a deeper conceptual understanding of domain principles and demonstrate better transfer and retention of skills over time than students who do not receive such feedback.

Staley & Dubois (2004) found that training in metacognitive skills enhance student’s sense of self efficacy, increasing their motivation to learn.

Kramarski & Mevarech (2003) report the results of a study investigating the effects of metacognitive training on the mathematical reasoning and metacognitive skills of 384 eighth-grade students. They found that students exposed to metacognitive instruction in either cooperative or individualized learning environments, outperformed, compared students with respect to the ability to interpret graphs, fluency and flexibility of correct mathematical explanations, use of logical arguments to support math reasoning, performance on transfer tasks, and level of domain-specific metacognitive knowledge, such as strategies for representing math concepts in multiple ways and specific mathematical strategies for interpreting graphs.
Kramarski & Mevarech (2003) provided students with sets of metacognitive questions, including comprehension questions, strategic questions, and connection questions, to be completed during the task. Comprehension questions were designed to encourage students to reflect on a problem before solving it. Strategic questions were designed to encourage students to think about what strategy might be appropriate for a given task and to provide a reason or rationale for that strategy choice. Finally, connection questions were designed to encourage students to identify and recognize deep-structure task attributes so that they could activate relevant strategy and background knowledge.

Hofer & Yu (2003) claimed that Metacognitive training increase students motivation to learn.

Enos, Kehrlahn & Bell (2003) training in the use of metacognitive strategies may invasive informal learning in less metacognitive sophisticated managers.

Sperling et al. (2002) developed and administered a self-report instrument for measuring general metacognitive knowledge and regulation in children in grades 3-8. Empirical results validated the instrument’s multidimensional approach to conceptualizing metacognition, in addition, the measure was significantly related to other, published measure of metacognition and weakly correlated with measures of achievement.

D’Amico & Capehart (2001) reported that TV 411- a national television series focuses, in part on helping adults manage their own learning using metacognitive skills.

Kuhn (2000) points out that instruction for metacognition should be delivered at the meta-level rather than the performance level, which means instruction should be aimed at increasing awareness and control of meta-task, rather than task, procedures.

Simpson & Nist (2000) had done a comprehensive investigation regarding difficult strategies of metacognitive training claimed that during metacognitive strategic learning students create examples, make analogies and explain relationship between concepts. Then students engage in the use of organizing strategies like concept maps,
network representations and other graphic organizes. The results highlighted the educational applications and implications of metacognitive strategic learning in self regulation.

**Hennessey (1999)** describes an instructional program involving 170 students in grades 1 through 6 over a period of three years. Students engaged in science units designed to explore students' science conceptions and the nature of science, with activities focusing specifically on development of metacognition. Teachers' instruction emphasized making students' science conceptions visible, creating opportunities for students to clarify their conceptions in small groups, promoting metacognitive discourse among students, encouraging conceptual conflict, and facilitating student practice in different contexts. Hennessey concludes that students did exhibit qualitative changes in their metacognitive abilities from one year to the next, with students as young as first graders exhibiting the highest level of metacognition.

**Eweel (1999)** conducted a case study on secondary school students found that it is possible to produce better critical thinkers, problem solvers and decision makers by teaching metacognitive skills.

**Chiang & Linda (1998)** examined how metacognitive strategies could enhance learning achievement and whether the use of individual learning contracts could enhance an individual's ability to become a conscientious learner. The criteria included whether students would learn by planning, controlling, monitoring learning processes, and using study skills. The process of using metacognitive strategies included setting goals for individual learning programs, developing individual learning contracts, monitoring learning processes, writing reflective journals, conducting individual conferences with the instructor, and being involved in summative evaluations. Participants were 222 college students. At the beginning of the semester, the instructor explained the purpose of the Individual Learning Plan (ILP), connected students to resources, and set the time frame for planning. The instructor reviewed students' ILPs for learning objectives and strategies, self-monitoring processes, evaluation processes, expected grade, and feasibility. At the
end of the semester, a summative evaluation was implemented, and an individual conference invited feedback. Students were asked about how well they used the skills and the overall effectiveness of the ILP. Data analysis involved tallying survey forms and transcripts from interviews and reflective journals. Results indicated that this process helped students become conscientious learners. The instructor found that using learning contracts, appraisals, reflective journals, and conferences helped develop a rapport with students.

**Schraw (1998)** recommends providing explicit prompts to help students improve their regulating abilities. He suggests using a checklist with entries for planning, monitoring, and evaluation, with subquestions 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.

**Stein & Lin (1998)** explained the use of IDEAL Problem Solving system in developing metacognitive awareness based on evidence that successful problem-solvers actively attempt to (a) identify problems that others may have overlooked (b) developed at least two sets of contrasting goals for any problem and define them explicitly (c) explore strategies and continually evaluate their relevance to their goals. (d) anticipate the effects of strategies before acting on them; and (e) look at the effects of their efforts and learn from them.

**Kuhn, Shaw & Felton (1997)** suggested that “active engagements” in thinking about a topic enhances the quality of reasoning about that topic.

**Mclnerney & Marsh (1997)** conducted a study among 250 students who completed classes that incorporated metacognitive process instead of traditional classes and found increased student achievement. They designed self-regulatory metacognitive questions to follow instruction on a particular topic and precede instruction on the next topic: (a) “What did I learn about this topic?” (monitoring) (b) “With what did I have difficulty?” (monitoring) (c) “What types of things can I do to deal with this difficulty?” (problem solving-planning) (d) “What specific actions (s) am I going to take this week to solve any difficulties?” (planning)
Hascher & Oser (1995) argued that metacognitive skills can be taught by incorporating metacognitive strategies in classroom instruction.

Carman & Askov (1994) suggested a curricula to enhance students higher order metacognitive skills which offered a number of activities designed for adult learners. Many of these are appropriate for Pre-managers, especially if they are contextualized.

Schneid (1993) assessed the effect of cognitive strategy instruction in enhancing learning by emphasizing the development of thinking skills and processes. The objective was to enable students to become more strategic, self reliant, flexible, and productive learners.

Bruner (1993) conducted a study on metacognitive skills pointed out that once adults have gained expertise and learned how to use a range of metacognitive skills in one domain, they can use some of their metacognitive skills to more rapidly learn in another domain.

Pressley & Ghatala (1990) advocates that students who have been taught metacognitive skills learn better than students who have not been taught these skills. The results of the study implies that it is possible to produce better learners by teaching metacognitive skills.

Marzano & Shunk (1990) found that metacognitive instruction increase students self-confidence and sense of personal responsibility for their own development. This increased confidence and a sense of increased personal responsibility may provide motivation for learning

Garner & Alexander (1989) suggests that through metacognitive training adults could monitor their thinking

Cross & Paris (1988) describe an intervention targeted at improving the metacognitive skills and reading comprehension of 171 students in third and fifth grades. Children were exposed to a curriculum (Informed Strategies for Learning) designed to increase their awareness and use of effective reading strategies. During instruction, students received strategy training that included explicit attention to
declarative, procedural, and conditional knowledge about reading strategies. Students in both grades made significant gains relative to comparison, students with regard to awareness about reading in three areas—evaluation of task difficulty and one’s own abilities, planning to reach a goal, and monitoring progress towards the goal.

Haller et al. (1988) meta-analyzed 20 empirical studies, comprising more than 1,500 students, on the effects of metacognitive instruction on students’ metacognition during reading. They computed a mean effect size of 0.71, which suggests that instruction in metacognition can have robust effects on children's reading awareness and comprehension. Effects were largest for students in the seventh and eighth grades, but were also impressive among students in the second and third grades. The most modest effect sizes were found among students in fourth through sixth grades. Results suggest that instructional interventions involving fewer than 10 minutes of instruction per lesson are insufficient for producing these types of effects. The most effective instructional strategies included the textual-dissonance approach, self-questioning, and backward-forward search strategies.

Perkins (1987) reported that learning enhanced when instruction [1] provides explicit content knowledge while [2] asking students to use metacognitive skills to operate on that knowledge.

Bransford et al. (1986) pointed out that cognitive development involves both knowledge acquisition and knowledge structuring. Metacognitive skills involve the conscious structuring of knowledge they are more likely to be more developed in areas of greater knowledge.

Nickerson & Smith (1985) found out the value of metacognition in identifying cognitive errors. When students monitor their learning, they can become aware of potential problems, including errors in encoding, operations and goals. Errors in encoding include missing important data or not separating relevant from irrelevant data. Errors in operations include failing to select the right sub-skills to apply or failing to divide a task into subparts. Errors in goal seeking include misrepresenting the task and not understanding the criteria to apply. Problems with cognitive load include being unable to handle the number of sub-skills necessary to do a task, or not
having enough automatic internalized sub-skills. A good way to discover what kind of errors managers are making in their thinking processes is to have them unpack their thinking by explaining, step by step, how they are approaching a given task. This not only allows the instructor to diagnose possible errors, it provides managers with an opportunity to describe their thinking processes, which by itself develops their metacognitive abilities.

**Ferrara & Campion (1983)** reported that metacognitive skills could be developed through metacognitive strategic instruction.

**Ericsson et al. (1980)** agrees that metacognitive skills learned in one context are not automatically transferred to another context.

**Conclusion**

From the review of literature it becomes clear that metacognition is a multifaceted topic of research. The empirical studies lead the Investigator to conclude that metacognitive training is a challenging task, involving more than just adding a few activities in learning environments. In order to achieve observable improvements, it is necessary to tailor/transmit the metacognitive message to the domain and blend it seamlessly into the teaching.

The empirical studies show that metacognitive skills play an important role in problem solving and students can be trained with a metacognitive method.

It is obvious that metacognition is an important concept and a critical strategy to teach in the classroom. From all the research over metacognition, it is a learned behaviour that can vastly improve students of all performing levels. If people are taught metacognitive awareness concerning the utility and function of a strategy as they are taught the strategy, they are more likely to generalize the strategy to new situations. The above reviewed literature and studies support the claim that metacognitive process has resulted with a number of positive outcomes in the school setting.

From the above reviewed literature it can be concluded that metacognitive process based instruction may provide a better opportunity for students to find out


From the studies of Whitebread (2009), Shen & Song (2008), Martinez (2006), Kymes (2005), veenman (2005), Mc Leod (1997) and Neto & Valentine (1997), it is clearly estimated that metacognition is directly proportional to problem solving abilities of an individual. Ewell (1999), Presley & Ghatala (1990), Garner & Alexander (1989), Bransford (1986) and Ferrarae & Campione (1983) pointed out that by teaching through metacognitive instruction it is possible to produce better critical thinkers, problem solvers and decision makers by the acquisition of metacognitive skills. Mathan & Koedinger (2005), Staley & Dubois (2004), Hofer & Yu (2003), Bruner (1993) and Mc Combs, Marzano & Shunk (1990), clearly stated that by the internalization of metacognitive skills students develops a sense of personal
responsibility for their own development. Sungur & Tekkaya (2006), Dressel & Haughwitz (2005), Enos Kehrlahn & Bell (2003), supported the views of Hascher & Oser (1995), Nickerson & Smith (1985) agreed that metacognitive skills are teachable and can be applied in active learning contexts.


The positive outcomes are

1. For students
   a) Metacognition based instructional programmes improved students academic achievements.
   b) Improved students’ motivation and participation.
   c) Improved self confidence, self efficacy and self management.
   d) Improved problem solving skills and critical thinking ability.
   e) Improved students’ interest and develops positive attitude towards learning.

2. For Teachers
   a) Positive influence on teacher’s belief about cognition, instruction and students’ achievement
   b) Enhanced student-teacher relationships.
   c) Change from teacher-centered to students centered practices.
   d) Enhanced teachers’ metacognitive awareness.

3. For schools
   a) Development of a supportive school culture.
b) Improved parental participation.

This literature review discussed positive outcomes of metacognition and importance of practising metacognitive skills by student learners. This review of the literature has provided clear justification for undertaking this study and has also established important background understandings which helped to frame the overall research design.