International Journal of Education and Psychological Research (IJEPR)
ISSN: 2279-0179 Volume 2, Issue 2, pp: 111-119, April 2013

Metacognitive - Cooperative Learning Approach to Enhance Mathematics Achievement

Dr. Mrs. Vijayakumari S.N.
Professor,
St. Ann's College of Education,
Mangalore-575001

Myrtle Joyce Shobha D'Souza
Lecturer & Research Scholar
St. Ann's College of Education, Mangalore-575001 hekkottu@yahoo.co.in

Abstract: It is important for pupils to be aware of their strengths and limitations as learners. Metacognitive environment provides scope for this. The present study, represents the significance of metacognitive strategies on learning Mathematics in Co-operative groups. The study has considered Self Questioning and IDEAL Strategies on Metacognition with Co-operative Learning Approach.The study was carried out by following Post-Test only Control Group design. The findings of the study reveal that Metacognitive Co-operative Learning Approach enhances Mathematics Achievement among Secondary School students. It has also revealed that the approach is significantly more effective to high achievers as well as low achievers than traditional method, but the effectiveness is significantly more on high achievers than low achievers.

I. Introduction

Learning how to learn and developing a repertoire of thinking process which can be applied to solve problems, is a major goal of education. A Metacognitive environment encourages awareness of thinking .In the creation of a metacognitive environment teachers monitor and apply their knowledge, deliberately modeling Metacognitive behavior to assist students in becoming aware of their own thinking. The more students are aware of their thinking processes as they learn more, the more they can control such matters as goals, dispositions and attentions. Self-awareness promotes self-regulation. If students are aware of how committed or uncommitted they are to reaching goals, of how strong or weak in their disposition to persist and of how focused or wondering in their attention to a thinking or writing task, then they can regulate their commitment, disposition and attention(Marzano et al,1988).

Many students don't feel good about Mathematics, largely as a result of the way they have been taught. Because of the prevalent belief that classroom Mathematics consists of mastering formulas, these students do not understand how Mathematics can be meaningful. Metacognition has the potential to increase the meaningfulness of students' classroom learning; and the creation "Mathematics culture" in the classroom best fosters Metacognition.

Recent research has focused on the phenomenon of Metacognition and its role in learning Mathematical performance and especially problem solving. Problem solving ability is recognized as a complex interplay between cognition and metacognition. A primary source of difficulty in problem solving may lie in pupils' inabilities to actively monitor and subsequently regulate the cognitive processes engaged in during problem solving(Artz and Armour Thomas, 1992).For the successful solution of any complex problem solving task a variety of Metacognitive processes is necessary. The present study was an attempt to explore the effectiveness of Metacognitive –Cooperative Learning on Mathematics Learning.

II. Metacognition

In Education Metacognition plays an important role. It is closely related to learning styles as well as teaching styles adopted by the teacher. In the process of learning, thought-provoking questions are essential for the development of learning abilities of pupils. Teacher can use a variety of strategies to enhance Metacognition independent of grade level and subject area.

Metacognition is thoughtfulness. It is thinking about our own thinking and about our processing of information effectively. Metacognition means cognition about cognition or knowledge about knowing and learning. Donald

Meichenbaum and his Colleagues(1985)describe Metacognition as people's awareness of their own cognitive machinery and how the machinery works. This Metacognitive Knowledge is used to monitor and regulate cognitive processes such as reasoning, comprehension, problem solving, learning etc., (Metcalfe and Shimamurar 1994). Because people differ on their Metacognitive Knowledge and skill they differ on how well and how quickly they learn. Metacognitive Knowledge is used to regulate thinking and learning (Brown 1987, Nelson 1996).

As Hyde and Bizar (1989) state, "Metacognition refers to our ability to understand and manipulate our own cognitive processes. It involves thinking about our thinking and purposely making changes in how we think". Research in Cognitive Psychology emphasizes that in Metacognition, the engaging of these processes is intentional and deliberate. Metacognition is controlled; it is purposeful thoughtfulness. In fact, when we think about our own thinking, we are far from having an absolute picture of how we think. In general Metacognition is thinking about thinking. More specifically Taylor (1999) defines Metacognition as "an appreciation of what one already knows together with a correct apprehension of the learning task and what knowledge and skills requires, combined with agibility to make correct inferences about how to apply one's strategy.Knowledge to a particular situation, and to do so efficiently and reliably." Metacognition relies on a fair amount of abstract thinking. The skills engaged are often highly representational and internalized. In theory, most of our students should be able to think about their own thinking and the significant processes that influence their learning. The downside of the research is that "should" and "do" are not the same; students who should be able to engage Metacognition frequently do not. It is important to consider, then, how teachers can encourage Metacognitive activity in students.

A growing body of research strongly supports a role for teachers in the Metacognition of students, despite the fact that what is at issue is student's thinking about their thinking. Teachers can teach students cognitive strategies to facilitate their Metacognition. Cognitive Psychologists, Flavell, (1976) also point out the importance of Metacognitive for higher order thinking. Metacognition includes knowing one's own cognitive systems and the ability to monitor and regulate this system. For example, in Mathematics, Metacognition of problem solving would involve the student standing outside their process as it were and understanding the kind of information that she used in solving the problem, in addition to aspects that were hindrance in solving the problem. This is also referred to as operative knowledge (Murphy and Gopps 1996). In this case, the teacher's role in developing higher order thinking involves not just giving information but creating scaffolds (Rogoff, 1990), for the students scaffolding involves the organization of verbal construction academic to help students become independent learners by acquiring sufficient understanding of their own learning process.

III. Teacher's Role in Training Metacognition

Metacognitive Strategies of self-regulated learning can be taught (Boekaerts, 1997). Teachers can play a significant role in the establishment of structure and networks in meaningful learning in students. In fact, there are strong recommendations that teachers should carefully train students in purposeful, strategic studying, reading, and problem solving (Gourgey, 1998; Willen and Phillips, 1995; Lucangeli et al., 1995; Feden, 1994; Ganz and Ganz, 1990; Hyde and Bizar, 1989).If the appropriate strategies are employed, teachers can make learners better users of their Metacognitive Skills (Dixon-Krauss, 1996).

Metacognitive Learning Strategies

A teacher interested in facilitating one's student's to use Metacognitive learning strategies would do well to teach them strategies such as Self-Questioning, KWL, PQ4R, and IDEAL. In the present study the following Metacognitive learning strategies were used . They were Self-Questioning and IDEAL.

Self - Questioning

Self-Questioning Metacognitive Strategy in which students generate and answer questions designed to facilitate information processing also called "self interrogation". To facilitate Metacognition, teachers can present divergent questions for students to answer, or they can encourage the students to generate their own questions (Cardiello, 1998).

A teacher can assist students in their use of Self-Questioning or self-interrogation (Ganz and Ganz, 1990). He suggests that Self-Questioning encourages the students' monitoring of their own cognition, along with the

assessment of their feelings about the efficacy of their thinking. It also assists students in the employment of self-correction and the development of newer understanding.
In this strategy the teacher demonstrates a task and guides students through the use of self-instruction and practice. Specifically, the teacher should demonstrate the procedure and then encourage students to execute the strategy along with the teacher, and finally, provide opportunities for students to enact the strategy alone.

When applying this model to teach Self-Questioning skills we would expect that a teacher would first identify Self-Questioning as the specific Metacognitive of that skill for effective study. The teacher might then model Self-Questioning prompts for the students.

In Self-Questioning, the students quietly ask themselves questions about the material. This process is also referred to as verbal mediation. The internal language, or covert speech, helps to organize material and behavior. Camp and Bash (1981) suggest the following types of questions:

a. What is the problem or What am I supposed to do?
b. What is my plan? Or How can I do it?
c. Am I using my plan?
d. How did I do?

IV. IDEAL

Another approach to Metacognition is to Identify, Define, Explore, Act, and Look. **IDEAL** is the acronym for these strategies, which are used for effective and efficient thinking and problem solving (Byrnes, 1996). Each of these specific Metacognitive Skills can be taught to students by a teacher who is concerned with facilitating effective thinking and problem solving. Effective problem solving should begin with identification or the careful anticipation of potential difficulties. Thus, after identification, problem definition is a significant step (Byrnes, 1996). Through this step, the efficient learner examines goals and looks for obstacles to those goals.

The third strategy in problem solving is exploration. Following the identification and definition of the obstacles to understanding, the student explores solution options. Expert learners are more reflective and open-minded to possible solutions while novice learners are more rigid and narrow. Both expert and novice learners act on their solution options, but only expert learners think purposefully before acting (Byrnes, 1996). In this strategy, in IDEAL, after trying a solution option, is for the student to look and note which actions lead to successful resolution and which do not. This is a critical step. Comparison research indicates that only expert learners monitor the outcomes of their choices, while novices are inattentive (Byrnes, 1996). IDEAL is a Metacognitive Strategy featuring student processing skills, i.e., identification, definition, exploration, action, and looking, to facilitate thinking and problem-solving.

Learning is an individual process. In learner centered approach the main focus is on learner and not on the teacher.If we provide an opportunity for each student to think about his or her thinking, learning becomes effective and fruitful. Instead of giving more importance to acquisition, retention and reproducing facts we should give importance to meta-memory- Knowing about own memory, what strategies work best. Meta – memory is the cognitive skill that helps to decide how to remember something. The Metacognitive process enhance learning by guiding students thinking and by helping in learner follow a wise course of action as he or she think through a problem, makes decisions or attempts to understand a situation or text. In this rapidly changing world, the challenges of teaching are to help students develop skills that will not become absolute. Metacognetive strategies are essential for the 21st century because they enable students to cope successfully with new situations.

V. Cooperative Learning

Cooperative Learning may be defined as a teaching-learning strategy in which the students of a class engaged themselves in a variety of useful learning activities in a cooperative and non-competitive environment by forming a number of teams, each consisting of a small number of students of different levels of ability for their understanding of a subject. Cooperative Learning is defined as "students working together in groups (often following a teacher – prepared lesson), with group goals but individual accountability (Willis, 1992). Each student evaluation depends, in part, on the success of the entire group in completing an assigned task. This feature helps students develop a pro-social commitment to help the other (Slavin, 1990), and it replicates the kind of productive group work featured in

the adult work place (Willis, 1992). Thus, Cooperative Learning is a teaching strategy involving pupils participation is small learning groups in which pupils learn through intra-group and inter-group interactions.

Cooperative Learning refers to instructional methods and techniques in which students work in small groups (four to six members) and are rewarded in some way for performance as a group. In Cooperative Learning, students are to work together for a common goal, motivating them by depending others, encouraging each other during the task of learning and by increasing positive contact among group members. Studies revealed that using Cooperative Learning is an instructional strategy will help the teachers to overcome the major difficulties of the conventional method of teaching. Cooperative Learning strategy is based on the psychology of co-operation and competition among students in the class.

Systematic Cooperative Learning program used as the principle means of delivering instructions were developed in the early 1970's. The rationale for this new emphasis was on co-operation among the students in the class room and a profound dissatisfaction with the traditional instructional system. The idea behind Cooperative Learning methods is that when groups rather than individuals are rewarded, students will be motivated to help one another to master academic materials. Cooperative Learning methods have also been found to improve group relations in de-segregated class rooms, acceptance of main streamed academically handicapped students by their classmates, development of students self –esteem and other effective out comes. Essential Components of Cooperative Learning are:

- Positive interdependence
- Face to face promotive interactions
- Individual group accountability
- Interpersonal and small group skills
- Group processing.

There are several approaches for organization students for Cooperative Learning activities.

VI. Cooperative Learning Approach

Cooperative Learning, as the name suggests, stands for a learning process or learning strategy in which students are provided with opportunities to learn by themselves in a group in a cooperative way. They share all the information among themselves and help each other in gaining the required knowledge, understanding and application of one or the other aspects of the content material or course units included in their syllabus. It seems quite contrary to the practice of the teaching-learning process prevalent in our current educational system.

Our ongoing classroom teaching is totally teacher dominated and content-centered. Here teachers are regarded as the repositories of subject knowledge and their role is simply to pour into the open, empty and willing or non-willing minds of students their vast reservoir of knowledge. They do not trust their students to learn. They thing that they must tell them what to learn and provide all the structure for the learning to take place. This structure of learning provided by them to their students, is highly individualistic. It encourages individual as well as competitive learning in place of group and Cooperative Learning. Here students are tempted to learn more and more in order to gain good grades, divisions, certificates and appreciations by excelling their own peers.

Cooperative Learning says 'no' to such practices. It advocates Cooperative and group learning in place of the competitive and individualistic approach prevalent in our educational system by redefining the roles of the teacher and the learner in a particular teaching-learning process. Many of them share the following characteristics:

- Students are organized into small groups or teams.
- Members of each team work together to accomplish a set of tasks.
- Rewards to individuals often are based largely on the accomplishment of the team and this builds an incentive for students to work productively together.

Cooperative Learning is the method of teaching in which the teacher provides the various tasks based on the content selected for the study, which were planned and designed in a definite sequence to attain objectives of the lesson for the group of four to six pupils of the same age and achievement level. Communication of the group goal and tasks structure, monitoring of group work and testing of individual learning were done by the teacher. The sequence of

moves followed is Communication of the Group Goal (C.G.G.), Communication of the Tasks Structure (C.T.S.), Pupil-Pupil Interaction (P.P.I), Monitoring and Intervention by the Teacher (M.I.T.), Testing of Individual Learning (T.I.L), (Vijaya Kumari, 2002). Thus Cooperative Learning is a teaching strategy involving pupils participation in small learning groups in which pupils learn through intra group, and inter group interactions.

VII. How to proceed with Cooperative Learning

The adoption of Cooperative Learning as a teaching strategy teacher may try a number of typical Cooperative Learning setups. A few of these are.

- A unit in a subject may be broken down into certain meaningful subunits. These sub-units may then be assigned to the different teams (each having five to eight students) of a class or grade for Cooperative Learning. The team members may collect relevant information and go through learning experiences, activities etc. to acquire the required knowledge, understanding and insight into the assigned sub-unit in a cooperative way mutually helping and complementing one another's efforts for doing so. After some time (this duration may be fixed in advance), the members of the different teams may sit together for discuss their learning outcomes with respect to the sub-units assigned to them. In fact, they may teach one another the content material or learning experiences acquired by them in their respective sub-units. After grasping the knowledge and understanding of the whole unit, the students may again be asked to work in their respective groups/teams for gaining more insight and understanding of the unit through cooperative efforts and then share the outcomes of their striving with all the students of the class.
- Students of a class in any subject/grade may be asked to work on a group project, which they may select. It may provide them with extra opportunities for Cooperative Learning as well as working in the group. Such group projects or investigation may be highly structured to emphasize higher order of thinking, analyzing and evaluating skills. They may also provide a proper platform for the demonstration of practical and working abilities on the part of students while working cooperatively in a group.
- In another Cooperative Learning setup, students with varying academic abilities may be assigned to four to five member teams for studying what has been initially taught by the teacher and to help each other to seek his or her highest level of achievement. After such cooperative efforts, all the students of the class are individually tested. After this, the different teams of the class may be awarded certificates or other recognition on the basis of the extent to which all team members have progressed over their past records.
- In another Cooperative Learning setup a particular topic or unit of the subject is assigned to five or six groups or teams of a class. Each group or team may have a small number of students of varying interests and abilities. In the respective teams, each team member is responsible for learning a specific part of sub-unit of a topic. He himself strives hard to learn the assigned sub-part in close collaboration with his or her counterparts in the other team. In fact they work closely in a cooperative spirit for acquiring necessary knowledge, experience and application related to that very sub-topic. Then all members of the team sit together for discussing the fruits of their striving and acquire a complete picture of the knowledge and understanding of the sub-topics or sub-units related to a particular topic. They may go for its deep understanding and advanced study by repeating their cooperative exercise in the process of learning.

Why Cooperative Learning

Review of research on Cooperative Learning yields the following findings:

- Cooperative Learning Enhances Student Achievement
- Improves Inter group Relations
- Aids in Successful Mainstreaming of Handicapped Students
- Develops Self-esteem
- Promotes the Liking Among Students for Class, School and Learning

Implementation of Cooperative Learning

Foyle and Lyman (1998) identified the following steps involved in successful implementation of Cooperative Learning activities.

- The content to be taught is identified, and the teacher determines criteria for mastery,
- The most useful Cooperative Learning technique is identified, and the teacher determines the group size.

- Students are assigned to group.
- The classroom is arranged to facilities group interaction.
- Group processes are taught or reviewed needed to assure that the groups run smoothly,
- The teacher develops expectations from group learning and makes sure students understand the purpose of the learning that will take place. A time line for activities is made clear to students.
- The teacher presents initial material as appropriate, using whatever techniques she or he chooses;
- The teacher monitors students interaction in the groups and provides assistance and clarification as needed. The teacher reviews group skill and facilities problem solving when necessary.
- Student outcomes are evaluated. Students must individually demonstrate mastery of important skills or concepts of the learning. Evaluation is based on observation of student performance or oral responses to questions, paper and pencil need not be used and
- Groups are rewarded for success. Verbal praise by the teacher or recognition in the class newsletter or on the bulletin board can be used to reward high achieving groups.

Meta Cognitive –Cooperative Learning Approach

Learning process in learner centered approach is characterized by cooperative and collaborative learning environments. The two methods compared in this experiment are – (i) Metacognitive - Cooperative Learning Approach and (ii) Traditional Method. Piaget calls operation when children are able to engage themselves in activities. Bruner, Gandhi and Pestalozzi have also stressed learning by doing. In activity based learning teachers provide environment for activities which are relevant to the subject matter. Cooperative Learning is an answer to the defects of competitive learning.

Today teachers need an instructional technique which is of low cost and which does not demand hard work, so that they could love the subject and be more efficient in their teaching. Metacognitive knowledge of people is an important concept for the classroom. Metacognitive knowledge of tasks operates when the nature of task forces us to think about how we will manage. In the similar manner Cooperative Learning refers to an Instructional Technique in which pupils study in small groups and are rewarded some way for performance as a group. This strategy based on the psychology of cooperation and competition among pupils in the class. Here pupils are to work together for a common goal, motivating themselves by depending on others, encouraging each other's during the task of learning and by increasing positive contact among the group members. So Metacognitive-Cooperative Learning Approach will result in better classroom performance. In this context Metacognitive-Cooperative Learning Approach is very useful and can be adapted by any teacher easily. Since learning strategies can be taught, we can help our pupils to concentrate on just what they do, when they learn.

With this theoretical background a research study was conducted to study the effectiveness of Metacognitive-Cooperative Learning Approach on the Achievement in Mathematics .With the aim of drawing some educational implication to Mathematics Education in general and Mathematics learning and teaching at the Secondary School level.

TITLE OF THE STUDY: "A study on the Effect of Metacognitive-Cooperative Learning Approach on Achievement in Mathematics among the Standard Nine Pupils of Dakshina Kannada District"

OBJECTIVES

1. To study the difference if any , in the Achievement on Mathematics among the Pupils of Standard Nine taught through Matacognitive – Cooperative Learning Approach and Traditional Method.
2. To study the difference if any, in the Achievement in Mathematics in terms of Knowledge, Understanding, Application and Skill objectives among the Pupils of Standard Nine taught through Metacongnitive - Cooperative Leaning Approach and Traditional Method.
3. To compare the effect of Metacognitive – Cooperative Learning Approach and Traditional Method on the Achievement in Mathematics among the High Achievers and Low Achievers of Standard Nine .
4. To compare the effect of Metacognitive – Cooperative Learning Approach on the Achievement in Mathematics among the High Achievers and Low Achievers of Standard Nine.

HYPOTHESES

1. There is a significant difference in the Achievement in Mathematics among the Pupils of Standard Nine taught through Matacognitive – Cooperative Learning Approach and Traditional Method.
2. There is a significant difference in the Achievement in terms of Knowledge, Understanding, Application and Skill objectives among the Pupils of Standard Nine taught through Metacongnitive -Cooperative Leaning Approach and Traditional Method
3. There is a significant difference in the effect of Metacognitive – Cooperative Learning Approach and Traditional Method on Achievement in Mathematics among the High Achievers of Standard Nine
4. There is a significant difference in the effect of Metacognitive – Cooperative Learning Approach and Traditional Method on Achievement in Mathematics among the Low Achievers of Standard Nine.
5. There is a significant difference in the effect of Metacognitive – Cooperative Learning Approach on the Achievement in Mathematics among the High Achievers and Low Achievers of Standard Nine.

VARIABLES IN THE STUDY

Independent Variables of the Study

Metacognitive – Cooperative Learning Approach .Metacognitive Strategy -Self-Questioning and IDEAL through Cooperative Learning Approach.

Dependent Variables of the Study

The Achievement in Mathematics. The Achievement in Mathematics refers to the scores obtained by the Pupils in the Achievement Test prepared by the Investigator on the topics taught through Metacognitive – Cooperative Learning Approach to the Pupils of Standard Nine.

Population

In the present study, the population consisted of all the Secondary School Students of Standard Nine, studying Karnataka State Syllabus in Dakshina Kannada District during the academic year 2006-07.

Sample

The sample consisted of fifty four pupils, of Standard Nine. The medium of instruction of the sample school was Kannada. The pupils' age ranged from fourteen to sixteen.

Tools

(i) Instructional Material in Mathematics using Metacognitive Strategy-Self-Questioning and IDEAL through Cooperative Learning Approach on selected topics from Standard Nine Mathematics Text Book of Karnataka State Syllabus.

(ii) "Achievement Test in Mathematics" constructed by the investigator on the topics selected for the experiment.

PROCEDURE OF DATA COLLECTION

An experimental study was conducted to study the effect of Metacognitive-Cooperative Learning Approach on the Achievement in Mathematics among the Pupils of Standard Nine. Post test only control group design was followed in the research.

The procedure in which the present study was conducted comprised of three phases.

Phase I: Grouping of the pupils as Control Group and Experimental Group: The Investigator selected fifty four pupils at random, from Standard Nine. While selecting the Pupils, the Investigator Controlled all the extraneous factors. The procedure followed in grouping of Pupils by ranking of subjects on the matching Variable One of the groups was randomly called as Control Group and the other as Experimental Group.

Phase II: Treatment through Metacognitive - Cooperative Learning Approach: For the present study, the Investigator selected the one type of true experimental design that is, the Post-Test-Only Control Group Design. Thus, the Investigator selected the Experimental Group with twenty seven Pupils for treatment. The treatment group was exposed to Metacognitive Strategy- Self-Questioning and IDEAL through Cooperative Learning Approach Instructional Material. The Investigator taught for fifteen teaching sessions of forty five minutes duration to both Experimental and Control Groups.

Phase III: Administration of the Post Test: The day for administrating the Achievement Test in Mathematics was fixed and informed to the students. The test required hundred minutes for administration. After the administration the answer sheets were collected .The procedure followed for the Post-Test of Experimental Group was same as the procedure followed for the Post-Test of Control Group.

ANALYSIS OF DATA

The data was analysed using the descriptive statistics namely Mean, Standard Deviation, Cumulative Percentage Distribution, Bar Graph and Ogive Curves and for inferential statistics 't' value was calculated to find out the significance difference between the means of Control Group and Experimental Group Hypotheses were checked at 0.05 significance level.

MAJOR FINDINGS

(i) Metacognitive-Cooperative Learning Approach has a positive effect on the Achievement in Mathematics among the Pupils of Standard Nine.

(ii) Metacognitive-Cooperative Learning Approach has a positive effect on the Achievement in Mathematics among the Pupils of Standard Nine in terms of Knowledge, Application and Skill Objectives.

(iii) Metacognitive-Cooperative Learning Approach and Traditional Method of Teaching Mathematics are equally effective in increasing Achievement in Mathematics among the Pupils of Standard Nine in terms of Understanding Objective.

(iv) Metacognitive Cooperative Learning Approach is significantly more effective than Traditional Method on the Achievement in Mathematics with respect to High Achievers.

(v) Metacognitive Cooperative Learning Approach is significantly more effective than Traditional Method on the Achievement in Mathematics with respect to Low Achievers.

(vi) Metacognitive Cooperative Learning Approach is significantly more effective on the Achievement in Mathematics with respect to High Achievers than the Low Achievers of Standard Nine.

VIII. EDUCATIONAL IMPLICATIONS

The findings of the study revealed that Metacognitive – Cooperative Learning Approach has positive effect on the Achievement in Mathematics among the Secondary School Pupils. The findingssuggests that Metacognitive - Cooperative Learning Approach could be implemental in the classroom, for improving Achievement in Mathematics through the prescribed curriculum.

The findings also revealed that with respect to Low Achievers in Mathematics Traditional Method of Teaching Mathematics in significantly more effective than Metacognitive - Cooperative Learning Approach. Hence before introducing Metacognitive- Cooperative Learning Approach in a Mathematics Class having High Achievers and Low Achievers, Low Achievers need to be trained in Metacognitive Learning and Cooperative Learning Strategies to enhance their Achievement in Mathematics. Gradually this approach could be introduced.

Pre - service Teachers need to be trained in using Matecognitive - Cooperative Learning Approach as a part of methodology subject in Mathematics. Hence an orientation on Metacognitive –Cooperative Learning Approach should be organized for in-service teachers.The theory and practice of Metacognitive - Cooperative Learning Approach to be included in Teacher Education courses at all levels.

Workshops and seminars could be conducted to in - service Teachers. This could include theory and practical experience of Metacognitive - Cooperative Learning Approach. This would provide an exposure to undertake innovative practices in the classroom.

IX. REFERENCES

Artz, A& Armour Thomas, E.,(1992). Development of Cognitive –metacognitive framework for protocol analysis of Mathematical problem solving in small groups, cognition and Instruction,9(2),137175.

Baker L., and Brown, "Metacognitive Skills of Reading". New york:Longman, 1984, p. 353-394.

Borkowski J.G., Carr, "Self Regulated Cognition, inter dependence of Metacognition, Attributions and Self-Esteem". Hills Dale : N.J. Lawrence Erlbaum, 1990.

Brown D., "Proven Strategies for Improving Learning and Achievement", U.S. : North Caroline, 1999. (ED 430179).

Bush, Thomas A., "The Effectiveness of Cooperative Learning for Low and High Achieving Students using an Integrated Learning System", U.S: Alabama 1996, (ED 397780).

Cams, Paula M, "The effects of Learning style upon the Metacognitive Behaviour of reading awareness in Elementary children". Dissertation abstracts international, Vol. 55, No. 4, p. 862.

Gloria, Markette, "The effects of Teaching Metacognitive strategies to Remedial Reading college students". Dissertional Abstracts International, Vol.57, p.29-45.
Hardling, R. Fredrick, Fletcher, and K. Jr. Richard., "Effectiveness of Variations in Collaborative Cooperative Learning in RDS Mathematics Classes", U.S: Tennesse, 1994. (ED 382453).
Johnson, "Cooperative Learning Methods – A Meta Analysis", Minnesota : Minnepolis, 2000. P 40-50.
Lyman, Lawrence, Foyle, Harvye C., Co-operative Learning Strategies and Children, FRIC Digest.
Leikin, Roza; Zaslavsky, Orit., "Facilitating Student Interactions in Mathematics in Cooperative Learning Setting", Journal for Research in Mathematics Education, Vol. XXVIII, May, 1997. P 331-354.
Marzano et al (1988).Dimensions of thinking: A frame work for curriculum and Instruction .Alexandria, JA:Association for supervision and curriculum development.
Mulryan, C.M., "Perceptions of Intermediate Student's Cooperative Small Group Work in Mathematics", Journal of Educational Psychology, 1982, P- 7,257-271.
Newmann, F.M. and Thompson, S.J., "Effect of Cooperative Learning on Achievement in Secondary Schools: A Summary of Research, Madison: University of Wisconsin. 1987, P. 29-34.
Nicholas, Joe D, Hall, Neff., "The Effects of Cooperative Learning on Students Achievement and Motivation in A High School Geometry Class". U.S:Indiana, 1995. (ED 387341).
Nonda Vijaya Kumari S., "Cooperative Learning – A model for Learning Centred approach to Teaching"- paper presented at International Conference of all India Association for Educational Research Learning centred Education, at St. Ignatius College of Education, Tiruvanaveli.
Pratt, Sherry J.; Moesner, Cheryl., "A Comparative Study of Traditional and Cooperative Learning on Student Achievement", U.S: Indiana, 1990. (ED 325258).
Slavin, R.E. "Cooperative Learning – Theory, Research and Practice", Boston : Allyn and Bacon, 1995, P 67.
Taylor, S.(1999). Better learning through better thinking:Developing students Metacognitive abilities.Journal of College Reading and Learning,30(1),34ff.Reviewed November 9,2002,from Expanded Academic Index ASAP.

