# METACOGNITIVE AWARENESS IN SCIENCE CLASSROOM OF HIGHER SECONDARY STUDENTS

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## ABSTRACT

Metacognition is the awareness one has about his/her thinking process and how he/she is able to control these processes. This study aims at examining the effects of inquiry based learning and cooperative learning on metacognitive awareness in science class room. A quasi experimental design involving three groups namely, two treatment groups- inquiry based learning and cooperative learning and control group was adopted. Standardized tool developed by Schraw and Dennision(1994) was used to measure metacognitive awareness in three groups. Results revealed that students in cooperative learning received higher metacognitive awareness compared to other groups. The researchers recommend that cooperative learning be adopted regularly in classroom to enhance metacognitive awareness of higher secondary students.

Key Words: Metacognitive awareness, Metacognition.

## INTRODUCTION

Today, one of the main goals of education is to make the students gain the thinking skills and strategies which they will use throughout their lives, rather than storing information. A good education should be able to show the students how to learn, how to remember, how to motivate themselves and how to control their own learning, so that they can teach how to learn. For all these reasons, to investigate the process of the metacognitive skills of students is quite important. Metacognition concept was put forward for the first time in 1976 by John Flavell and developed by many researchers until today. Some descriptions related to the concepts of metacognition made by different researchers are as follows: Flavell (1976) sees metacognition as ''the cognitive processes or outcomes of individuals or the knowledge of anything about them.'' According to Brown (1980) metacognition includes the capabilities such as the estimation of one's own mental activities, planning, monitoring and evaluation. Brown(1987) divides metacognition into two broad categories: Knowledge of cognition and regulation of cognition. Knowledge of cognition refers to activities that involve conscious reflection on one cognitive abilities and activities. Regulation of cognition refers to activities regarding self-regulatory mechanisms during an ongoing attempt to learn.

Shelia(1999) stated that, the fact that metacognition has been linked to increases in the academic achievement of learners at all ability levels is another reason for its use. Ellis(1999), Lippmann(2005) and Coutinbo(2007) in their contributions noted that metacognitive activity engages the student in the learning process and seeks to improve the critical thinking, reasoning, and problem-solving skills of the learner. Coutinbo(2007) again emphasized that as learners, some of who might normally "turn out" or refuse to speak out in a traditional

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setting, become actively involved in the learning process through metacognition. Ozsoy(2008) noted that every metacognitive strategy, when used appropriately, can enable students to move beyond the text, memorization of basic facts, and learning lower level skills. This method which results in cognitive restructuring leads to an increase in understanding of students.

Apart from academic benefits, metacognitive approach has been found to promote self-esteem, and improved attitudes toward school and peers (Magno,2001). Kramarski et.al (2004) found that different metacognitive strategies can be employed to help low ability students to improve achievement, who had difficulties making success in the traditional classroom. In general, metacognitive strategies can be said to lead to the promotion of critical thinking, reasoning, and problem-solving behaviour (Sheila 1999; Lippman,2005; Coutinbo,2007).

## STATEMENT OF THE PROBLEM

It has been observed by the researcher that many students, after learning about science concepts through activities that address the various intelligences and learning styles, still choose not to participate in classroom discussions. Instead a select few students answer teacher generated questions and develop their own questions on the topic while the rest of the students remain mute. Based on the lack of response from the majority of students, many times the teacher assumes that students that do not speak up have mastered the material but the results of an assessment over that topic frequently indicate something different.

Students can gain the metacognitive skills by a science lesson based on the constructivist approach. In recent years, "constructivist learning" theory which has an important place in the field of science education, aims to educate students who play an active role of engaging in research for deep knowledge, and use the information they have learnt rather than the students, who play a passive recipient role in information. There are approaches such as cooperative learning and inquiry based learning which can develop metacognitive skills among students.

The cooperative learning and inquiry based learning would be easy to put into metacognitive practice in the science classroom even with the pressure of syllabi and the demand for marks from the parents. In this article, an attempt is made to compare the influence of the cooperative learning and inquiry based learning in science classroom of higher secondary students.

## DESIGN OF THE STUDY

The research was carried out using a quasi-experimental design with pre- and post tests with two experimental groups and one control group. Higher secondary students from Municipal Girls Higher Secondary School, Tirunelveli town, Tamilnadu, India were taken as the sample of the study. The sample was divided into three groups consisting of 35 students. Each group is almost having equal number of low ability students and high ability students. Those students who have scored below 35 out of 100 in science in school record are treated as low ability students. Remaining students are treated as high ability students. The three groups were first administered metacognitive awareness test (MAT) and the results have been compared in order to study the equivalence of the groups.

Table 1: Comparison between control and experimental groups in MAT pre-test

| Group | N | Mean | S.D | 't' value | Remarks at 0.01 level |
|---|---|---|---|---|---|
| Control group | 35 | 22.9 | 7.1 | | |
| Experimental group1 (Inquiry based learning) | 35 | 24.2 | 6.9 | 0.77 | Not significant |
| Control group | 35 | 22.9 | 7.1 | | |
| Experimental group2 ( Cooperative learning) | 35 | 23.7 | 7.3 | 0.46 | Not significant |

From Table 1 there is no significant difference between metacognitive awareness pre-test mean scores achieved by experimental groups with control group. The researchers assigned three experienced teachers to teach the experimental and control groups and trained them on the basic skills of metacognitive strategy before the commencement of treatment. The three teachers selected to teach the subjects had taught science for the past ten years and both of them were graduates of science. The three teachers had similar experiences on teaching skills based on their training as teachers. The teachers were randomly assigned to the experimental and control classes. All the classes were taught by their respective teachers at the early hours of the day.

## INSTRUMENT

The standardized tool for metacognitive awareness developed by Schraw and Dennison(1994) was used in the present study. It consists of 52 items. It is used as a metacognitive awareness tool by many researchers in metacognition research.(Lin,2002; Lippmann,2005) The items helps to identify the presence of metacognitive behaviour among students. Items were reviewed for face validity. Wording and grammatical structures were changed according to the local Indian context and the target groups' level.

## TREATMENT PROCEDURE

The researcher had gone through the 12th standard text book of National Council for Educational Research and Training of Indian Government. The chapter human anatomy was selected for the study. The topics were: Integumentary system, Skeletal system, Muscular system, Digestive system, Circulatory system, Lymphatic system and Nervous system. The study consisted of three different treatments: a control group, Inquiry based metacognitive instructions group and cooperative learning based metacognitive instructions group. The study lasted for 20 days.

The control group was taught in the existing normal process of teaching followed and answering cognitive questions that were related to the material being taught. Students were asked to share the information with the entire class if they so desired. The teaching of students in this group was centered on the use of the textbook. Instead of discussing the material, helping each other, students read the assigned reading material silently, completed assignments independently at their seats.

The experimental group1 i.e. inquiry based metacognitive instructions group followed the procedure used by the control group with one modification. The investigator formulated pivotal questions in advance. After the lesson taught, the teacher conducted inquiry based learning by posing carefully drafted questions. Metacognitive questions were framed in terms of student responses. The students were asked to respond to these questions, which helped them to develop higher level of thinking. For example, teacher provides metacognitive instructional practice such as *what information is important to remember? What do you need to do if you don't understand? Are you on the right way? How should you proceed?* When they are monitoring lesson they are guided to ask themselves the metacognitive questions. How am I doing? What information is

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important to remember? What do I need to do if I don't understand? How well did I do? Did my particular course of thinking produce more or less than I had expected? What could I have done differently? Do I need to go back through the topic to fill in any "blanks" in my understanding? Students engaged in discussions with the teacher in response to the teacher's questions. But pivotal questions planned in advance gave direction and thrust to the lesson and helped to accomplish the goal. Hartman(2001) states that teaching with metacognitive strategies means that teacher will think about how their questions will activate and develop students' metacognition.

The experiment group2 i.e. cooperative learning based metacognitive instructions group followed the procedure used by the control group with one modification. After the lesson taught, individual students in the group read the textbook. Each student was paired off with a classmate to discuss the topic with the help of metacognitive instructions. In the cooperative learning strategy students have the opportunity to discuss their answers with fellow students. The students could jot –down their answers to a question, turn to their neighbour and talk about their answers and sharing the same with the entire class. It forces student to discuss their thinking, analyze their position, and explain their point of view to their classmates. By their sharing information with the entire class, students would be able to evaluate themselves while gathering information from other classmates. The teacher would also have the opportunity to evaluate the students' understanding based on the content of the discussions. Some of the questions that are posed during the discussion can be meaningful and multifaceted.

The cooperative learning group incorporated the following metacognitive strategies recommended by Blakey and Spence (1990):
1. Define what you know and what you do not know:
Students determine their levels by asking themselves 'What is my relevant information about the subject?' What do I know? What do I want to learn? What do I not know?

2. Talk about what you are thinking:
This includes the loud thinking in the process of making plan or problem solving. This study can be performed in peer groups or in small groups, that one student assumes the role of a teacher. These students talk and ask questions by telling and making explanations and abstraction.

3. Keeping a diary of thinking:
Students can write difficulties and their interpretations about problems in that notebook. They also note the process and methods used to solve the problem. Thus, students have the idea about experience and methods of thinking.

4. Planning and self-control:
It is students' plan to control the process that is relevant to the subject that is going to be learnt. However, students must have earned some characteristics in advance such as adjusting time, identifying and using materials.

5. Thinking process briefing:
This strategy covers, develops and uses the metacognitive and thinking skills that the students acquired. It involves a three-step method. Primarily, the teacher needs to guide the students about how they gained information by thinking in class and how they took part in activities. In the next stage, students need to group ideas and define which thinking strategies they used, and in the final stage, students should evaluate their own achievements and make assessments about their election in relation to future strategies.
6. Self-assessment:

It is the determination of the metacognitive skills of the students by the pre-prepared individual checklist in the form of assessment. Metacognitive strategies are the sequential processes used to provide control in learning and in reaching one's goal. They help individuals significantly to make regulations and take control of their learning. For example, after reading a text, a student can query himself about the concepts discussed in the paragraph. This self evaluation is a monitoring metacognitive strategy and at this stage, the cognitive purpose of students is to understand texts. If a student fails to answer his own question, he must determine what he needs to perform his cognitive purpose which is to understand the text.

## RESULTS

Statistical calculations such as paired 't' test was used to analyse the data.

Table 2: Comparison of MAT score using paired 't' test

| Group | N | Mean | | SD | | Paird test 't' value | Remarks at 0.01 level. |
|---|---|---|---|---|---|---|---|
| | | Pre test | Post test | Pre test | Post test | | |
| Control group | 35 | 22.9 | 24.3 | 7.1 | 5.4 | 2.2 | NS |
| Experiment group1 (Inquiry based learning) | 35 | 24.2 | 31.2 | 6.9 | 4.2 | 5.6 | S |
| Experiment group2 ( Cooperative learning) | 35 | 23.7 | 36.7 | 7.3 | 3.8 | 7.2 | S |

NS- Not significant     S- Significant.

The observed 't' value for the control group was $t(34)=2.2 (p>0.01)$. Hence there is no significant improvement in metacognitive awareness in control group. In the experiment group1 the t value was $t(34)=5.6 (p<0.01)$. It shows that there is significant improvement in metacognitive awareness in inquiry based learning. In the experiment group2 the t value was $t(34)=7.2 (p<0.01)$. It indicates there is significant improvement in metacognitive awareness in cooperative learning.

The results revealed that the cooperative learning group received higher metacognitive awareness and they could also answer higher level of cognitive questions compared to inquiry group and control group.

Table 3: Comparison of MAT scores of low ability students using paired't' test

| Group | N | Mean | | SD | | Paird test 't' value | Remarks at 0.01 level. |
|---|---|---|---|---|---|---|---|
| | | Pre test | Post test | Pre test | Post test | | |
| Control group | 35 | 15.4 | 22.4 | 4.2 | 3.6 | 1.9 | NS |
| Experiment group1 (Inquiry based learning) | 35 | 16.1 | 23.7 | 4.4 | 3.1 | 2.1 | NS |
| Experiment group2 ( Cooperative learning) | 35 | 15.9 | 31.7 | 4.1 | 2.8 | 7.9 | S |

NS- Not significant     S- Significant.

The observed 't' value for the control group was $t(34)=1.9 (p>0.01)$. Hence there is no significant improvement in metacognitive awareness of low ability students in the conventional lecture method. In the experiment group1 the 't' value was $t(34)=2.1 (p>0.01)$. It shows that there is no significant improvement in metacognitive awareness of low ability students in inquiry based learning. In the experiment group2 the t value was

$t(34)=7.9 (p<0.01)$. It indicates there is significant improvement in metacognitive awareness of low ability students cooperative learning.

The results revealed that the low ability students in cooperative learning group received higher metacognitive awareness and they could also answer higher level of cognitive questions compared to inquiry group and control group.

## DISCUSSION

The findings of this study have demonstrated the effectiveness of method to promote metacognitive awareness in the teaching and learning of science at the higher secondary school level of education. This study is also significant in that it demonstrated the effects of inquiry and cooperative learning on students' metacognitive awareness in one single study.

One major finding of this study is that students taught using the cooperative learning approach scored higher marks in metacognitive awareness than those taught using the inquiry based method. This may have been achieved by the high level of students' participation in learning activities. All the students in the cooperative learning performed specific roles in solving problems which are presented in the classroom to the benefit of all members of the group. When learners are confronted with problems which they must solve, they are forced to reason and think critically in order to solve the problems. It is believed that when properly and carefully used metacognitive activities engage the students in the learning process and seek to improve the critical thinking, reasoning and problem solving skill of learners (Taylor,1999; Coutinbo,2007; Magno,2010).

In the control group , when the teacher explains a concept to the whole class only the high achievers are able to follow the class while the low achievers may simply be listening without grasping the facts. They are not benefited by the conventional lecture given to the whole class.

## CONCLUSION

As described in this study, cooperative learning makes sense for students' metacognitive awareness, is a very viable option among other instructional methods for teaching science in higher secondary schools. The major purpose of student-student interaction during cooperative learning is to promote metacognitive awareness. The interaction among students in cooperative learning groups is intense and prolonged. Teachers must improve their students' metacognitive awareness in order to improve their learning abilities. "The more students know about effective learning strategies, the greater their metacognitive awareness and the higher their classroom achievement is likely to be"(Mango 2010).

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