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METACOGNITIVE INSTRUCTION AND COOPERATIVE LEARNING- STRATEGIES FOR PROMOTING INSIGHTFUL LEARNING IN SCIENCE

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ABSTRACT

Teachers constantly face the challenges of finding and applying the most effective methods of instruction that could enhance academic achievement and match the diversity among students. This study aimed at examining the effects of metacognitive and cooperative learning strategies on achievement in science classrooms. A quasi-experimental design involving 3 groups namely, two treatment groups-- cooperative learning(CL) group a metacognitive instructions(MI) group and a control group, was adopted. The study lasted for 11 weeks. A researcher-made achievement test in the topic 'Human Anatomy' was used to measure achievement in the 3 groups. Results revealed that the metacognitive instructions were most effective in enhancing academic achievement. Multiple regression analysis shows that there is significant relationship between metacognitive awareness and achievement. The researcher recommends that metacognitive instruction be adopted regularly in the classroom so as to help students learn material more efficiently and enhance academic achievement.

Key Words: Metacognition, Metacognitive strategies.

INTRODUCTION

In an ideal science classroom, students would be required to reflect on concrete examples and relate these with abstract theories. 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 while the rest of the students remain mute. Thus there is no peer level interactions on the content of the lessons learnt. As a rule the teacher assumes that students who do not speak up have mastered the material but the results of an assessment subsequently indicate something different. Teachers encouraging students' reflective and autonomous thinking and opportunity for discussion may offer a solution.

Metacognition and Cooperative learning

Metacognition refers to one's knowledge concerning one's own cognitive processes or anything related to them (Flavell, 1976). Quite simply, metacognition is thinking about thinking. Brown(1987) devides 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. Any process in which students examine the method that they are using to retrieve, develop or expand information is deemed to be metacognitive in nature.(Everson et.al.(1998)). Metacognitively aware learners "know what to do when they don't know what to do" (Countinbo(2007)). In other words, they have strategies for discovering or working out what needs to be done. Metacognitive strategies are designed to monitor cognitive process. Metacognitive strategies are ordered processes used to control one's own cognitive activities and to ensure that a cognitive goal has been met. A student with good metacognitive awareness oversee his own learning process, plan and monitor ongoing cognitive activities.The use of metacognitive strategies ignites one's thinking and can lead to better learning and higher performance, especially among learners who strive . Developing metacognitive instructions or questions about the topic at hand would be more challenging for the teacher. The teacher would have to change his/her mind-set and pose questions that truly require the teacher to analyze the existing links to other common experiences and material, determine which processes the student may possibly use, and formulate questions accordingly. Some of the questions that are posed during the discussion can be meaningful and multifaceted. Hartman(2001) states that teaching with metacognitive strategies means that teacher will think about how their instruction will activate and develop students' metacognition.

Bilgin, I.et.al.(2006), and Chang, C-Y., & Mao, S-L. (1999) in their contributions noted that cooperative learning activity engages the student in the learning process and seeks to improve the critical thinking, reasoning, and problem-solving skills of the learner. Stevens, R., & Slavin, R. (1995) stated that peer interaction is central to the success of cooperative learning as it relates to cognitive understanding. They further noted that comprehension is facilitated. They emphasized that as learners, some of who might normally "turn out" or refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. Chang.et.al(1999) noted that every cooperative-learning 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 all students in a cooperative group. Apart from academic benefits, cooperative learning has been found to promote self-esteem, interpersonal relationship and improved attitudes toward school and peers (Bilgin,I.et.al.(2006).

In the cooperative learning strategy students have the opportunity to discuss their answers with a 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.

The use of either the cooperative learning or metacognitive instructions would be easy to put into practice in the science classroom even with the pressure of syllabi and deadlines and the demand for marks from the parents. In this article an attempt is made to compare the influence of the cooperative learning and metacognitive instructions on achievement of science students.

Design

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. The three groups were first administered a science achievement test (SAT) and a metacognitive awareness test (MAT) and the results have been compared in order to study the equivalence of the groups.

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

Test	Group	N	M	S.D	't' value	Remarks at 0.01 level
SAT	Control group	35	32.5	7.8	0.83	Not significant
	Cooperative learning group	35	30.9	8.2		
	Control group	35	32.5	7.8	0.68	Not significant
	Metacognitive instruction group	35	31.2	8.1		

As seen in table1 there is no significant difference between achievement pre-test mean scores achieved by experimental groups with control group.

Table 2: Comparison between control and experimental groups in MAT pre-test

Test	Group	N	M	S.D	't' value	Remarks at 0.01 level
MAT	Control group	35	22.9	7.1	0.77	Not significant
	Cooperative learning group	35	24.2	6.9		
	Control group	35	22.9	7.1	0.46	Not significant
	Metacognitive instruction group	35	23.7	7.3		

From table2 there is no significant difference between metacognitive awareness pre-test mean scores achieved by experimental groups with control group.

Instruments

The science achievement test(SAT) has been developed by the researcher. 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 test consists of 75 questions and all the questions are multiple choice questions. The quality of each questions was ascertained by difficulty index and discriminating power. Questions were selected based on blue-print followed in schools covering knowledge, understanding, application and skill type questions. The test was administered to the sample. A score of '1' was assigned for each correct answer. 'Zero' score was assigned for each wrong answer. The split-half reliability of the test was 0.82. This shows that the test has reliability. The ensure content validity the different subunits of the content were carefully examined and questions were included with a help of teachers handling this topic in schools.

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.(Lippmann(2005),Yunus et.al.(2008)) 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.

Procedure

The three 45 minute classes were taught by the same teacher. The study consisted of three different treatments: a control group, cooperative learning group(CL), and a metacognitive instructions group(MI).

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.

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The CL group followed the procedure used by the control group with one modification. After the lesson taught, individual students in the CL group read the textbook. Each CL student was paired off with a classmate to discuss the topic one-on-one before sharing the information about the topic with the entire class and answering the text book questions.

The MI group followed the procedure used by the control group with one modification. After the lesson taught the MI group read the text book using the following metacognitive strategy instructions.

Using strengths: While reading, I exploit my personal strengths in order to better understand the text. If I am a good reader, I focus on the text; if I am good at figures and diagrams, I focus on that information.

Inferring meaning (through word analysis): While I am reading, I try to determine the meaning of unknown words that seem critical to the meaning of the text.

Using background information: While I am reading, I reconsider and revise my background knowledge about the topic, based on the text's content.

Evaluating: As I am reading, I evaluate the text to determine whether it contributes to my knowledge/understanding of the subject.

Searching according to the goals: I search out information relevant to my reading goals.

Reading goals**:** I evaluate whether what I am reading is relevant to my reading goals.
Distinguishing**:** As I am reading, I distinguish between information that I already know and new information.
Deciding on the difficulty: I note how hard or easy a text is to read.
Revising**:** While I am reading, I reconsider and revise my prior questions about the topic, based on the text's content.
Guessing the later topics**:** I anticipate information that will be presented later in the text.

Here 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 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?

The strategy forces student to use metacognition to examine their thinking, analyse their position and explain their point of view. The metacognitive questions ask students to examine how they arrive at an answer versus the cognitive questions, which are based on content.

The three treatment groups were taught the same science lessons on a daily basis. Only class discussions, which were generated by students of the individual classes, varied from class to class. The procedure continued like this for 11 weeks. Post-test was given to all groups.

RESULTS

Statistical calculations such as paired 't' test and multiple regression analysis were used to analyse the data.

Table 3: Comparison of experimental groups and control groups in SAT using paired 't' test.

	Group	N	Mean		SD		Paired test 't' value	Remarks at 0.01 level.
			Pre test	Post test	Pre test	Post test		
SAT	Control group	35	32.5	34.2	7.8	4.6	1.6	NS
	Cooperative learning group	35	30.9	41.7	8.1	4.3	13.7	S
	Metacognitive instruction group	35	31.2	55.4	8.2	4.4	24.8	S

NS- Not significant S- Significant.

It is inferred from the table3 that in the control group the observed 't' value was t(34)=1.6(p>0.01). Hence there is no significant improvement in achievement mean score from pre-test to post-test. In the cooperative learning group the calculated 't' value was t(34)=13.7(p<0.01). In accordance with the results, it has been seen that there is significant improvement in achievement mean score from pretest to post test. In the metacognitive instruction group the pre-test and post-test mean scores are 31.2 and 55.4 respectively. It indicates that metacognitive approach had more positive effect on the achievement than the cooperative learning. The t value t(34)= 24.8(p<0.01) shows that there is significant improvement in achievement mean score from pretest to post test.

Table 4: Comparison of experimental groups and control groups in MAT 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		
MAT	Control group	35	22.9	24.3	7.1	5.4	2.2	NS
	Cooperative learning group	35	24.2	27.1	6.9	4.2	2.4	NS
	Metacognitive instruction group	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 the cooperative learning group the t value was t(34)=2.4(p>0.01). It shows that there is no significant improvement in metacognitive awareness. In the metacognitive instruction group the t value was t(34)=7.2(p<0.01). It indicates there is significant improvement in metacognitive awareness.

The results revealed that the experimental group received metacognitive instructions reported higher metacognitive knowledge and achievement and they could also answer higher level of cognitive questions compared to cooperative learning group and control group. These findings corroborate with those of Coutinbo (2007) and Lippmann (2005), where they found positive results for student achievement and increased participation in learning.

Multiple regression analysis was done to find out the relationship between the achievement in science of the metacognitive instructions group with intervening variable metacognitive awareness.

Table 5: Results of multiple regression analysis

	β	T	R	R square	Adjusted R square
Metacognitive awareness	0.4	6.79	0.80	0.64	0.631

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In the table5, the correlation between metacognitive awareness and achievement(R value) is 0.80. The adjusted R sqare value is 0.631. It indicates metacognitive awareness shows 63.1% variability in achievement. The beta value is 0.4 when metacognitive awareness adds up bu one unit, the level of achievement increases by 0.4 units. The obtained t value is 6.79, which is significant at 0.01 level. Hence there is significant relationship between achievement and metacognitive awareness.

Delimitation of the study

This investigation is restricted to Municipal girls higher secondary school, Tirunelveli, India. The investigation is confined to higher secondary students. The topic Human Anatomy alone is covered for the experimental purpose. The study conducted for 11 weeks.

Educational implications of the study

The findings of the present study have an implications for the improvement of present system of school education on both theoretical and practical context.

- The classroom teacher has a critical role in the turning of actual classroom situations into a metacognitive way. Teachers should have an awareness of the know-how of metacognitive skills, how it can be instilled and developed among pupils and how the stage can be prepared for teaching-learning process. Therefore in-service training should be given for providing effective training in developing metacognitive skills for teacher-students during pre-service training.
- Teachers' handbook with emphasis on the metacognitive skills should be prepared and made available sufficiently earlier to the teachers, at the beginning of the academic year in order to frame a metacognitive strategy. Model metacognitive strategy packages may be designed and developed by expert teams and made available to the teachers for their classroom.
- Teachers should give many opportunities to practice metacognitive activities. As students practice the activities, provide guidance and support to the students. Give them feedback until they can use the activities independently. As part of your feedback, inform them about where and when the metacognitive activities are most useful.
- Teachers should remember that it takes students a considerable amount of time to learn how to use an effective strategy. Be patient and give students continued support during this learning experience. Keep encouraging students to use the metacognitive activities over and over again until can use it automatically.
- Teachers should encourage students to monitor the effectiveness of their new strategies in comparison to the effectiveness of old strategies. These help students to see the utility of using the new strategy.

Recommendation for policy makers

The results of the present study can significantly influence the field of higher secondary education.

- From the findings of the study, the higher secondary students learn better by the use of metacognitive strategies. Hence there is a need to change the teaching methods and strategies adopted in higher secondary level.
- Conventional methods of teaching science are not compatible with attaining conceptual learning and higher-order cognitive skills. A major purpose of science education should be to develop instructional practices for developing scientific reasoning skills, critical thinking and decision-making capacity. Since metacognition is an inherent component in developing cognitive skills, students and teachers must be taught how to develop metacognition. State level academic bodies should develop metacognitive skill enrichment activities.
- Textbooks are dominated by declarative knowledge (facts, definitions and descriptions) whereas procedural (knowing how, knowing why) and situational knowledge should be provided for deep study processes. Text book should be designed by raising meaningful and interesting questions and emphasizing applications and problem solving. Metacognitive strategies should be incorporated in text-book.

- Encouraging an understanding of problems, rather than giving numerical procedures which may be memorized and used without understanding. Qualitative discussions could be carried out while problems are solved on the chalkboard and also by getting students to work together while solving problems with students being asked to derive general procedures rather than mathematical solutions.
- The existing curricula will not be able to cope with the proposed metacognitive strategies. So the curricula must be modified accordingly. To attain achievement objectives more number of research on metacognitive strategies should be conducted and the strategies should be incorporated in the curriculum.

CONCLUSION

Metacognition is a strong predictor of academic success and problem solving ability (Theide et al., 2003). Students who are able to effectively discriminate between information they have learned and information they have not learned are more likely to review and learn new information (Everson & Tobias, 1998). If students believe they know everything for the test, they will probably end their studying. The will for changing and the desire for innovation in teachers come from the necessity of 'motivating' students, who seem to have lost their interest in science. The metacognitive strategies , which can motivate students and give them the opportunity to learn, understand and recognize the information received in class and in their everyday life(Kramarski.et.al.(2004)). This will make the students to be more and more independent in facing new situations. Teachers should allow the students to seek understanding by exploring and investigating on their own with teachers as facilitators.

From this study we can infer that metacognitive instructions can increase their metacognitive awareness and develop in them a positive attitude towards learning. Besides, this students' academic achievement can be increased if teaching strategies are planned in a metacognitive way. Students must be taught how to develop and be aware of the strategies. 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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