The Effect of Metacognitive Instructional Strategy on Mathematics Achievement and Retention among Secondary School Students in Ekiti State, Nigeria

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ABSTRACT

The purpose of this study is to investigate the effect of using metacognitive instructional strategy on Mathematical achievement and retention. The experimental group are trained and instructed to improve their metacognitive skills while the students in the control group received no treatment but taught by the traditional method in their normal lessons. The study adopts a quasi-experimental design with a target population of all secondary school students in Ikere local government area of Ekiti state, Nigeria. The sample consists of four secondary schools that are in grade A. Intact classes are used in order to avoid disruption of school activities. The experimental group which consists of 158 students (75 males and 83 females) were trained and instructed to improve their metacognitive skills. The students in the control group (142 students of which 68 are male and 74 are female). All students involved in the study were pre, post and retentively tested with forty items of the Secondary Mathematics Achievement test (SMAT). The results indicate that students in the metacognitive treatment group significantly improved in both post and retentive tests. It is recommended among others that mathematics teachers should encourage their students on the use of metacognitive instructional strategy in order to improve their performance in Mathematics.

Keywords: *Metacognition, metacognitive instructional strategy, retentive ability and Mathematics achievement.*

INTRODUCTION

Mathematics is one of the core subjects in Nigeria secondary schools. The subject has an important role to play in meeting our societal needs and requirements. It can be taken as a means for developing students' creativity as the deductive structure of Mathematics is flexible enough to provide for different ways of organizing the content, that is, from the whole to the part or from the part to the whole. Despite all efforts to improve students' performance in Mathematics, it has been observed that the educational system is to a great extent not achieving its' predetermine goals and objectives both in public and private secondary school examinations. Therefore, the strategies for learning should be overhaul to enable students improve on their performance. The study through the use of checklist which has direct link with the concepts to be learnt focused on encouraging students to

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organize information in a way that is compatible with their understanding of the lesson in order to help them learn Mathematics better. Mathematics plays a central role in all facets of modern human endeavors .The importance of Mathematics in the modern society is overwhelming and must be emphasized. Any serious and virile nation, according to Ilori (2003) encourages its citizens to learn and use mathematics and thereby cultivate the mathematics culture, whose inherent ingredient include the ability to think logically, to be objective and to be able to classify things. However, despite the important contribution of mathematics to nation building as stated above, mathematics is still been dread by secondary school students. Some students consider mathematicians to be special people. They believe mathematics is highly structured and abstract and abstract in nature, that its study requires some intellectual talents. Obodo (1991) thereafter observes that mathematics is not as bad or difficult as it is labeled by some students, but that students sometimes prefer doing other difficult things than attending Mathematics class because of their hatred for the subject which invariably leads to student's low performance in the subject.

It has been observed by some scholars as Akinsola (2002) and Okurumeh (2003) that students' achievement in Mathematics is low because mathematics students are not acquiring the skills and understanding they needed to participate effectively in the culture, economic, political and scientific environment later in future. Also Kolawole and Popoola (2009) and Adaramola (2012) at different times highlighted some contributing factors to students under-achievement in mathematics to include among others; large class sizes, anxiety, lack of preparation among candidates, poor understanding of mathematical language by both teachers and students, overloaded mathematics content, stereotype teaching method, inadequate number of qualified mathematics teachers, poor Mathematics background and poor mathematics classroom environment. Some researchers such as Popoola (2008), Olawumi (2015) and Olagunju (2001) are of the opinion that students centered strategies which involve a lot of activities where the learner can construct and engage on their own knowledge and understanding rather than teacher's center will enhance learning and favorable achievement. Further studies such as Cullen (2013), Popoola (2009) and Adetula (2005) show that teaching methods and strategies employed by teachers during lessons are mainly the traditional and passive one that cannot make a positive impact on the teaching of Mathematics by the learners. Mathematics which appears to be the base of all science subjects demands systematic and interesting methods that will gear up the learners. It therefore, implies that the old teacher center method may not be able to meet the need of the twenty first century teaching and learning process.

Thinking in general and creativity to be precise as a pattern of thinking are necessary for this current age because of the variant problems we encounter daily. In today's educational system, the internet had shifted from teachers centered learning process and focus on students. Students should be trained in a way that enable them to know what to do, to think, to establish new connections, to be aware of their own learning process and come up with solutions to any problem when necessary. One of the strongest contributions to such learning in mathematical problem solving activity will be the integration of metacognitive instructional strategy into the educational process. Hence, this study addresses the effect of metacognitive instructional strategy on mathematics achievement and retention among secondary school students in Ekiti State, Nigeria. The following research hypotheses were formulated to guide the study.

$H_0$1: There is no significant difference between the pre-test achievements mean scores of students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method.

$H_0$2: There is no significant difference between the post-test achievements mean scores of students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method.

$H_0$3; There is no significant difference between the post-test achievements mean scores of male and female students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method.

$H_0$4: There is no significant difference between the retentive-test achievements mean scores of students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method.

Metacognitive Instructional Strategies

These strategies refer to the conscious monitoring of one's cognitive strategies to achieve specific goals, for example when learners ask themselves questions about the work and then observe how well they answer these questions (Flavell, 1981). Olawumi (2015) views metacognitive strategies as the decisions learners make before, during and after the process of learning. High metacognitive ability positively influenced students' problem-solving performance. The high-metacognitive students' advantage in problem-solving performance was linked to increased hypothetic-deductive reasoning and prioritization of strategies. The high-metacognitive students demonstrated efficient and effective information processing by correctly monitoring right and wrong answers.

Pintrich (2002) argues that novices need to have a repertoire of different general strategies for learning and thinking to master new or challenging tasks. Metacognitive instruction would enable students to perform better and learn more in the classroom. This instruction needs to be taught explicitly by embedding it within content-driven lessons in different subject areas. Explicit metacognitive instruction helps students connect the strategies to other knowledge they may already have. According to Ozsoy and Ataman (2009), metacognitive training through self –questioning induces students to self-regulate their learning. The metacognitive questioning encourages students to activate prior knowledge, analyze information, reconceptualize the problem space by integrating information into a coherent representation and self-monitor their progress by evaluating and correcting their mistakes. The various metacognitive strategies which aimed at developing learners' metacognition (Costa, 1984; Blakey and Spence, 1990) are stated as follows:

Planning strategy: At the start of a learning activity, teachers should make learners aware of strategies, rules and steps in problem solving. Time restrictions, goals and ground rules connected to the learning activity should be made explicit and internalized by the learners. Consequently, learners will keep them in mind during the learning activity and assess their performance against them. During the learning activity, teachers can encourage learners to share their progress, their cognitive procedures and their views of their conduct. As a result, learners will become more aware of their own behaviour and teachers will be able to identify problem areas in the learners' thinking (Costa, 1984). When learning is planned by someone else, it is difficult for learners to become self-directed (Blakey and Spence, 1990).

Generating questions: Blakey and Spence (1990) state that learners should ask themselves what they know and what they do not know at the beginning of a research activity. As the research activity progresses, their initial statements about their knowledge of the research activity will be verified, clarified and expanded. Ratner (1991) views the questioning of a given information and assumptions as a vital aspect of intelligence: Learners should pose questions for themselves before and during the reading of learning material and pause regularly to determine whether they understand the concept; if they can link it with prior knowledge; if other examples can be given; and if they can relate the main concept to other concepts. Here, Muijs and Reynolds (2005) argue that the connection of prior knowledge and new concepts should take place during the lesson and not only when a new concept is introduced. This integration of prior knowledge and new concepts, according to Ornstein and Hunkins (1998) enables the learner to understand the unified and interconnected nature of knowledge, while also facilitating profound understanding of subject matter (Blank, 2005).

Choosing consciously; Teachers should guide learners to explore the results of their choices before and during the decision process. Therefore, learners will be able to recognize underlying relationships between their decisions, their actions and the results of their decisions. Non-judgmental feedback to learners about the consequences of their actions and choices which promotes self-awareness (Costa, 1984), and it enables the learners to learn from their mistakes.

Setting and pursuing goals: Artzt and Armour-Thomas (1998) define goals as "expectations about the intellectual, social and emotional outcomes for students as a consequence of their classroom experiences". Learners who are self- regulating strive to attain a self-formulated goal while self-regulated behaviour can be adapted with changing circumstances (Diaz, Neal and Amaya, 1990).

Evaluating the way of thinking and acting: Metacognition can be enhanced if teachers guide learners to evaluate the learning activity according to at least two sets of criteria (Costa, 1984). Initially, evaluative criteria could be jointly developed with the learners to support them in assessing their own thinking. As an example, learners could be asked to assess the learning activity by stating helpful and hindering aspects and their likes and dislikes of the learning activity. Accordingly, learners keep the criteria in mind when classifying their opinions about the learning activity and they motivate the reasons for those opinions (Costa, 1984). Guided self-evaluation can be introduced by checklists focusing on thinking processes and self-evaluation will increasingly be applied more independently (Blakey and Spence, 1990).

Identifying the difficulty: Costa (1984) advises teachers to discourage the use of phrases like "I can't"; "I am too slow to…" or "I don't know how to…" Rather, learners should identify the resources, skills and information required to attain the learning outcome. As a result, learners are assisted to distinguish between their current knowledge and the knowledge they need. They also have more conviction in seeking the right strategy for solving the problem.

Paraphrasing, elaborating and reflecting learners' ideas: Teachers should support learners to restate, translate, compare and paraphrase other learners' ideas. Consequently, learners will be better listeners to other learners' thinking and also to their own thinking (Costa, 1984). The teacher can, for example, respond: "What you are explaining to us is…"; "I understand that you are suggesting the following…" Carpenter and Lehrer (1999) assert that the ability to articulate one's ideas requires profound understanding of significant aspects and concepts. They view the ability to reflect as a prerequisite for articulation and that articulation requires the identification of the essence and critical elements of an activity.

Clarifying learners' terminology: Learners regularly use vague terminology when making value judgments, for example "The question is not fair" or "The question is too difficult". Teachers should elucidate these value judgments, for example "Why is the question not fair?" or "Why is the question too difficult?" (Costa, 1984).

Problem-solving activities: In problem solving, existing knowledge is applied to an unfamiliar situation to gain new knowledge (Killen, 2000). Problem solving activities are ideal opportunities to enhance metacognitive strategies, as good problem solvers are generally self-aware thinkers. Learners with superior metacognitive abilities are better problem solvers. The ability to analyze their problem solving strategies and reflect on their thinking reveals the learners' metacognitive skills (Blakey and Spence, 1990; Panaoura, Philippou and Christou, 2003).

After the problem-solving process, teachers should encourage learners to clarify their course of action, instead of merely correcting the learner (Costa, 1984). Killen (2000) states that non-cognitive aspects, like learners debilitating beliefs about the nature of mathematics and about themselves, could have a positive or negative effect on cognitive and metacognitive processes involved in problem solving. When the whole class works on a problem, the teacher, instead of steering the learners to the answer, helps the learners to take full advantage of those aspects that they have produced. During this process of guiding the learners, the teacher will ask questions like: "Are you all convinced that you understand the Problem?" and "Which of the suggestions to solve the problem should we attempt first, and why?" After the class has worked on the problem for about five minutes, the teacher could ask them whether the process is going well, and if not, to re assess the strategy. If the class decides to reject that strategy, the teacher could ask whether anything helpful could be recovered from their effort. When a solution is reached, the teacher reviews the whole problem-solving process and indicates where the class went wrong initially. Teachers also lead the class in finding alternative solutions to the problem. In this regard, Muijs and Reynolds (2005) list reflection as one of the elements of constructivist teaching strategies. They describe reflection, a key learning moment, as the comparing of solutions between learners. They also regard reflection as the process learners engage in when they think about problem-solving strategies and their effectiveness.

Schoenfeld (1987) considers whole class problem solving as promoting self-regulation, because the teacher's role as a moderator compels learners to focus on control decisions made by themselves, and not by the teacher. Another aspect of whole class problem solving that Schoenfeld discusses is the opportunity it affords to pose problems that evoke beliefs about mathematics. An example is mentioned of the belief that problems can be solved relatively quickly if the subject matter is well understood. To challenge this belief, a problem is assigned that would probably take the class a few days, or even weeks, to solve. His aim with small group problem solving is to provide learners with a range of problem-solving strategies (heuristics), and then to train them to use those strategies effectively. When learners are only taught about heuristics and then have to work on problems at home, the teacher is not present in the midst of problem solving when his/her input could have promoted the use of self-regulation skills, for example, the teacher informs the learners that they are going to be asked the following three questions whenever they work on a problem: "What exactly are you doing?"; "Why are you doing it?"; and "How does it help you?". Gradually, it becomes a matter of practice for the learners to start asking the questions themselves, thereby improving their problem-solving skills and operation on a metacognitive level.

Thinking aloud: Teachers should promote the habit of thinking aloud when learners solve problems (Costa, 1984). Talking about their thinking will help learners to identify their thinking skills (Blake and Spence, 1990) Muijs and Reynolds (2005) use the term "articulation" to describe learners' expression of their own thoughts and ideas. They recommend that learners should discuss complex tasks and present their ideas to fellow learners. They furthermore suggest that group work could be very effective in promoting articulation. In this regard, Blakey and Spence (1990) mention paired problem solving, where one learner describes his/her thinking processes while his/her partner helps him/her to clarify his thinking by listening and asking questions. A main aspect of Vygotsky's developmental theory is that children start using language not only to communicate, but also to regulate their activities by guiding, planning and monitoring (Diaz, Neal and Amaya 1990). Three consequences for self-regulation through the use of language can be identified.

Firstly, children organize and restructure their perceptions in terms of their goals. Secondly, children's actions are less impulsive as they allow them to act reflectively according to their goals. Finally, language not only enables children to regulate their way of perceiving stimuli, but also to regulate their behaviour. Camp, Bloom, Hebert and Van Doornick (1977) develop a program called *Think Aloud* to improve self-control. Children are taught to use the following four questions when solving problems: "What is my problem?"; "How can I do it?"; "Am I using my plan?" and "How did I *do*"?

Journal-keeping: Keeping a personal diary throughout a learning experience facilitates the creation and expression of thoughts and actions. Learners make notes of ambiguities, inconsistencies, mistakes, insights, and ways to correct their mistakes. Preliminary insights can be compared with changes in those insights as more information is gathered or obtained through feedback from assessment (Costa, 1984; Blake and Spence, 1990).

Cooperative learning: Cooperative learning creates the opportunity for learners to work together in small groups to enhance learning. It entails more than group work, as group work is considered as a modification of whole-class discussion. In cooperative learning, the teacher gives indirect guidance as the group works together to achieve specific learning outcomes (Killen, 2000). Cooperative learning may promote awareness of learners' personal thinking and of others' thinking. When learners act as "tutors", the process of planning what they are going to teach, lead to independent learning and clarifying the learning material (Blakey and Spence, 1990).

Modeling: Modeling occurs when teachers demonstrate the processes involved in performing a difficult task, or when teachers tell learners about their thinking and the motivation for selecting certain strategies when solving problems (Muijs and Reynolds, 2005). Modeling and discussion enhance learners' thinking and talking about their own thinking (Blakey and Spence, 1990). Schoenfeld (1987) refers to the importance for teachers of not always presenting the finished, neat presentation of the answers on the board, but to sometimes model the problems and working through the problem step by step. Consequently, the processes yielding the correct answer (for example false starts, recoveries from false starts and interesting insights) are exposed and the chief purpose of the modeling approach is achieved, namely the centering of learners' awareness on metacognitive behaviours**.** Costa (1984) suggests that modeling could be the most effective strategy used to enhance metacognition among learners because they learn best by imitating adults. Teachers will, by thinking aloud throughout planning and problem-solving activities, demonstrate their thinking processes. Van der Walt and Maree (2007) find that mathematics teachers employed question-posing strategies and think-aloud models, but that they did not sufficiently promote the implementation and practice of these strategies among learners.

Schraw (1998) suggests the use of an instructional strategy called regulatory checklist to improve student's regulation of cognition while attending to instruction and problem solving. The regulatory checklist is considered a metacognitive strategy because it functions to help learners keep a continuous check on their progress. The questions are designed to help students clarify the problem and access their existing knowledge and strategies when relevant. The checklist included questions grouped into three metacognitive categories: Planning, monitoring, and evaluating

Planning: What is the problem? What am I trying to do here? What do I know about the problem so far? What information is given to me? How can this help me? What is my plan? Is there another way to do this? What would happen if ….? What should I do next?

Monitoring: Am I using my strategy? Do I need a different strategy? Has my goal changed? What is my goal now? Am I on the right track? Am I getting closer to my goal?

Evaluating: What worked? What didn't work? What would I do differently next time?

With the above self-impose questions, learners eventually learn and study alone, without the advantage of an external prompter.

METHOD

The design for this study was quasi-experimental, a pre-test post-test non-equivalent control group research design. The four co-educational public secondary schools of average age of 15 years used exist as intact groups. The independent variable was the teaching method while students' achievement is the dependent variable likewise age and gender was extraneous variables. The design used is:

Experimental group:	0_A	X_1	0_B,	0_1
Control group:	0C	X2	0D,	02

Where: 0A, 0C represent pre-test
0B, 0D represent post-test
01, 02 represent delayed post-test
X1 represents treatment through metacognitive instructional strategy
X2 represents treatment through traditional teacher's centered method

The population was made up of Senior Secondary School Two students in Ikere local government area in Ekiti State, Nigeria. Purposive sampling technique was used to select six schools in grade A, for the study and they were then assigned randomly into an experimental group and control group. The four schools chosen were those that have between 25 and 35 students each in their senior secondary school two (SSSII) classes. Thus a sample of three hundred (300) SSSII students (143 male and 157 female) participated in the study. The experimental group which consists of 158 students (75 male and 83 female) were trained and instructed to improve their metacognitive skills. The students in the control group (142 students of which 68 are male and 74 are female) only received traditional teacher's center method.

The researcher developed and used a 40-items multiple-choice objective question in Secondary Mathematics Achievement Test (SMAT) with one key and three distractors. The SMAT was based on the six level of cognitive domain. The instrument used was validated by two lecturers from the Department of Mathematics, College of Education, Ikere-Ekiti, who are experts in measurement and evaluation, administered it on a sample of thirty-five (35) co-educational senior secondary school two students different from the group for the study but in the same local government and of the same demographics in term of age and class level. A reliability coefficient of 0.87 was recorded using the Kuder-Richardson (formula 21) method. The same questions were re-arranged and administered to the same set of students to measure their ability to retain knowledge over a long period.

The researcher made use of direct Mathematics teacher in the four schools during the process of executing the strategy, since intact classes were randomly assigned for the study. The experimental group was taught using metacognitive instructional strategy while the control group was taught using the traditional teacher's centered lesson plan. The students involved were pre-tested before the strategies were used. On the other hand, the post-test was conducted after the treatments while the retentive test was conducted after six weeks interval. The hypotheses were tested using t-test statistical tool, where

$$t_{cal} = \frac{\bar{x}_e - \bar{x}_c}{\sqrt{\left(\frac{(n_e - 1)S_e^2 + (n_c - 1)S_c^2}{n_e + n_c - 2}\right)\left(\frac{1}{n_e} + \frac{1}{n_c}\right)}}$$

$\bar{x}_e$ is the mean of experimental group.

$\bar{x}_c$ is the mean of control group.

n_e is the number of experimental group.

n_c is the number of control group.

S_e^2 is the variance of experimental group.

S_c^2 is the variance of control group.

The t-test of significant was used to compute the magnitudes of the mean achievement score for possible comparisons of experimental and control group on the pre-test, post-test and retentive-test for possible test of significant difference at significant level of 0.05.

RESULTS AND DISCUSSION

The results in table 1 show that the pre-test mean score of students in the experimental group was not significantly different from that of the students in the control group. This indicates that the two groups used in the study exhibited comparable characteristics. Hence, they enter the instruction experiment on equal strength. This is a confirmation that if any observable significant difference is seen in the post-test mean scores of the two groups then such difference would not be attributed to chance but the effect of intervention which is the metacognitive instructional strategy. Therefore, the hypothesis that there is no significant difference between the pre-test achievements mean scores of students exposed to the metacognitive instructional strategy and those exposed to the traditional teacher's centered method is rejected.

Table 2 reveals the magnitude of the post-test mean achievement scores of the students exposed to the two treatment conditions. With a post-test mean achievement score of 35.64, the students exposed to metacognitive instructional strategy outperformed their counterparts exposed to traditional teacher's centered method whose post-test mean achievement score was 28.73. The outcome thus revealed that the experimental group has the greater potency at effecting students' achievement in Mathematics. Hence, the acceptance of the hypothesis which states that there is no significant difference between the post-test achievements mean scores of students exposed to the metacognitive instructional strategy and those exposed to the traditional teacher's centered method.

The results in table 3 reveal no significant main effect of treatment and gender on the students' post-test achievement scores. This outcome shows no significant variation between the sampled male and female students' achievement in Mathematics. Similarly, result of control group reveals no significant difference in the sampled male and female students' achievement in Mathematics. Thus, shows there is no significant effect of both treatments and gender on the students' achievement in Mathematics. Hence, the hypothesis that there is no significant difference between the post-test achievements mean scores of male and female students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method is accepted.

The results in table 4 show that there was a significant difference in the achievement of students taught using metacognitive instructional and traditional teacher's centered in favour of metacognitive instructional strategy. This indicates that the mean retention scores of the students exposed to metacognitive instruction differed significantly from the mean retention scores of the students exposed to traditional teacher's centered treatment. In lieu of this, the null hypothesis which states that there is no significant difference between the retentive-test achievements mean scores of students exposed to metacognitive instructional strategy and those exposed to the traditional teacher's centered method is rejected.

The study was carried out to determine the effectiveness of metacognitive instructional strategy on student's achievement and retention in mathematics. The study shows that there was significance difference between the performance mean scores of students exposed to metacognitive instructional strategy and those not so exposed. This indicates that enhanced metacognitive strategy have significant influence on students' achievement in mathematics. The study finds no significant difference between the achievement of male and female students in mathematics when metacognitive instructional strategy was used as means of instruction. Thus, imply that there is no gender inequality in the use of the strategy if properly handled. This result is in consonance with the submission of Olawumi (2015), Cullen (2013) and Adaramola (2012).

Table 1: Summary of T-test difference between students pre-test achievement Scores

Group	**N**	**Mean**	**SD**	**DF**	**T_{cal}**	**T_{tab}**	**Result**
Experimental	158	14.53	1.32	298	0.15	1.96	Not-significant
Control	142	14.56	1.34				

Source: Quasi-experiment, 2015

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Table 2: Summary of T-test difference between students post-test achievement Scores

Group	N	Mean	SD	DF	T_{cal}	T_{tab}	Result
Experimental	158	35.64	2.67	298	23.39	1.96	Significant
Control	142	28.73	2.42				

Source: Quasi-experiment, 2015

Table 3: Summary of T-test for difference in the mean performance scores of Male and Female students based on the two methods after treatment

Method	Gender	N	Mean	SD	DF	T_{cal}	T_{tab}	Result
Metacognitive	Male	75	35.01	1.96	156	0.39	1.96	Not-significant
(Experimental)	Female	83	34.89	1.89				
Traditional	Male	68	28.96	1.92	140	0.52	1.96	Not-significant
(Control)	Female	74	29.13	1.94				

Source: Quasi-experiment, 2015

Table 4: Difference in the delayed test achievement scores of Students exposed to different treatment conditions

Group	N	Mean	SD	DF	T_{cal}	T_{tab}	Result
Experimental	158	36.68	2.56	298	27.31	1.96	Significant
Control	142	28.43	2.67				

Source: Quasi-experiment, 2015

CONCLUSION AND RECOMMENDATIONS

The major aim of this study was to assess the effect of metacognitive instructional strategy on mathematics achievement and retention among secondary school students in Ekiti State, Nigeria. The findings suggest that students generally become successful when they are aware of what they need to do and do it best. It helps them to reflect on their thoughts and activities about the problem solving process in mathematics. From the findings of this research, if students were taught using metacognitive instruction, they will perform better and retain knowledge learnt over a long period of time. To cap it all, the study adds to knowledge regarding the effectiveness in promoting students' achievement in mathematics.

The findings of this study have obvious implications for mathematics classroom. It has provided empirical evidence in respect to the efficacy of metacognitive instructional strategy in teaching of mathematics. Since mean achievement was observed to be statistically significant, there is the need for mathematics teachers to adopt metacognitive instructional strategy to teach concepts and topics in mathematics lessons.

In this study, the use of metacognitive instructional strategy had been proven effective in promoting students' mathematics achievement and retention; mathematics teachers should help the students to become aware of all that metacognitive instruction entail as a new way for thinking about thinking in learning processes. Mathematics teachers should be encouraged to adopt the strategy in their mathematics classroom teaching. Authors of mathematics textbooks should lay emphasis on the use of the strategy.

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