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Metacognitive Skills And Mathematical Problem Solving Ability Among Students At Secondary Level

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Abstract

The present study is to find out the effect of metacognitive skills in developing mathematical problem solving ability among students at secondary level. This is an experimental study with pre test post test non equivalent group design. From the findings of the study it is clear that the mathematical problem solving ability among students at secondary level was increased after the experimentation and the metacognitive skills have significant effect in developing mathematical problem solving ability among secondary school students. The sample was selected randomly and divided into two groups- Experimental and Control. It can be concluded that the metacognitive skills have significant effect in developing mathematical problem solving ability among students at secondary level.

Keyterms: *Metacognitive skills, Mathematical Problem Solving Ability, Students at Secondary Level*

Introduction

Mathematics is always one of the difficult subjects for students (Yong, H. T. & Kiong, L. N., 2012). Metacognitive processes focus on students' ability to supervise and adjust their own cognitive processes in problem solving (Artzt, A. F., Armour-Thomas, E, & Schoenfeld, A. H.,1992). Some experts specify that metacognition is a person's knowledge of cognitive processes and a person's perception of a mathematical problem related to the planning, monitoring and evaluation process of problem solutions (Flavell, J. H. 1979). In metacognition, the ability to think about thought is central to this process because it relates to awareness of the cognitive process and its ability to control it. According to Flavell, metacognition is a system of information, experience, goals and strategies. Metacognition, which means thinking about thinking, generally includes many skills related to thinking and learning, which are critical thinking, problem solving and decision making. Actual problem-solving processes include processes and skills. Solving the problem is to find a solution to overcome difficulties other than reaching solutions. Math teachers need to make every effort to help students succeed, try to find the best ways to teach, get students involved in the learning process.

Following RW Hollingworth and C McLoughlin, (2001) metacognitive term refers to learners' knowledge of their cognitive processes and their ability to control and monitor them as a function of feedback that learners receive through learning outcomes. Therefore, the two essential components of metacognition include knowledge and control. Knowledge in metacognition is understanding what learners understand and believe in an issue or task, and the judgments they make in allocating cognitive resources as a result of that

knowledge (Flavell, J. H., 1976 & Brown, A. L. 1987). Metacognitive controller controls the approaches and strategies that learners devise to achieve specific learning goals and the extent to which learners organize, track and modify those activities to ensure that learning is effective.

According to Kuhn, D. (2000) Metacognition becomes clearer, stronger and more effective as it operates increasingly under the conscious control of each individual. Raising (a) metacognitive awareness about what people believe and how people know it and (b) controlling strategies in adopting new information processing strategies are important objectives of development and education.

Studies on metacognition have proven that there is a strong correlation between problem solving and metacognition (see Gurat & Medula, 2016).

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In the field of mathematics, problem solving is a common process. This study necessitates the effect of metacognitive skills in developing mathematical problem solving ability among students at secondary level.

Need and Significance of the Study

Metacognition helps learners identify the presence of a problem that needs to be solved, to distinguish exactly what the problem is and to understand how to achieve a problem solving solution. For the successful solution of any complex problem-solving pocess, a series of metacognitive processes are needed such as planning, monitoring, inspection, revision and evaluation, especially the use of mathematical representations and evaluation of the effectiveness of problem-solving options. As metacognition plays an important role in problem solving, there is an increasing number of studies investigating the role of metacognition in problem solving under various aspects. Kuzle (2011) pointed out a number of cases where metacognition is mentioned in problem-solving studies such as metacognitive processes in student problem-solving activities, the role of metacognition in problem solving, the role of non-cognitive factors such as beliefs, values in problem solving, the influence of metacognitive-oriented teaching on solving processes problem solving. Kuzle (2011) has concluded that although metacognitive practitioners have been studied and its influence on problem solving has been initially shown, studies on metacognition in the process of problem-solving is necessary to conduct to identify the influence of metacognition in the problem-solving process of learners.

Each student has different ability in solving the problem (Abubakar, 2016). Some students consciously pay attention to the given problem by solving it in hierarchical way, but there are also students who just carelessly answer the problem when facing the test. Based on the research result, it can be stated that each student has different process of thinking or plan of thinking in solving the problem. Therefore they require different instruction (Retnowati, 2016). In sum, teachers should make use strategies of mathematics instructions by which students can dominate mathematics knowledge underpinning the problem solving.

The following research question was asked;

Does the metacognitive skills of students have any effect in developing their mathematical problem solving ability?

Objectives

The objectives of the study are,

1. To find out the metacognitive skills of students' at secondary level
2. To find out mathematical problem solving ability of students at secondary level
3. To find out the effect of metacognitive skills in developing mathematical problem solving ability among students at secondary level

Hypothesis

1. The metacognitive skills have no significant effect in developing mathematical problem solving ability among students at secondary level

Methodology

The present study is an experimental study. Experimental design is the blue print of procedures that enable the researcher to test the hypotheses by reaching valid conclusions about relationship between independent and dependent variables. Of the different experimental designs, the pre test post test non equivalent group design was adopted for the present study. For the study, the investigator selected a random sample of 100 students at secondary level studying in Kottayam district of Kerala State. The pre test was given to both the groups, then the treatment to the experimental group and then the post test to both the groups. The investigator tested the effect of metacognitive skills in developing mathematical problem solving ability .

Tools and Materials Used

1. Package to develop mathematical problem solving ability by inculcating metacognitive skills in students.
2. Test to measure the mathematical problem solving ability of students

Statistical Techniques Used

Comparison using 't' test

Analysis and Interpretation

The mean, standard deviation and 't' value of pre test scores of mathematical problem solving ability among students at secondary level were found out.

Table 1*Mean*, *Standard Deviation and 't' value of Pre test scores on mathematical problem solving ability among students at secondary level*

Group	Experimental Group			Control Group			t	Level of Significance
	M_1	SD_1	N_1	M_2	SD_2	N_2		
Mathematical Problem Solving Ability	22.75	5.1	50	21.25	6.7	50	1.26	*p > 0.05*

The arithmetic mean and standard deviation of two groups were found out and it is clear that the arithmetic mean of the two groups were not having much difference. The mean scores of the groups were low. This means that mathematical problem solving ability of two groups before experimentation were low.

The obtained 't' value is less than the table value when compared Experimental and Control Groups before experimentation at 0.05 level and hence there is no significant difference in the pre test scores of learning of mathematics in the experimental and control groups. This shows that the experimental and control groups are equated groups with respect to their mathematical problem solving ability.

The mean, standard deviation and 't' value of pre test and post test scores on mathematical problem solving ability among students at secondary level were found out. The details are given below.

Table 2 *Mean, Standard Deviation and 't' value of Pre test and Post test on mathematical problem solving ability among students at secondary level*

Group	Pre test			Post test			t	Level of Significance
	M_1	SD_1	N_1	M_2	SD_2	N_2		
Experimental Group	22.75	5.1	*50*	*47.5*	*4.23*	*50*	26.33	*p < 0.01*
Control Group	21.25	6.7	*50*	*22.50*	*5.82*	*50*	0.99	*p > 0.05*

The arithmetic mean and standard deviation of Experimental and Control groups were found out. The arithmetic mean of pre test and post test in the Experimental group were having difference and that of the Control Group were having not much difference. The mean scores of post test in the experimental group was higher than pre test scores and that of control group was almost same. This means that the mathematical problem solving ability of secondary school students after the experimentation was high in the experimental group and having no difference in the control group.

The obtained 't' value is greater than the table value at 0.01 level of the Experimental group and hence there is significant difference in the pre test and post test scores of mathematical problem solving ability in the experimental group. The obtained 't' value is less than the table value at 0.01 level of the Control group. Hence there is no significant difference in the pre test and post test scores of mathematical problem solving ability in the control group.

This means that the mathematical problem solving ability of the secondary school students increased after the experimentation in the Experimental Group.
The mean, standard deviation and 't' value of post test scores on mathematical problem solving ability among students at secondary level were found out. The details are given below.

Table 3 *Mean, Standard Deviation and 't' value of Post test scores* on mathematical problem solving ability among students at secondary level

Group	Experimental Group			Control Group			t	Level of Significance
	M_1	SD_1	N_1	M_2	SD_2	N_2		
Total	*47.5*	*4.23*	50	*22.50*	5.82	50	24.51	$p < 0.01$

The obtained 't' value is greater than the table value for the Total sample when compared the Experimental and Control groups after experimentation. This implies there is significant difference between Experimental and Control groups in mathematical problem solving ability. It is clear that the metacognitive skills have a significant effect in developing mathematical problem solving ability in secondary school students.

Findings

From the findings it is clear that metacognitive skills had a significant effect in developing the mathematical problem solving ability of secondary school students.
Individual's cognitive skills are important for metacognitive skills and evaluating the problem-solving process. Because of the deficient-incorrect understanding of students on metacognitive skills the students cannot demonstrate the relevant behaviours during the problem-solving process in the study. Therefore, much research on putting correct meanings to metacognitive behaviours is needed in the field.
In sum, this study gave insight into metacognitive skills of students in the disciplines of mathematics. Furthermore, this study can also be used a material consideration in planning learning model or strategy that aims to optimize and improve students' ability in mathematics problem solving.
The results of this study is in tune with those of Van der Stel, M.; Veenman, M.V.J. ;Deelen, K. *et al.* (2010) and Pratama, L.; Lestari, W.; & Jailani, J. (2018)

Educational Implications

- Studies on metacognition have proven that there is a strong correlation between problem solving and meta cognition. Therefore, teachers should employ metacognition to students in the process of mathematical problem solving.
- Through metacognition students learn to plan, monitor, evaluate and regulate their approach to learning and the way they are thinking about a given problem. Students become independent in the process of solving mathematical problems so in the daily life problems. Opportunities must be included in the curriculum for the same.
- Teachers of mathematics must use questioning to trigger metacognitive reflection in students, that help in mathematical problem solving.

Conclusion

Developing metacognitive ability in learners is an important aim of education. Metacognitive skills help individuals to process and retain information through self-recognition and reflection. Metacognitive skills are important because they help individuals to understand their learning processes and how they learn effectively. Further, metacognitive skills help people learn information quickly and retain information for their educational or professional development. This is because they understand the methods they need to use to educate themselves and overcome potential learning barriers. This study only explores the effect of metacognition in developing mathematical problem solving ability of secondary school students. It can be concluded that metacognitive skills had significant effect in developing mathematical problem solving ability in students

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