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Metacognitive Skills Among Technical Student Through Mathematical Problem Solving: Technical Students' Perceptions

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Abstract: This study was conducted to identify metacognitive skills consisting of monitoring skills, evaluating skills and regulating skills among TVET students in problem solving of mathematic subject. The cognitive development of university students to solve the problem is an important factor in education. Metacognitive is a set of cognitive skills and process to our mind to think deeply and critically on the task. Survey questionnaire was used to collect the data of 135 respondents. Descriptive and inferential statistics was employed to analyze the data. The means score of respondents' metacognitive skills were investigated. The results show that respondents have high metacognitive skills in solving mathematical problems. Monitoring skills are the dominant among the three metacognitive skills. From the T-test (independent sample T-Test), there was no significant difference in metacognitive skills across gender. In conclusion, students have high metacognitive skills and need to be applied in the teaching and learning process to improve their result in mathematical subjects.

Keywords: Metacognitive skills, monitoring, evaluating, regulating

1. Introduction

Mathematics holds a special place in curriculum as mechanisms do most of the calculations that students are taught in K-12. Given the importance of mastery, understanding, appreciation and application of mathematics, then it is needed the positive and scientific efforts are necessary implemented immediately to strengthen the level of mathematical domination among students (Rosalie, 2003). According to Marzano et al., (2008), teaching and learning existing mathematical learning is now unable to produce development metacognitive, creative, and critical thinking. Creative and critical thinking can be help students decide when troubleshooting. Curriculum of mathematics were design by topics that are required students to develop an understanding of mathematical concepts and methods of problem solving. Although the problem solving has long been assertion in mathematical curriculum but feedback from lecturer still showing that student performance in answering questions problem solving, especially in the form of sentences is low (Lim, 2008). Professional engineers use a wide range of mathematics in their field (Goold and Devitt, 2012) and mathematics achievement is a strong predictor of third level persistence generally (Mooney et al., 2010). Besides that, Technical and Vocational Education and Training (TVET) students also face a difficulties in learning mathematics. However they have no choice but to learn it because most of the topic included relate to their working lives soon. The role of mathematics grows together with the role of technology, as mathematics is at the core of what computers do. Basically all mathematical

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operations that are taught in primary, secondary, and tertiary education can be performed by computers and are performed by computers in the world outside school (Gravemeijer et al., 2017). The importance of mathematics outside the classroom, mathematics within the classroom is evolving from formal knowledge to being mathematically prepared for an increasingly technological world.

Mathematics is the foundation and fundamental practise for technical and engineering where (Radzi et al., 2009) are of the view that mathematics is not a subject that merely provides the basic knowledge needed in those area but it is importantly help to instruct essential and effective critical thinking skills. Mathematics oriented thinking skills involve the ability to interpret information presented in a mathematical way and to use mathematics precisely to gather the information and solve problems. According to Ernest (2011) there are two forms of mathematics knowledge, these are explicit (theorems, definitions) and tacit (personal know how). He's view is that knowledge is usually cultured in a social context. He says that the transmission of learning between contexts often does not take place and that it is the social context that elicits the skills and knowledge from long term memory.

Mathematics educators have an agenda to produce skills such as critical thinking, problem posing, problem solving, collaborating, and communicating for a long time. These skills are seen as instrumental in problem-centered instructional approaches that identify that knowledge is not transferred and aim at supporting students in constructing mathematics. Problem solving in mathematics is the process of doing mathematical problems which are a reinforcement of knowledge (Ernest 2011). Problem solving strategies are methods that guide the choice of skills and knowledge to apply at each stage in problem solving and they offer no guarantee of success.

Compared to other subjects, mathematics concepts are more abstract, and learning the subject involves manipulation of symbols with little or no tangible meaning (Nardi and Steward 2003). Metacognitive activities include "planning, controlling and monitoring progress, decision making, choosing strategies, checking answers and outcomes and so on" (Ernest 2011). Schoenfeld (1992) showed that students' problem solving performance is enhanced when engaging in self-monitoring and controlling activities. While there is little work on the effectiveness of teaching problem solving strategies to students, Schoenfeld's work demonstrates that teacher interventions can raise the level of metacognitive activity and effectiveness in problem solving among students (Schoenfeld 1992).

There are several studies stated that there is lack of exposure to metacognitive skills and mastery students' metacognitive skills at a weak level. Achievement and mastery in mathematical problem solving is influenced by the student's metacognitive skills, though students have the capacity and potential (Zan, 2000 & Dosoete et al., 2001). When the level of student metacognition is at a weak level, achievement students in the examination were also affected. The data derived from mathematical lecturer at Faculty of Technical and Vocational Education (FPTV) identified that the achievement of Mathematic II semester I 2016/2017 which results of B and below is 89.8%. The statistic shows the mastery of students in mathematical subject is weak. The purpose of this study is identify the level of mastery metacognitive skills (monitoring, evaluating and regulating skills) to support students' problem solving skills from students perceptions. Besides, this study will reveal the difference of metacognitive skills between male technical students' and female technical students'.

1.1 Concepts of Metacognition

The concept of metacognitive was introduced by Flavell (1976) which indicated that metacognitive as valuable information in problem solving that related to cognitive processes, associated knowledge and the output. Metcalfe and Shimmura, (1994) found that metacognition concept as a cognitive knowledge and regulation of cognition (metacognitive regulation). Metacognitive knowledge will designed the information, awareness, and deeper understanding of one's own cognitive process. Swanson and Torhan (1996) identified metacognitive as awareness and control cognitive control in learning. Van der Stel and Veenman (2010) revealed that metacognition has been conceptulized one of the most relevant predictors of accomplishing complex higher order thinking process. The lecturer should planned teaching strategies to develop higher order thinking process and creating learning environments which support the development of students' metacognitive skills.

Metacognitive skills allows students to take action in flexibility to adjustable problem solving tasks, demands, and contexts (Allen and Armour-Thomas, 1992; Desoete et al, 2001). Findings from Winn and Snyder (1998) found that metacognition as a mental process contains of two concurrent procedures which is monitoring the progress in learning, and making changes and adapting strategies if previous perceives they are not doing well. active learning, problem solving and decision making. Students with well-developed metacognitive skills will become a better problem- solver, decision makers which are involve critical thinking process. They become more motivated to learn, be able to control and manage their emotions even in stressful condition, also can cope with conflict. Metacognitive skills can be develop by learning and thinking practises that can produce as a habits of mind to be apply in a wide variety of contexts.

1.2 Metacognitive skills

Metacognitive skills are the integrated of knowledge, skills, abilities and attributes of individual to handle any problem in any situation (Hannah & Avolio, 2010). Research studies have expressed critical thinking skills as the metacognitive skills (Magno, 2010), creative problem solving skills (Marshall-Mies et al., 2000), and decision making processes (Batha & Carroll, 2007). It is obviously important to expose students with metacognitive skills in educational system (formal or informal), because they helps students develop higher order thinking process and improve their academic success (Flavell, 2004; Larkin, 2009).

Veenman and Spaans (2005) stated that metacognitive skills include planning, monitoring, and assessment skills that will support students to focus on the problem solving task and to develop understanding related to the task. Its drive students in integrating activities and discussions that will help them understand how they learn, their strengths and needs, also learning process for the students to get better understanding for the subject they taken. According to Borich (2007), metacognitive skills can be learn. He stress out that academic achievements in students taught metacognitive skills were better as they were able to develop higher order thinking by themselves. Therefore, metacognitive skills can be trained to the students to support their learning success.

The recent study by Choy and Cheah (2009) indicated the connection between metacognition and critical thinking. They found that when the teacher provides guidelines such metacognition to learn materials effectively, the students will encourage to think critically. Specific strategies include techniques, prompts, topics, and keywords. In addition, they also found that structuring a more conducive environment can help facilitate critical thinking. These cognitive strategies and environmental structuring taught to students are specific metacognitive skills that are used to develop critical thinking.

There are a lot of previous research discussed about metacognitive knowledge, metacognitive regulation and metacognitive skills. (Jacobs and Paris, 1987) considered planning, monitoring and evaluation as regulatory skills in metacognition process. This research emphasis on metacognitive skills which produce by Jousovec (1984), Namsoo (1998) and Vos (2001) consist of monitoring, evaluation and regulation skill.

2.0 Methodology

This study utilized the survey method using questionnaire adapted from O'Niel & Brown (1997) dan Namsoo (1998). This study used purposive sampling methods where 135 student become the respondents who took Mathematics II at Faculty of Technical and Vocational Education. This study is based on students' perception on metacognitive skills. The scaling technique of 1-5 was applied to measure the students' perception of the metacognitive skills consist of three dimensions; 1) monitoring, 2) evaluation and 3) regulation. The data was analyzed by employing the statistical mean, standard deviation and T-Test.

3.0 Findings

The presentation of data and interpretation of the findings in this study are based on the objectives of this research. Table 1 present the respondents' demographic characteristics. The table I shows the distribution and percentage of respondents according to their gender and their courses.

Table 1 - Respondents' demographic characteristics

Socio Demographic		Numbe	Percentage (%)
Gender			
	Male	59	43.70
	Female	76	56.30
Total		135	100
Course			
	BBA	24	17.78
	BBB	21	15.56
	BBD	15	11.11
	BBE	30	22.22
	BBF	33	24.44
	BBG	12	8.89
Total		135	100

Based on Table 1, female respondents were 56.30% and 43.70% were male. The data obtained was equivalent of the field of study among respondents. The highest number of respondents based on their course is BBF (24.44%) meanwhile

the lowest number is BBG students with 8.89%.Table 2 shows the findings of respondents' perception on their metacognitive skills in mathematical problem solving.

Table 2 - Score means of metacognitive skills among technical students

Skill	Score means	SD	Level
Monitoring	4.16	0.616	High
Evaluating	4.14	0.793	High
Regulating	4.04	0.625	High

Based on the Table II, the domain element among three of metacognitive skills is monitoring. Those three skills showed are high level but regulating skills is the lowest skill in metacognitive. This study provide eight items for each elements. In monitoring skills, the lowest score means is "when I solve the problem, I am try more than one way" where the score means is 3.96 (SD= 0.823), meanwhile the highest item is "I read the problem given more than one time" with score means 4.35 (SD= 0.619).

In evaluating elements, the lowest score means is "after sending the problem solving task, I will try and think the better solution" with score means 3.80 (SD=1.106) while the highest item is "I am checking out my calculation" where the score means is 4.35 (SD= 0.705). In regulating elements, lowest score means is "I am prefer to translate the problem to other form when I have to solve the problem" with score means 3.67 (SD= 0.911). The highest item in regulating skill is "I try to remember whether I had solve this problem" where the score means is 4.22 (SD=0.604). Table 3 illustrates the t-test results on the comparison between male and female students' metacognitive skills.

Table 3 - Comparison between male and female students' on perceived metacognitive skills (n= 59 males and 76 females)

Variable	Mean	SD	T	Sig.
Metacognitive skills			0.79	0.45^{ns}
Male	4.05	0.42		
Female	4.	0.		

^{ns} not significant

Means of two group indicated that metacognitive skill for female (mean=4.16) was higher than male (mean= 4.05). The inferential statistical analysis however showed that there was no significant difference between genders in metacognitive skills. This means that metacognitive skills are not influenced by gender.

4.0 Discussions

The findings show that that the level of monitoring of metacognitive skills is the highest. This finding is in line with the findings by Tasir, Harun and Zakaria (2008) about innovative and creative approach in teaching and training problem solving approach, where the results found that students have high monitoring skill in solving mathematics problems. Although the result implied high score means, the lowest score means item of questionnaire in monitoring shows that the students are not trying to solve the problem given variously. They are not creatively or critically think that the problem can be solve using the other ways. Meanwhile, the highest item is monitoring revealed that our students prefer to read the problem repeatedly. This means that they are trying to understand the problem well before find the solution.

The results of this study also indicated that the lowest item of evaluating skills element because of our students not prefer to check and try to find the better solution after they sent the task. It is shows that, they are choose not to think about the task given after the sent it. But, the highest score means item revealed that every time they complete the calculation, they will check out it again and again to make sure that they get the right answers. For regulating skills element, the lowest item proved that they are comfortable using only one solution compared to try others alternative solution. But based on the highest item of regulating skills, they are tried to remember whether they have solve the same problem before.

Those characteristics are to reflect that the students' ways of cognitive thinking. These results were against their mathematics achievement. What we can do as a lecturer is to provide more effective learning environment. Teaching with problem solving method will have students to develop higher level of intrinsic goal orientation, task value, and use of elaboration learning strategies, critical thinking and metacognitive skills (Sungur and Tekkaya, 2006). Therefore, positive learning environments and teaching strategies, that put emphasis on metacognitive knowledge and regulation considering the higher order thinking process, should be design.

5.0 Conclusion

Based on the findings and discussion above, it can be concluded that from students' perceptions, metacognitive skills among technical students are high. To ensure that students' perceptions aligned with their mathematics achievements, lecturer need to consider learning strategy that can help boost up students' metacognitive skills. Reveal students on how to solve the problems creatively and empower students' metacognitive skills to increase their performance. Metacognitive training can increase students' self-confidence and sense of personal responsibility of the own development. Metacognitive skills is one of the important factors for technical students because they will use the calculation in few subjects of technical. These skills is not just important for computation but also will help them to be a better problem solver. Therefore it is further suggested that to investigate metacognitive skills using cognitive learning test. It is to help the lecturer evaluating students' metacognitive skills correctly and will use appropriate approach in developing students' thinking level.

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