

Metacognition Skills of Field Dependent-Independent Students in Mathematics Problem Solving

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Abstract: The objective of this study was to analyse students' metacognition skills in mathematics problem solving. The data were collected through metacognition survey from 35 seventh grade students, 14 were Field Dependent (FD) and 21 were Field Independent (FI) students respectively and the data were descriptively analysed. The results of the analysis showed that students of FI type tended to be more frequent in metacognition skills than FD type in developing planning and evaluating actions in solving mathematical problems. While metacognition skill in monitoring the implementation of problem solving of both types of students was likely to be the same.

Key words: Metacognition skills, field dependent-independent, Mathematics problem solving, Field Dependent (FD), Field Independent (FI)

INTRODUCTION

Problem solving skill is necessary for everyone in order to play proper role in complex and dynamic society. Mathematics problem solving is the core value of mathematics learning. This skill can be applied in solving calculation related matters in daily life. The skill and ability in mathematics problem solving should be cautiously taught since elementary level. Problem solving is an integral part of holistic mathematics learning (NCTM, 2000) and the base line of all Mathematics activities (Reys *et al.*, 2014) cited by Baiduri (2015).

Problem solving is a cognitive process to choose the most effective way to find solution or answer to a particular problem (Santrock, 2009). Several researchers have developed strategies or stages in problem solving (Polya, 1973; Posamentier *et al.*, 2007; Santrock, 2011; Baiduri, 2015). These problem solving stages would generate questions from the problem solver who is likely to form self awareness of his/her own thinking, about what the problem is what strategies should be applied to solve the problem whether she/he encountered the same problem previously or any other possible way to solve the problem as well as whether the given answer is correct or not. To think about the thinking process is called metacognition (Flavell, 1979; Parsons *et al.*, 2001). Desoete *et al.* (2001) states that metacognition has three components in solving a problem for learning; they are metacognition knowledge, skills and confidence. Recently, however, the most common difference in metacognition is to separate metacognition knowledge

from skills. Metacognitive knowledge refers to declarative, procedural and conditional knowledge in problem solving. Whereas metacognitive skill portrays planning, monitoring and evaluation skills as the most significant element of metacognition in solving various problems. These skills are required to solve issues smoothly and properly.

There are many factors affecting the success of problem solving. The characteristic of problem solver is the most determinant factor compared to types or level of difficulties of a problem (Ginn and Boote, 2003; Phonapichat *et al.*, 2014). Individual differences may lead to some gaps in terms of cognitive ability or style. This might represent individual mind pattern that rules and controls a particular person in processing and making sense of information (Jonassen and Grabowski, 1993). One popular and well documented source about cognitive difference is Field Dependence Independence (FD-I) (Dillon and Gabbard, 1998). Field dependence-independence is seen to be the most heuristic cognitive construct (Messick, 1996; Price, 2004; Sternberg *et al.*, 2008) and has proven its consistency to determine academic professionalism (Guisande *et al.*, 2007), teaching styles and strategies (Evans, 2004) and types of interaction between teacher and students (Saracho, 2000). The characteristic of FD-I is considered as a dimension of global style versus articulation, reflecting a person's degree in processing information as the result of contextual arena. FD student who was asked to identify simple geometric shapes embedded in a complex shape took longer time compared to FI student, even in some cases, FD student could not identify the

simple geometric shape. Therefore, FD-I analysis is considered important in science education and mathematics problem solving (Witkin *et al.*, 1977; Witkin and Goodenough, 1981; Alamolhodaei, 2002; Azari *et al.*, 2013).

Based on the above fact, the statement of the problem of this study was on “how do the metacognition skills of junior high school students of field dependence-independence type influence mathematics problem solving?”

MATERIALS AND METHODS

Subject: The subjects were the seventh grade students of SMP Muhammadiyah I Malang selected based on Group Embedded Figures Test (GEFT) developed by Witkin *et al.* (1977) cited by Baiduri (2015). Cognitive style grouping reflected Alamolhodaei (2002)’s assertion where students were grouped into FD cognitive style if their test score was $< \text{Mean} - (1/4)\text{SD}$ and FI style if the test score was $> \text{Mean} + (1/4)\text{SD}$. From the test result derived from 90 students, the study was narrowed down to 14 students with cognitive dependent style and 21 students with cognitive independent style.

Instruments: The instrument of this present research consisted of two parts. The first was mathematics exercise on algebra and geometry for seventh grader. The exercise items were taken from national examination. The second part was questionnaire on metacognition skills as stated by Oktalianda however, the researcher modified its alternative answers into five choice scale; Never (N), Seldom (S), Sometime (ST), Often (O) and Always (A) from the previous four choice scale (Scale 4) answers. Questionnaire items were developed based on metacognition skills during or after problem solving occurred which comprised: developing a plan with 4 scale indicators as many as 11 items, monitoring the administration with 4 indicators in 6 question items and evaluating the treatment with 3 indicators in 4 question items. The questionnaire was relatively reliable with Cronbach alpha scale that was 0.849.

Data collection and analysis: Data collection process was conducted through questionnaire on metacognition delivered after all research subjects finished their mathematics problem solving task. Further data analysis was administered by using statistically descriptive design based on subject responses to questionnaire items.

RESULTS AND DISCUSSION

Metacognitive skill in this study was classified into three main aspects, they were planning development, administration monitoring and action evaluating. Furthermore, indicators and descriptors were provided for each aspect.

Metacognition skills in planning development:

Metacognition skill in planning development aspect comprised some indicators that were reflected by student’s skill to write what they knew and what they asked, to determine objective of their problem solving plan, to find out correlation with previously solved task and to achieve problem solving plan or strategy.

The FD subjects portrayed ‘often’ and ‘always’ categories who always applied metacognition skills in: writing what they knew and asked, determining objectives of problem solving planning, finding correlation with previously solved task and achieving problem solving plan consecutively as much as 45.24, 35.71, 46.43 and 50%. Overall, an FD metacognition skill in developing planning was often done with 45.46% occurrence rate. That number implied that FD subjects applied less planning to solve problem which was proven by the lack of indicators in solving mathematics problems.

The overall performance of FI metacognition skill in development planning was in ‘often’ and ‘always’ categories by 59.31% with each indicator showing ‘often’ and ‘always’ categories respectively writing down points to know and to ask by 61.90%, setting goals that would be done to solve the problem by 45.24%, determining the relationship with the question previously solved by 61.90% and obtaining the work plan up to 63.10%. In general, FI subjects had always or often developed problem solving planning projected in each indicator, except for determining the objectives which was still lacking. Goal determination involved understanding of what was desired in problem item and comprehending things that were crucial and the first step in problem solving process (Polya, 1973). This means that FI students were better mathematical problem planners than FD students (Garofalo and Lester, 1985; Hembree and Marsh, 1993).

Metacognition skills in monitoring:

Metacognition skill in monitoring aspect involved the activity of observing indicators such as why a certain notation was implemented, to match the step that should be exercised, to check the suitability of plans with the implementation and to seek for alternative solutions.

The overall metacognition skill of FD students in implementation monitoring was categorized as 'often' and 'always' as much as 46.43% whereas for the indicators, they always showed often category in each aspect. On the usage of a specific notation, it was as much as 35.71%, while observation in each step being exercised was 85.71%. In the next point about matching plans with the implementation, the number reached 42.86% and seeking alternative solutions was with the same percentage as above, 42.86%. These results proved that FD subjects performed less implementation of monitoring and lack of indicators' awareness when solving mathematics problems. However, FD subjects succeeded in checking each step in the implementation of problem solving strategy. The finding was relevant with FD subjects' characteristics that were often influenced by the field force; therefore the chance of failure was higher. The subjects failed to isolate target information, since other information tended to conceal the core target information (Jonassen and Grabowski, 1993). FD subjects had not realized the use of different notations for various purposes or conducts in problem solution session. It can be concluded that the way the FD students solved mathematics problem followed procedural knowledge.

The FI subjects with 'often' and 'always' categories exercised metacognition skills in: finding out why a particular notation was used, implementing the exercise in each step, observing the suitability of the plan with the implementation and seeking out alternative plans to answer a problem which were consecutively in 42.86, 57.14, 38.10 and 28.57%. All in all, FI metacognition skill in implementation monitoring was still less conducted, especially in finding out alternative plans to answer a problem. It was because FI subjects were sure that their choice of answer was the correct one. FI subjects were more successful in isolating the target information from all the complex matter and were able to process information with more accurate performance on tasks of visual search. They performed better in analyzing the ideas into their constituent parts and reorganizing ideas into a new configuration (Davis, 1991; Bieler and Snowman, 1993). Furthermore, FI subjects as well as FD subjects had not understood why particular notation or operations were used in solving problems. This means that the way students solved mathematical problems was by procedural knowledge.

Metacognition skill in action evaluation: Metacognition skill in action evaluation comprised several indicators such as to observe the advantages and disadvantages of already completed action, to analyze the suitability of result with objective achievement and to strongly believe that the evaluation is correct.

The FD subjects were in 'often' and 'always' categories that always performed their metacognition skills in: checking advantage and disadvantage of the conducted activities, confirming the results with the achievement of objectives and being confident that the evaluation was correct as much as 42.86, 85.71 and 64.29% successively. The overall metacognition skills performance of FD subjects was in 'often' and 'always' categories by 58.93%. The result showed that FD subjects had performed self evaluation many times when mathematical problem solving activity occurred. This was in line with metacognition skill indicator in implementation monitoring that was to check every stage of conduct. FD always or often checked the relevance of result with objective achievement. It means that FD subjects always or often checked the result with the question of the problem. This act improved the FD subjects' confidence that their answer was correct. However, FD subjects seldom checked every step of the problem solving procedure.

The FI subjects with 'often' and 'always' categories applied metacognition skills in: checking plus and minus points of already conducted action, observing the suitability between the result and objective achievement and believing that the evaluation is correct which had 64.29, 57.14 and 76.19% consecutive scales. Overall, FI's metacognition skill in action evaluation was in 'often' and 'always' categories by 65.48%. These findings implied that FI subjects often evaluated their own action in solving mathematics problem by checking every step of conduct as well as observing the coherence between result and question. As the result, FI subjects felt assure that their answer was the correct one. This means that FI students were better evaluator than FD students in mathematical problem solving (Garofalo and Lester, 1985; Hembree and Marsh, 1993; Kafiar and Kho, 2016).

CONCLUSION

Metacognition skills are aspect to consider when solving problems. Therefore, teachers should teach these skills to students in mathematics learning process. Based on the research, FD students still rarely conducted metacognition in developing planning and evaluating actions, the first and last of mathematical problems solving steps (Polya, 1973; Posamentier *et al.*, 2007) compared to those of FI students when solving mathematical problems. However, in terms of monitoring the implementation, both FD and FI students still rarely did so. This means that FI students were better mathematical problem solvers than FD students.

This study was limited to metacognition skills in solving mathematical problems for students with field dependence-independence cognitive style. Further researches on metacognition knowledge of students with similar or different characteristics are fully encouraged.

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