Analysis of metacognition skills of students in junior high school based on cognitive style

L R Izzati¹* and A Mahmudi²

¹Pendidikan Matematika Pascasarjana, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Karangmalang, Depok, Sleman, Yogyakarta, Indonesia
²Jurusan Matematika, Fakultas MIPA, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Karangmalang, Depok, Sleman, Yogyakarta, Indonesia

*lihar.raudina2016@student.uny.ac.id

Abstract. This paper aims to analyze the aspect of mathematical metacognition skills of students in Junior High School based on cognitive style. The instrument in this research is a metacognition skill questionnaire that uses 27 statements consisting of 14 positive statements and 13 negative statements validated by 3 expert validators and Group Embedded Figure Test (GEFT) developed by Witkin. In the medium and low categories, students do not perform the three aspects well that are planning, monitoring and evaluating. In terms of cognitive style, students’ metacognition skills of very high categories with FI cognitive style as well as students with cognitive style FD. Students' metacognition skills of high categories with FI cognitive styles are better than students with FD cognitive styles. Students' metacognition skills of medium categories with FI cognitive styles are better than students with FD cognitive styles. Students’ metacognition skills of low categories with FI cognitive styles are better than students with FD cognitive styles.

1. Introduction

One of the goals of mathematical education is mathematical problem solving [1]. One of the competencies that must be possessed by students in solving the problem is metacognition skills. Mahmudi reveals that encouraging the growth of self-awareness and habits of students to independently monitor and evaluate their own thought processes and learning progress is considered far more important [2]. In line with what is said by Mokos and Kafoussi, that metacognition emphasizes the importance of conscious control of the cognitive mind during problem solving and composing new knowledge schemes, so metacognition skills can facilitate the development of students' understanding [3]. Wells reveals that metacognition is the mind that applies to the mind [4]. Schneider also reveals that metacognition is a person's knowledge of their own skills in information processing, as well as knowledge of tasks of thinking, and of strategies for copying similar tasks [5]. Quirk reveals that metacognition is the ability of a person to think about his own thoughts and feelings and to predict what others think [6]. Ozsoy and Ataman reveals that metacognition means one's awareness of the thought process and its ability to control the process [7]. In addition, Schraw and Dennison reveals that metacognition leads to the ability to reflect, understand, and control a person's learning [8]. Larkin distinguishes metacognition into four, metacognition knowledge, metacognition experiences, goals or tasks, and actions or strategies [9]. Topcu and Ubuz distinguishes metacognition ability into three aspects, namely metacognition knowledge, metacognition judgments and monitoring, and self-
regulation and control of cognition [10]. Williams and Atkins divides metacognition into two aspects, namely knowledge / awareness of cognitive process and control of cognitive process [11]. Metacognition aspects in this paper is control of cognitive process. Ozsoy and Ataman reveals that metacognition control is the ability to use knowledge to regulate and control thought processes [7]. Schraw and Dennison [8] also add that metacognition control is a set of sub processes or activities that facilitate a person in controlling the learning aspects. Larkin divides metacognition control into two aspects, namely the monitoring of cognitive process and the ability to regulate cognition to improve effectiveness [9]. Schraw and Moshman divides metacognition control into three aspects: planning, monitoring, and evaluation [12]. Planning involves choosing the right strategy and the allocation of reason that affects performance. Monitoring leads to a person's awareness of understanding and performance tasks. Evaluation leads to assessing the outcomes and regulation of one's learning process. Mahmudi also added that the planning aspect means student activity in creating problem-solving plans by identifying appropriate problem-solving strategies [2]. Monitoring means students' awareness in determining whether the activity is going according to plan. Evaluation means student activity in assessing efficiency related to strategy used. In this paper the metacognition control aspects that used is planning, monitoring, and evaluation.

Each student has the characteristics of cognition in receiving, processing, and compiling information and presenting the information based on experiences that have in improving mathematics learning achievement that called the cognitive style. As Sealetsa and Moalosi points out that cognitive style occupies an important position in learning and one of the learning variables to consider in designing learning [13]. Sealetsa and Moalosi states that the cognitive style describes the habit of processing information that represents a typical fashion of students from observing, thinking, solving problems and remembering [13]. Cognitive styles as the approach to receiving, remembering, and thinking that tend to be used by individuals to understand their environment [14]. One of the dimensions of cognitive style in receiving information is Field Independent (FI) and Field Dependent (FD) which reflects the way a person's analysis interacts with his environment. According to Riding this cognitive style does not meet the who list and analytic cognitive styles, in other words this cognitive style is related to the ability so that this cognitive style suitable for use in this study [15]. The general characteristics of FI cognitive styles are 1) having the ability to analyze to separate objects from the surrounding environment, so that perception is not affected when the environment undergoes change; 2) have the ability to organize objects that have not been organized; 3) have impersonal orientation, less sensitive, cold, distance from others, and individualists; 4) choosing a profession normally done individually with more abstract material or requiring theory and analysis; 5) tend to define own goals; 6) tends to work with intrinsic motivation and is more influenced by intrinsic reinforcement [16]. Thus someone who has FI cognitive style is categorized as a person who has the character as an analyst, who behave always refers to himself with an impersonal orientation. General characteristics of the FD cognitive style are 1) tend to think globally, view the object as one unity with its environment, as perceptions are easily influenced by environmental changes; 2) tend to accept existing structures, due to lack of restructuring capacity; 3) have a social orientation so as to appear better kinder, kinder, wise and loving towards other individuals; 4) tend to choose professions that emphasize social skills, such as social workers, extension workers; 5) tend to follow existing goals; 6) tend to work with an emphasis on external motivation and more interested in external reinforcement in the form of rewards, praise, or encouragement from others [16].

Based on the explanation above, the purpose of this paper is to analyze how the junior high school students' metacognition skills in terms of cognitive style, especially students of SMP N 2 Ungaran. Metacognition skills in this paper include planning, monitoring, and evaluating. By knowing metacognition skills of student based on cognitive style, teacher can select learning strategies to optimize student learning outcomes.

2. Experimental method

This research is qualitative descriptive research. This research was conducted in junior high school in Ungaran, Indonesia. Subjects in this study involved 68 students of grade 8 (around age 13-14 years).
The instrument in this research is a metacognition skill questionnaire that uses 27 statements consisting of 14 positive statements and 13 negative statements validated by 3 expert validators and Group Embedded Figure Test (GEFT) developed by Witkin. The data in this research is the result of questionnaire of metacognition skill and result of Group Embedded Figure Test (GEFT) developed by Witkin. The result of questionnaire of metacognition skill was analyzed to know the characteristic of metacognition skill of the students based on cognitive style.

3. Result and discussion

3.1. Metacognition skills aspect of very high category student in field independent cognitive style
Students perform the three aspects of metacognition skills that are planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, devising various ways or strategies to study or solve mathematical problems, and plan the time to be used to achieve the goal of studying or solving mathematical problems. In the monitoring aspect, students review the attainment of the objectives of studying or solving mathematical problems and monitoring the time spent. In the evaluating aspect, the student checks the results of the work whether in accordance with the objectives to be achieved, evaluate the effectiveness of the ways or strategies and knowledge used, evaluate the use of time, and make conclusions.

3.2. Metacognition skills aspect of high category student in field independent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, devising various ways or strategies to study or solve mathematical problems, and plan the time to be used to achieve the goal of studying or solving mathematical problems. In the monitoring aspect, students review the attainment of the objectives of studying or solving mathematical problems and monitoring the time spent. In the evaluating aspect, the students check the results of the work whether in accordance with the objectives to be achieved, evaluate the effectiveness of the ways or strategies and knowledge used, evaluate the use of time, and make conclusions.

3.3. Metacognition skills aspect of medium category student in field independent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, devising various ways or strategies to study or solve mathematical problems, and plan the time to be used to achieve the goal of studying or solving mathematical problems. However, when students think of different ways or strategies to learn or solve mathematical problems, students do not think about whether or not they are the right way to solve math problems. In the monitoring aspect, students review the attainment of the objectives of studying or solving mathematical problems and monitoring the time spent. However, students do not monitor the use of time when solving math problems. In the evaluating aspect, the students check the results of the work whether in accordance with the goals to be achieved, evaluate how well the strategies and knowledge used in studying mathematical material, evaluate the use of time, and make conclusions. However, students do not evaluate whether the method or strategy used is the easiest strategy when solving math problems.

3.4. Metacognition skills aspect of low category student in field independent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the objectives to be achieved in studying mathematical material and pay attention to the things that are known and asked on mathematical problems, utilize the knowledge they have to solve mathematical problems, and allocate time to learn math, and determine the schedule to achieve learning objectives with the best. However, students do not set goals in solving mathematical problems, do not think about whether they are appropriate, think only of one way to solve
math problems, and do not plan time to solve math problems. In the monitoring aspect, students review the achievement of the objectives of studying or solving mathematical problems and monitoring the adequacy of time to achieve learning objectives. However, it does not monitor the use of time in solving math problems. In the evaluating aspect, the student evaluates how well the strategy is used in studying mathematical material, and makes conclusions after working on math problems. However, the student does not check the results of the work whether it fits the goals to be achieved, does not think about whether the easiest way / strategy to solve mathematical problems, does not measure how well the knowledge used to solve math problems, does not evaluate the use of time, does not make conclusions about which parts are lacking or not mastered, do not make conclusions about what is learned while learning, do not make conclusions to plan follow-up what to do.

3.5. Metacognition skills aspect of very high category student in field dependent cognitive style
Students perform the three aspects of metacognition skills that are planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, devising various ways or strategies to study or solve mathematical problems, and plan the time to be used to achieve the goal of studying or solving mathematical problems. In the monitoring aspect, students review the attainment of the objectives of studying or solving mathematical problems and monitoring the time spent. In the evaluating aspect, the student checks the results of the work whether in accordance with the objectives to be achieved, evaluate the effectiveness of the ways or strategies and knowledge used, evaluate the use of time, and make conclusions.

3.6. Metacognition skills aspect of high category student in field dependent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, devising various ways or strategies to study or solve mathematical problems, and plan the time to be used to achieve the goal of studying or solving mathematical problems. In the monitoring aspect, students review the achievement of the objectives of studying or solving mathematical problems and monitoring the adequacy of time to achieve learning objectives. However, students do not monitor the use of time in solving math problems. In the evaluating aspect, the students check the results of the work whether in accordance with the objectives to be achieved, evaluate the effectiveness of the ways or strategies and knowledge used, evaluate whether the time spent is sufficient to achieve the learning objectives, evaluate whether the time spent solving the problem is in accordance with the time determined and made a conclusion. However, students do not care how long to solve math problems.

3.7. Metacognition skills aspect of medium category student in field dependent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the goals to be achieved in studying or solving mathematical problems, utilizing the knowledge they possess to solve math problems, figuring out whether the methods or strategies are appropriate and planning the time to be used to achieve the objectives of studying or solving mathematical problems. However, students only think of one way to solve math problems. In the monitoring aspect, students repeatedly check the correctness of the problem-solving steps used, check the understanding of the material being studied and monitor the time spent. However, students do not monitor whether the steps are being performed in accordance with the objectives in studying or solving mathematical problems. In the evaluating aspect, students re-examine each of the problem-solving steps whether appropriate, evaluate how well the strategies and knowledge are used in studying mathematical material and make conclusions. However, students do not evaluate whether the results of the work have been in accordance with predetermined goals, do not consider whether the easiest way or strategy to solve math problems, does not measure how well the knowledge used to solve math problems, does not assess whether the time spent solve the problem according to the time specified.
3.8. Metacognition skills aspect of low category student in field dependent cognitive style
Students perform the three aspects of metacognition skills i.e. planning, monitoring and evaluating. In the planning aspect, students determine the objectives in learning a mathematical material, taking into account the things that are known and asked on the mathematical problems that solve, utilize the knowledge they have to solve the math problem, and determine the schedule to achieve the learning objectives as well as possible. However, it does not set goals in solving mathematical problems, do not think about whether the way is right, just think of one way to solve math problems, do not plan time to solve math problems. In the monitoring aspect, students monitor the use of time in solving math problems. However, it does not check the correctness of the problem-solving steps used, does not check understanding of the material being studied, monitors the time sufficiency to achieve the learning objectives. In the evaluating aspect, students evaluate the use of time. However, it does not evaluate whether it has achieved its learning objectives, does not re-examine each of the problem-solving steps whether appropriate, does not evaluate how well the strategies used in studying the material or solve the problem, do not think about the easiest method / strategy to solve the problem mathematics, not making conclusions after doing math problems, not making conclusions about what to learn while learning, not making conclusions about which parts are lacking or not mastering, does not make a conclusion to plan what follow-up to do.

4. Conclusion
The conclusion of this research is the category of metacognition skills both cognitive style of FI and FD ranging from very high category to low category doing the three aspects that is planning, monitoring, and evaluating. However, in the medium and low categories, students do not perform the three aspects well. In terms of cognitive style, students’ metacognition skills of very high categories with FI cognitive style as well as students with cognitive style FD. Students' metacognition skills of high categories with FI cognitive styles are better than students with FD cognitive styles. Students’ metacognition skills of medium categories with FI cognitive styles are better than students with FD cognitive styles. Students’ metacognition skills of low categories with FI cognitive styles are better than students with FD cognitive styles. Therefore, teachers need to facilitate students in learning that develop metacognition skills by adjusting the students’ cognitive style.

References
[1] National Council of Teacher Mathematics 2000 Principles and Standards for School Mathematics Reston VA NCTM
[2] Mahmudi A 2013 Strategi Metakognitif dalam Pembelajaran Matematika Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA, Fakultas MIPA Universitas Negeri Yogyakarta PM-49-PM-53
[3] Mokos, E and Kafoussi S 2013 Elementary Students’ Spontaneous Metacognitive Functions in Different Types of Mathematical Problem REDIMAT Journal Research in Mathematics Education 2(2) 242-267
[4] Wells A 2009 Metacognitive Therapy for Anxiety and Depression New York NY The Guildford Press
[5] Schneider W 2010 Metacognition, Strategy Use, and Instruction in H S Waters and W Schneider (Eds.), Metacognition and Memory Development in Childhood and Adolescence pp 54-81 New York NY The Guilford Press
[6] Quirk M 2006 Intuition and Metacognition in Medical Education: Keys to Developing Expertise New York NY Springer Publishing Company Inc.
[7] Ozsoy G and Ataman A 2009 The Effect of Metacognitive Strategy Training on Mathematical Problem Solving Achievement International Electronic Journal of Elementary Education 1(2) 67-82
[8] Schraw G and Dennison R S 1994 Assessing Metacognitive Awareness Contemporary Educational Psychology 19 460-475
[9] Larkin S 2010 *Metacognition in Young Children* Oxon OX Routledge

[10] Topcu A and Ubuz B 2008 The Effect of Metacognitive Knowledge on The Pre-service Teachers’ Participation in The Asynchronous Online Forum *Educational Technology and Society* 11(3) 1-12

[11] Williams J P and Atkins J G 2009 Handbook of Metacognition in Education In D J Hacker, J Dunlosky and A C Graesser (Eds.) *The Role of Metacognition in Teaching Reading Comprehension to Primary Students* pp 26-43 new York NY Routledge

[12] Schraw G and Moshman D 1995 Metacognitive Theories *Educational Psychological Review* 7 351-371

[13] Sealetsa O J and Moalosi R 2012 Cognitive and Learning Styles of The Faculty of Engineering and Technology Students University of Botswana *World Transactions on Engineering and Technology Education* 10(2) 138-143

[14] Aiken L R 1997 *Psychological Testing and Assessment* Boston Allyn and Bacon

[15] Riding R and Rayner S 1998 *Cognitive Style and Learning Strategies Understanding Style Differences in Learning and Behaviour* London David Fulton Publishers

[16] Witkin H A, Moore C A, Goodenough D R, and Cox P W 1977 Field-Dependent and Field-Independent Cognitive Style and Their Educational Implications *Review of Educational Research* 47(1) 1-64