Metacognition of Junior High School Students in Mathematics Problem Solving Based on Cognitive Style

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https://doi.org/10.24191/ajue.v17i1.12604

Received: 29 December 2020
Accepted: 8 February 2021
Date Published Online:8 March 2021
Published: 8 March 2021

Abstract: The aim of this study was to explain junior high school students' metacognition with Field Independent (FI) and Field Dependent (FD) cognitive styles in mathematics problem solving. The statistical population of this study was all junior high school students in the Sragen regency in the 2018/2019 academic year. Purposive sampling was used to pick the subjects. Different instruments such as the cognitive style tests, the problem-solving exercises, and the interview guidelines were used to reach the research purpose. Moreover, time triangulation was used to ensure data validity. The data has been processed through four stages of data collection, data reduction, data presentation, and conclusion. The results indicated that the students who have field-independent cognitive styles indicated high self-confidence and the ability to solve the problem correctly. They were also able to do planning steps, make important decisions for themselves, and solve the problem properly. However, students with FD cognitive style are completely confident that their answer is correct, but they have not yet clarified the steps they need to solve their problems. They also have not yet focused on their shortcomings in mathematics problem-solving. Hence, their task results in mathematics problem-solving have incorrect answers.

Keywords: Cognitive style; Mathematics problem solving; Metacognition

1. Introduction

Solving mathematics problem is the basis for students to settle on studying mathematics (Singh, 2009; Santos-Trigo, 2020; Jiang, Liu, Star, Zheng, Wang & Hong, 2020). Through mathematics lessons, students can develop their abilities to build mathematical knowledge and reflect on the mathematical problem-solving process (Singh & White, 2006; Anggo, 2011). Undeniably, problem solving is the action or attempt made by individuals to find the best solution to the problem. It is closely related to the process of thinking (Flavell, 1979; Savic, 2016). It means that to solve an individual problem needs a series of processes such as thinking strategy in solving the problem and do control in every action so that the right problem solving is acquired (Jiang et al., 2020).

The well-organized solution has to be used to get an optimal outcome in problem-solving. Polya (1973) argues that problem-solving consists of four steps, that are (1) recognizing the problem, (2) developing a plan, (3) executing the plan, and (4) looking back. Through systematic steps and procedural, the individual will get the right problem-solving. They will also construct a well-structured mindset to face the problem that needs to be solved.

Metacognition is an essential aspect of problem-solving. It is the ability to track, control, and assess one's thought, as well as the experience and understanding of one's cognitive processes (Flavell, 1979). It is in line with the study of Radmehr & Drake (2017) which explained that metacognition is a process of personal thinking about their way of thought in building a strategy to solve the problem. In fact, mathematical problem solving involves a lot of metacognition. This is because multi-step problem solving in mathematics necessitates the coordination of a number of cognitive tasks and experiences, such as the use of pre-existing knowledge (facts, principles, and competencies) and problem-solving techniques (such as analysis) (Tzohar-Rozen & Kramarski, 2014). Metacognition involved two aspects, such as metacognitive knowledge and metacognitive experience (Flavell, 1979). Furthermore, Flavel explained that metacognitive knowledge is a personal knowledge of himself and others as a cognitive agent about tasks, actions, or techniques and how different intellectual efforts influence these experiences. Jacobs & Paris (1987) further categorizes three hierarchically organized knowledge: declarative, procedural, and conditional knowledge. Declarative knowledge is a knowledge of what is understood about something being debated. Procedural knowledge describes the mechanism of perception and thought. Conditional knowledge addresses the circumstances and tasks before one knows why the process is going and how the situation is going.

Jacobs & Paris (1987) suggest that metacognitive experience requires efforts of preparing, tracking, and assessing the operation. Preparing is the willingness of individuals to be prepared for their learning experiences. Activities in the plan's execution include developing the best approach and availability of an information number from reliable sources that can affect results. Tracking is the participant's capacity to monitor the learning process and items related to the learning process, such as monitoring the completion steps to find the right response. Evaluation is an individual's ability to determine his learning strategy's success, whether he will change his learning strategy, be aware of the situation, and end the activity (Kireeva, Slepenkova, Shipunova, & Iskandaryan, 2018). In the research of Kireeva, Slepenkova, Shipunova, & Iskandaryan (2018), the researchers carried out a pre-survey task to know the potential of junior high school students 1 Miri in mathematics problem solving. The researchers in comparative content performed a task-based interview with the students. The pre-survey results showed that students have difficulty deciding the completion plan so that their task resolution is an incorrect response. This issue demonstrates that the individual's knowledge of planning, executing, and assessing the task would impact its outcome.

Based on the statement above, metacognition is an integral part of mathematics problem-solving. Metacognition helps students develop problem-solving techniques before choosing the right answer (Chimuma & Iris, 2016). Kuzle (2013) also explains that metacognition allows people to recognize the problem that needs to be resolved, look back at the real problem, and accomplish the goal or solution. Obviously, metacognition is important since this is an individuals' knowledge of doing helpful things rather than doing negative things to solve mathematics problems.

Among them, many factors affect metacognitive knowledge and metacognitive experience in solving mathematics problems; however, the major one is cognitive style. Cognitive style is a consistent way to achieve stimulus or information, a way of remembering, thinking, and solving problems (Sudia & Lambertus, 2017). In line with this, Hooda & Devi (2017) sees cognitive style as the favorite way for the student to think, process, and understand information. So, cognitive style means the character owned by an individual to process data, thought, remember, and solve problems consistently and long-lasting.

The cognitive style tends to be individual for everyone and differentiate individual one from another. So, it can indicate that the cognitive style of one individual with another is different. This difference does not show the level of intelligence or a specific skill because individuals who are different in cognitive style cannot be predicted to have the same intelligence and ability (Jantan, 2014). It means that individuals with different cognitive styles have significant differences of tendency related to intelligence and ability.

The cognitive style used as a reference in this study is Field Independent (FI) and Field Dependent (FD) (Witkin, Moore, Goodenough & Cox, 1977). An individual with a cognitive FD style prefers to consider one pattern as a whole. It is difficult to concentrate on one element from one case or to analyze the pattern to another. On the contrary, the individual with cognitive FI style can achieve more separate parts from the whole pattern and analyze the pattern into its components. Individuals with FI cognitive style tend to learn independently by formulating their learning objectives to be achieved and more concerned with motivation and strengthening from him-self. Based on those descriptions, a student's metacognition in mathematics problem solving is important. Therefore, it is necessary to analyze the Junior High School students' metacognition in solving math problems seen from the FI and FD cognitive styles. As mentioned earlier, in this study, it was tried to explain the metacognition of junior high school students with FI and FD cognitive styles in mathematics problem-solving.

2. Research Methods

The type of this research is based on its qualitative approach with a case study strategy. The subject of this research was all junior high school students in the Sragen regency for the academic year 2018/2019. The selected subjects were chosen by purposive sampling. The selection of subjects is intended to enable researchers to choose the individual who is the subject of research and understand the phenomena, which are the focus of research (Creswell, 2012). Firstly, the researcher chooses six students, i.e., three students who had FI cognitive style and three students with FD cognitive style. The category of cognitive style was obtained based on the cognitive style test developed by Witkin et al. (1977).

Other methods for this study were the topic of mathematics on comparative material and interview guidelines. The mathematics problem for the subjects during the in-depth interview is presented as follows.

2.1 Task I of mathematics problem-solving.

If 120 workers can complete the building in 8 months, how many additional workers will complete the building in 6 months?

2.2 Task II of mathematics problem-solving.

If 150 workers can complete the apartment in 6 months, how many additional workers are needed to complete the apartment in 4 months?

Research data were collected through in-depth interviews and recording of students' activities. Data validity for this research used a time triangulation. Satori & Komariah (2013) explain that the time triangulation test is carried out by gathering data at various times. The researcher performed two task-based interviews, which were held at different times. We use interactive analysis to analyze the research result. This means that data reduction, data presentation, and conclusion are reciprocal (Budiyono, 2017). The research methods for this research can be shown in Figure 1.

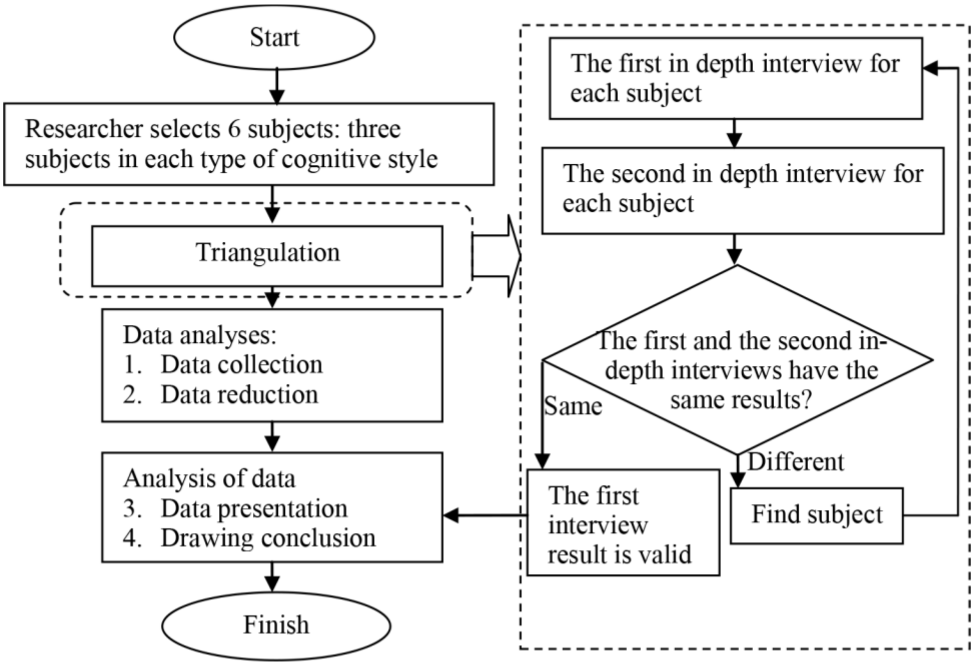


Fig. 1 Flow map of the methods of analysis

As shown in Figure 1, in the first step, the researchers select six students (three students who had FI cognitive style and three students who had FD cognitive style). After that, as a second step, two different interviews should be done. In the next step, it should be evaluated that the first and second interviews have the same results or not. If the results are the same, in this way, we can say that the results of the first interview results are valid.

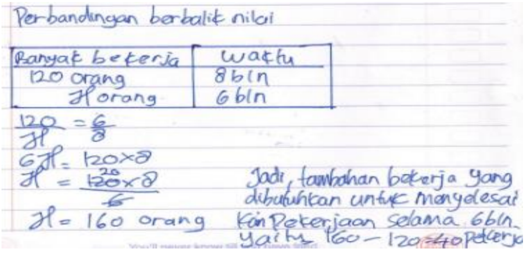
3. Results

Research subjects were selected based on the researcher's cognitive style tests and observation to subjects based on FI and FD cognitive style characteristics directly. In this research, the cognitive style test used the Group Embedded Figure Test (GEFT) developed by Witkin et al. (1977). It consists of 3 steps with total processing time in 15 minutes. The first step conducted as an exercise consists of 7 questions, while the second and third steps consist of 9 questions. Cognitive style classification was obtained based on the score from GEFT. Students with a score of less than 10 are students with FD cognitive style, while students with a ten score or more belong to FI cognitive style. This research obtained FI_1 subjects with a score of 15, FI_2 subjects with a score of 14, FI_3 with a score of 13, FD_1 with a score of 9, FD_2 with a score of 8, and FD_3 with a score of 8. The outcome of the tasks and the explanation of the metacognition for each subject are described as follows.

3.1 Metacognition of Junior High School Students in Mathematics Problem Solving based FI Cognitive Style

3.1.1 Recognizing the Problem

Subjects can understand the problem by reading the question and seeking the keyword to solve the mathematics problem. The subject grasped the issue by writing a statement inside a task using his own sentences. The interview results with FI cognitive style subjects, when recognizing the problem, are presented as follows (R = researcher; F = field-independent cognitive style subjects).



R_1: Do you understand the problem?
F_1: Yeah, I do that. We have ordered the estimate of additional workers needed to complete the building in 6 months.
R_2: What are you doing to understand the problem given?
F_2: Reading the question at first, knowing the question, and searching for a concept related to the lesson material

Fig. 2 The product of the task of FI cognitive style subjects on understanding the problem step

Data F_1 shows that the subject can understand the problem. The F_2 explains how the subject understands the problem. The subject was able to write statements and explain the task with his or her sentences, as shown in Figure 2.

3.1.2 Developing a plan

The topic was the planning methods used to solve problems based on the similarity between the mission's known formulas. The subject clarified the plan phases by relating the subject's prior experience to the information obtained from the mission. Excerpts from interviews with cognitive FI-style subjects on the creation of a strategy are presented as follows.

R_3: What do you do to solve the problem?
F_3: I will find many workers needed to complete the building in 6 months, then we can find the additional workers.
R_4: Why do you plan on it?
F_4: Because we will find many additional workers are needed to complete the building in 6 months.

Data F_3 shows that the participants understand the steps that have been taken to solve the problem. F4 results explain the reason for choosing plan F_3.

3.1.3 Executing the plan

Subjects tackle the problems that were necessary for the program. The topic used a technique that was deemed the most effective to solve the problem. The subject was able to accomplish the task correctly. The work of the subject in carrying out the plan can be seen in Figure 3.

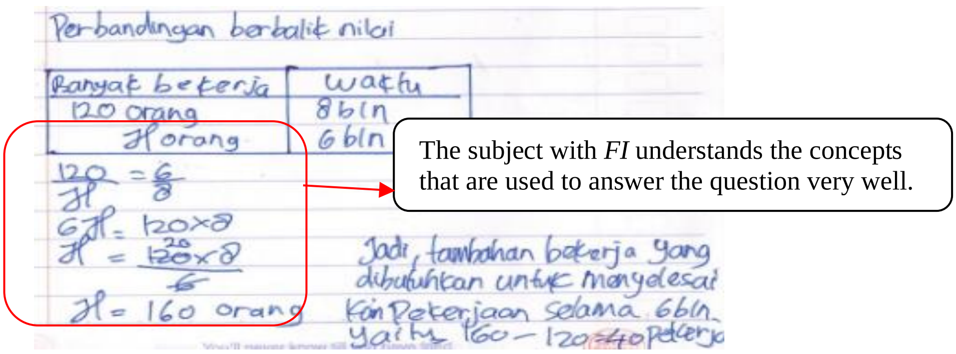


Fig. 3 Task product of subject FI cognitive style when executing the plan

3.1.4 Looking back

Subjects verified the answer by looking back at the results of the mission. The subjects decide that the results are appropriate with the questions, and the examinations of completion result have been correct. Excerpts from interviews with subjects with cognitive FI type when looking back are presented as follows.

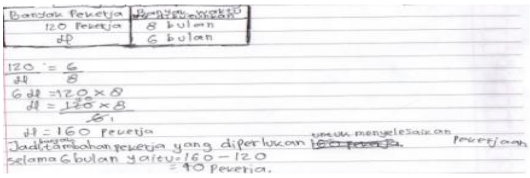
R_5: Are you certain that the answer that you write is right?
F_5: Yes, I'm certain.
R_6: Why are you completely sure that the answer you are writing is correct?
F_6: I am entirely confident that my answer is right because the formula and the equation are correct.
R_7: Does your result answer what is asked by the task?
F_8: Sure, because I did it based on the current data and the mission's issue.

The data F_5 and F_8 indicate that the subject is certain for his right answer. The positive explanation for the correct answer is clarified by data F_6.

3.2 Metacognition of Junior High School Students in Mathematics Problem-Solving based on the Cognitive FD-Style

3.2.1 Recognizing the Problem

The topic grasped the issue by writing what is known in the task with its sentences. The findings of an interview with cognitive FD-style subjects on understanding the problem are summarized as follows (R = researcher; D = field-dependent cognitive style subjects).



R_1: Do you understand the problem?
D_1: Yeah, I do that. We ordered the number of workers needed to complete the building in 6 months.
R_2: What are you doing to understand the problem given?
D_2: Reading the question first, grasp the idea of contrast and the question.

Fig. 4 The task result of FD cognitive style subjects when understanding the problem step.

We can see that the subject can understand the problem given, as shown in D_1. The D_2 data explains why the subject does what he does when he understands the problem. The subject was able to write task statements in his or her sentences, as shown in Figure 4.

3.2.2 Developing a plan

The topic was designing a strategy by considering stages that would be used in solving the problem. Still, they were unable to mention detailed steps used in solving a mathematics problem. Excerpts from interviews with FD cognitive style subjects on the creation of a strategy are presented as follows.

R_3: What are your intentions to solve the problem?
D_3: Write statements of the task in the table, then find how many workers needed to complete the building in 6 months.
R_4: Why do you plan it?
D_4: Because we should find many workers needed to complete the building in 6 months.
Based on data D_3, the subject knows the steps taken to solve the problem, although the answers were still not correct. D_4 explains why the subject chooses Plan D_3.

3.2.3 Executing the plan

Subjects with FD cognitive style executing the strategy step by step. Subjects still do not yet solve the tasks appropriately. Subjects assumed that his answer was correct, although the answers were still incorrect. The results of the role of the subject in executing the plan are seen in Figure 5.

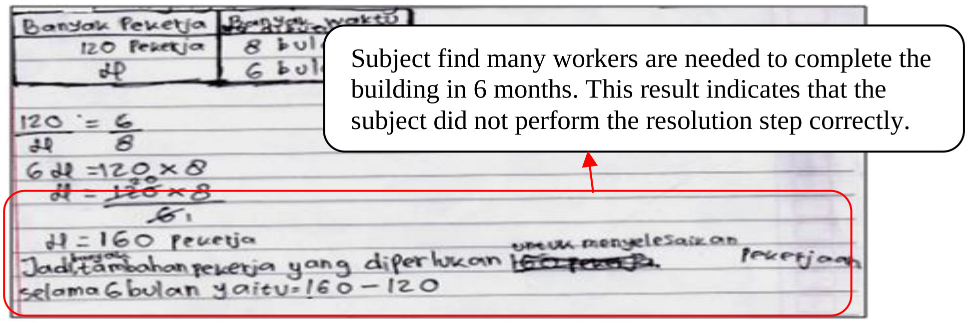


Fig. 5 Task result of FD cognitive style subject on executing the plan

3.2.4 Looking back

Subjects who have FD cognitive style checked the answer by looking back at the results of their work. Excerpts from the subject interview are presented as follows.

R_5: Are you aware that your answer is correct?
D_5: Yeah, I am. I am pretty sure that my answer is the right one.
R_6: Why are you completely confident that your answer is correct?
D_6: Because I am certain that I use the right formula to answer the problem given.

For the excerpts, the subject involves looking back for the result of their tasks. Data D_5 shows that the subject was completely confident that his answer is correct. Still, he does not yet explain the steps for mathematics problem-solving why the subject is confident that his answer is right is explained by data D_6.

4. Discussion

The research finding towards a subject with a field-independent cognitive style suggests that the subject includes declarative knowledge, procedural knowledge, and conditional knowledge in mathematics problem solving. The subject has well understood the problem. With declarative knowledge, they are capable of determining the information known and requested; capable of relating their specific knowledge quickly to the problematic information; and knowing that they have a weakness and try hard to avoid the mistake in solving the questions. On the hand, procedural knowledge of field-independent cognitive style subject did help them in knowing steps or ways to solve the problem generally and using the strategy they think easier. Lastly, conditional knowledge has assisted them choose formulas that can be used to solve the problem and explain the reason used for that formula (Angeli & Valanides, 2013).

The research finding towards a subject with a field-independent cognitive style indicates that it involves planning, monitoring, and evaluating in every problem-solving stage. When understanding the problem, they will do the following:

(1) in planning activities: subjects tend to know what they will do for the first step, what they know, what they will ask, what will be asked in a given question, and think to explain the problems with their word;
(2) in monitoring activities: subjects ask the question to themselves about what will they do for the first time, what they know, what will be asked, and what is the meaning of given question; and

(3) in evaluation activities: subjects decide whether the data obtained about what they have known and asked and the statement they made by themselves is already correct or not.

When devising a plan, they will practise the following:
(1) in planning activities: the subjects find out the relationship between data and the questions, usable formulas, and the considerations of the initial knowledge that can solve the problem;
(2) in monitoring activities: the subjects carry out and ask the question to themselves about the relationships between the data and the questions, choose the usable formulas for the data, and ask themselves what background knowledge should be used; and
(3) in evaluation activities: the subjects decide whether the relationships between the data and the questions already correct and the formulas chosen have been suitable for use.

When carrying out the plan, they will do the following:
(1) in planning activities: the subjects think what steps of the settlement will be done correctly, make improvements on the steps of settlement if they found errors;
(2) in monitoring activities: the subjects ask by themselves about the settlement steps, whether the answers to the questions have been through the right steps, how to precede the completion steps and to carry out or monitor the remedial steps if they found errors; and
(3) in evaluation activities: the subjects decide that the settlement steps and the questions have been done in the right step.

When looking back into the problem, they will do the following:
(1) in planning activities, the subjects think to check the suitability between question and answer being asked and whether the problems may be solved in different ways;
(2) in monitoring activities: the subjects check whether the results have been appropriate and they ask to themselves whether the problem can be solved in different ways or not; and
(3) in evaluation activities: the subjects decide that the results are appropriate with the questions and the examinations of completion result have been correct, and they also decide whether the last to the beginning results have the same data.

Thus, based on the procedures used, they believe that their problem-solving results have been correct (Darmawan & Suparman, 2019). From the procedures practised by them, the researchers have identified them have adopted a field-independent cognitive style. These subjects decide that their answers are appropriate with the questions, and the examinations of completion result have been correct, so they can carry out the preparation steps correctly to solve the problem properly. The statement was the same as Rahman & Ahmar's (2017) statement that students with FI cognitive style can easily achieve more separate parts from the whole pattern and analyze patterns into its components to solve the problem easily. We can conclude that subjects who have FI cognitive style appear to be autonomous and have high self-confidence to make important decisions for themselves (Ulya & Kartono, 2014).

The research result towards a subject with a field-dependent cognitive style suggests that the subject involved declarative and procedural knowledge, but could not optimize conditional knowledge. Declarative knowledge of field-dependent cognitive style subject involves abilities such as capable of evaluating the information known and requested, and can relate their basic knowledge with the information they have from the task. However, conditional knowledge of field-dependent cognitive style subject involves abilities of choosing a formula that can be used in solving the problem, but they cannot explain the reason used for that formula. So, they still not yet find the right answer.

The research finding towards a subject with a field-dependent cognitive style indicates that the subjects involve the use of planning, monitoring, and assessing the problem phase process. When it comes to understanding the problem, they will do the following:
(1) in planning activities: the subjects consider determining what to do first, comprehending the meanings of questions by reading them repeatedly, and being able to state the problems using their words;
(2) in monitoring activities: subjects attempt to comprehend what they have learned, the questions that will be asked, and the intent of the questions that they receive; and

(3) in evaluating activities: subjects evaluate if the data collected regarding what they have learned is correct.

When devising a plan, they will do the following:

(1) in planning activities: the subjects consider the links between the data and the questions and try to come up with a formula to solve the problems; and
(2) in monitoring activities: the subjects select formulas that can be applied to the data.

When carrying out the plan, they will practise the following:

(1) in planning activities: The subjects consider how to correctly complete the steps of the completion, as well as how to improve if mistakes are detected; and
(2) in monitoring activities: if they notice mistakes, the subjects query themselves about the settlement measures and adopt and track the improving steps.

When looking back into the problem, they will do the following:

(1) in planning activities: the subjects consider whether the results obtained are sufficient, whether changes can be made in the event of incorrect results, and whether the problems can be solved in different ways.; and
(2) in monitoring activities: the participants analyse the outcomes to see if they are acceptable.

However, the subjects who have FD cognitive style are certain that their answer is right, but they have not yet explained steps for mathematics problem solving, so their task resulted in incorrect answers (Witkin et al., 1977; Altun & Cakan, 2006). Students with field-dependent cognitive styles find it challenging to concentrate on one aspect of a situation or examine trends in various sections (Firdausy, Setyaningsih & Waluyo, 2019). The results are in accordance with Azlina, Amin, & Lukito (2018), that individuals who have an FD cognitive style do not reflect their weaknesses in mathematics problem-solving probably.

5. Conclusion

The discovery of a subject with a field-independent cognitive style in mathematics problem-solving indicates that these subjects involve declarative information, procedural knowledge, and conditional knowledge. These subjects have a detailed understanding of the problem and they are capable of rapidly applying their specific expertise to the problematic data. Basically, every problem-solving stage includes preparation, tracking, and assessing, according to research findings on a topic with a field-independent cognitive style. When creating a plan, the students search for correlations between data and questions, and identify formulas that can be used, and give considerations of prior experience that can help them solve the problem. These subjects assess whether the data-to-question relationships are accurate and whether the formulas chosen are appropriate for use. Besides, these subjects determine if the settlement steps and questions were completed in the correct order during assessment activities. Overall, students with the FI cognitive style can easily accomplish more separate parts from a larger pattern and break down patterns into their components to solve problems quickly.

On the other hand, subjects with a field-dependent cognitive style are also involved in the problem phase processes of preparation, tracking, and evaluating. When making a strategy, these students think about the relations between the data and the problems and try to come up with a formula to solve the issues. In that, these subjects in monitoring exercises will analyse the results to see if they are appropriate. Overall, these subjects with the FD cognitive style are confident that their answer is correct, but since he has not yet demonstrated how to solve math problems, their task yields incorrect results. Hence, students with field-dependent cognitive styles find it difficult to focus on a particular aspect of a situation or analyse patterns across several parts. Thus, individuals with an FD cognitive style do not show their math problem-solving limitations.

6. Acknowledgement

We would like to express our gratitude to the Ministry of Research, Technology, and Higher Education, who has provided financial support in implementing this research. Our gratitude also goes to the head of Junior High School 1 Miri, which has permitted the implementation and collection of research data. We want to thank the head of the Research Institute of Universitas Muhammadiyah Surakarta and the staff. They have provided facilities and support so that this research can be carried out smoothly. This publication was funded by LPPI Universitas Muhammadiyah Surakarta, APS No. 2263.

7. References

Altun, A., & Cakan, M. (2006). Undergraduate students' academic achievement, field dependent/independent cognitive styles and attitude toward computers. *Journal of Educational Technology & Society*, *9*(1), 289-297

Anggo, M. (2011). Pelibatan metakognisi dalam pemecahan masalah Matematika. *Edumatica: Jurnal Pendidikan Matematika*, *1*(01), 12-19. https://doi.org/https://doi.org/10.22437/edumatica.v1i01.188

Azlina, N., Amin, S. M., & Lukito, A. (2018). Creativity of field-dependent and field-independent students in posing Mathematical problems. *IOP Conf. Series: Journal of Physics: Conf. Series 947*. https://doi.org/10.1088/1742-6596/947/1/012031

Budiyono. (2017). *Pengantar Metodologi Penelitian Pendidikan*. Surakarta: UNS Press.

Chimuma, L. L., & Iris, D. J. (2016). Assessing students' use of metacognition during Mathematical problem solving using smartpens. *Educational Research: Theory & Practice*, *28*(1), 22–36. Retrieved from https://files.eric.ed.gov/fulltext/EJ1252563.pdf

Creswell., J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River: Pearson Education, Inc.

Darmawan, E. W., & Suparman, S. (2019). Design of Mathematics learning media based on discovery learning to improve problem solving ability. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *1*(2), 20-28.

Firdausy, A. R., Setyaningsih, N., & Waluyo, M. (2019). The Contribution of Student Activity and Learning Facilities to Learning Independency and it's Impact on Mathematics Learning Outcomes in Junior High School. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *1*(2), 29-37.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, *34*(10), 906–911. https://doi.org/https://doi.org/10.1037/0003-066X.34.10.906

Hooda, M., & Devi, R. (2017). Significance of cognitive style for academic achievement in Mathematics. *Scholarly Research Journal for Humanity Science & English Language*, *4*(22), 5521–5527. Retrieved from http://www.srjis.com/pages/pdfFiles/150176229937 Dr.Madhuri Hooda & Rani Devi.pdf

Kireeva, N., Slepenkova, E., Shipunova, T., & Iskandaryan, R. (2018). Competitiveness of higher education institutions and academic entrepreneurship. *Espacios*, *39*(23)

Jantan, H. R. B. (2014). Relationship between students' cognitive style (field dependent and field–independent cognitive styles) with their Mathematic achievement in primary school. *International Journal of Humanities Social Sciences and Education*, *1*(10), 88–93. Retrieved from https://www.arcjournals.org/pdfs/ijhsse/v1-i10/13.pdf

Jiang, R., Liu, R. D., Star, J., Zhen, R., Wang, J., Hong, W., & Fu, X. (2020). How mathematics anxiety affects students' inflexible perseverance in mathematics problem-solving: Examining the mediating role of cognitive reflection. *British Journal of Educational Psychology*, e12364-71.

Kuzle, A. (2013). Patterns of metacognitive behavior during Mathematics problem-solving in a dynamic geometry environment. *International Electronic Journal of Mathematics Education*, *8*(1), 20–40. Retrieved from https://www.iejme.com/article/patterns-of-metacognitive-behavior-during-mathematics-problem-solving-in-a-dynamic-geometry

Polya, G. (1973). *How to solve it: A new aspect of Mathematical method*. Princeton, New Jersey: Princeton University Press.

Radmehr, F., & Drake, M. (2017). Exploring students' mathematical performance, metacognitive experiences and skills in relation to fundamental theorem of calculus. *International Journal of Mathematical Education in Science and Technology*, *48*(7), 1043–1071. https://doi.org/10.1080/0020739X.2017.1305129

Rahman, A., & Ahmar, A. S. (2017). Problem posing of high school Mathematics students based on their cognitive style. *Educational Process International Journal*, *6*(1), 7–23. https://doi.org/10.22521/edupij.2017.61.1

Santos-Trigo, M. (2020). Problem-solving in mathematics education. *Encyclopedia of mathematics education*, 2(3), 686-693.

Satori, D., & Komariah, A. (2013). *Metodologi penelitian kualitatif*. Bandung: Alfabeta. Savic, M. (2016). Mathematical Problem-Solving via Wallas' Four Stages of Creativity: Implications for the Undergraduate Classroom. *The Mathematics Enthusiast*, *13*(3), 255–278. Retrieved from http://scholarworks.umt.edu/tme/vol13/iss3/6

Singh, P. (2009). Variation in first year college students' understanding on their conceptions of and approaches to solving Mathematical problems. *Asian Journal of University Education (AJUE)*, *5*(1), 95-118.

Singh, P., & White, A. (2006). Unpacking first year university students' mathematical content knowledge through problem solving. *Asian Journal of University Education*, *2*(1), 33-56.

Sudia, M., & Lambertus. (2017). Profile of high school student Mathematical reasoning to solve the problem Mathematical viewed from cognitive style. *International Journal of Education and Research*, *5*(6), 163–174. Retrieved from https://www.ijern.com/journal/2017/June-2017/14.pdf

Tzohar-Rozen, M., & Kramarski, B. (2014). Metacognition, motivation, and emotions: contribution of self-regulated learning to solving Mathematical problems. *Global Education Review*, *1*(4), 76–95. Retrieved from https://core.ac.uk/download/pdf/25518514.pdf

Ulya, H., & Kartono, A. R. (2014). Analysis of Mathematics problem solving ability of junior high school students viewed from students' cognitive style. *International Journal of Educational Research*, *2*(10), 577-582.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research*, *47*(1), 1–64. https://doi.org/https://doi.org/10.2307/1169967