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Student Metacognition in Mathematics Problem Solving on Set Materials

Metakognisi Siswa dalam Pemecahan Masalah Matematika pada Materi Himpunan

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ABSTRAK

Memecahkan permasalahan matematika adalah hal yang penting dalam matematika. Memecahkan permasalahan matematika membutuhkan keahlian berpikir kompleks, yaitu keahlian kognitif serta pemahaman dalam menggunakan metode dan taktik yang benar. Kesadaran siswa dalam menggunakan pemikirannya untuk merencanakan, mengontrol, serta menilai proses dan taktik kognitif yang dimilikinya adalah arti dari metakognisi. Penelitian ini bertujuan untuk mendeskripsikan tingkat metakognisi siswa dalam memecahkan permasalahan matematika pada materi himpunan. Dilibatkan 32 siswa SMP kelas VII untuk menyelesaikan masalah himpunan yang diberikan. Hasil penelitian menunjukkan bahwa subjek yang memiliki tingkat kemampuan pemecahan masalah matematika tinggi cenderung termasuk dalam tingkat metakognisi "reflective use", subjek yang memiliki tingkat kemampuan pemecahan masalah matematika sedang termasuk pada tingkat metakognisi "strategic use", dan subjek yang memiliki tingkat kemampuan pemecahan masalah matematika rendah tergolong pada tingkat metakognisi "aware use". Dari hasil ini, direkomendasikan kepada guru untuk memperhatikan kecenderungan tingkat metakognisi siswa berdasarkan tingkat pemecahan masalah siswa, baik dalam perencanaan, proses dan assesment pembelajaran guna mewujudkan pembelajaran terdiferensiasi.
Kata kunci: Metakognisi, Pemecahan Masalah Matematika, Himpunan

ABSTRACT

Solving mathematical problems is an important thing in mathematics. Solving narrative problems requires complex thinking skills, namely cognitive skills and understanding of using the right methods or tactics. Awareness of students in using their thoughts to plan, control, and assess their cognitive processes and tactics is the meaning of metacognition. This research is a descriptive study that aims to describe the level of students' metacognition in solving mathematical problems, especially a set of material. The population in this study is class VII B of SMPN 2 Sukodadi. To focus on data analysis, 3 students were closed who represented problem-solving abilities, they are high, medium, and low. Based on the data analysis conducted by researchers, the subject who has a high level of mathematical problem-solving ability is included in the "reflective use" metacognition level. The subject who has a moderate level of mathematical problem-solving ability is included in the "strategic use" metacognition level, and a subject who has a low level of problem-solving ability in math problems is classified as "aware use" metacognition level. From these results, it is recommended for teachers to pay attention to the tendency of students' metacognition levels based on students' problem solving levels, both in planning, learning processes and assessment in order to realize differentiated learning.
***Keywords**: Metacognition, Solving Mathematical Problems, Set*

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PRELIMINARY

Mathematics is one of the basic fields of science that has an important role in the development of science and technology. Mathematics subjects must be given to all students, starting from elementary school to equip them with the ability to think logically (reasoning), analytically, systematically, critically, creatively, and cooperatively, as well as the ability to work together (Sunendar, 2017). Students are required to be able to think well so that they can learn mathematics easily. Therefore, a study of how students' thinking processes need to be carried out (Firdaus & Shodikin, 2022). This view is based on Lester's opinion as quoted by Özsoy & Ataman (2009) that the key to successful problem solving depends on metacognition. Students who have good metacognitive skills will have good self-study skills as well, which allows him to set reasonable goals, plans and strategies (Sumarno et al., 2022).

Metacognition is a student's awareness of the thought process and his ability to control that process. Young (in Murti, 2011) explains that the metacognition process is the ability to control one's thought process which consists of monitoring the tactics and thought processes used in carrying out tasks, searching for other answers, and checking the accuracy and rationality of the answers that have been obtained. Ability in metacognition can promote better learning outcomes. Better learning outcomes are found in classes that apply metacognitive strategies compared to classes that only use conventional learning (Anggo, 2011). Therefore, it can be concluded that the ability of metacognition on students' mathematics learning achievement is very influential. To improve metacognition skills, it is necessary to have an awareness that students must have in every step of their thinking. But every student has different abilities when facing problems. The following is the level of students' awareness in thinking when solving problems by Swartz and Perkins (Wulandari & Minarni, 2018):

1. Tacit Use is thinking without awareness. This type of thinking is concerned with making decisions without thinking about them. Students use methods, tactics, or skills without specific awareness or through trial and error rather than solving a problem.

2. Aware Use is thinking using awareness. This type of thinking is related to students' awareness of something and the reasons students have these thoughts. In this case, the student realized that he had to use a problem-solving step by using an explanation of his reasons for choosing that step.
3. Strategic Use is thought that is interconnected. This type of thinking is related to the individual's regulation of the thought process, which is consciously using specific strategies to increase the accuracy of his thinking. In this case, students consciously can select specific methods, tactics, or skills to solve problems.
4. Reflective Use is the use of reflexive thinking. This type of thinking uses the reflection of each student in his thinking process before, after, or even during the thought process by considering the follow-up and improvement of the results of his thinking. In such cases, students consciously correct the mistakes that have been made in the problem-solving steps given.

Success in metacognition is not only on student learning outcomes, but metacognition can solve an existing problem. Students with a high level of problem-solving ability have metacognitive thinking because they have been able to plan, monitor, and evaluate their thinking processes in solving mathematical problems (Novita & Widada, 2018). According to Stanic and Kilpatrick in Schoenfeld, 3 goals are needed based on learning mathematics through problem-solving, namely problem solving as content, problem-solving as a skill, and problem-solving as an art (Afgani, 2011). The ultimate goal of learning is to make students who have knowledge and expertise in solving problems that will be faced in society. Solving this problem is not just a form of being able to implement the rules that have been mastered through previous learning activities but more than that, namely the process of accepting the rules at a higher level. Problem-solving can be viewed in various ways. Problem-solving can be interpreted as an effort to find a way to achieve goals.

One of the forms of organizing mathematical problem solving consists of understanding the problem, making a plan of completion (planning), implementing a settlement plan, and re-examining the solutions that have been completed (Polya, 1973). Through systematic problem-solving steps and the results are not only correct solutions but the formation of a structured mindset in a student when facing problems that must be solved. In 2018, Indonesia was ranked 72 out of 77 countries with a score of 371, far below the average reading score of all OECD countries, which was 487 (Schleicher, 2019). Meanwhile, the average score for mathematics is 379, which is also far from the OECD

average score of 489. This shows that students' reading and mathematical abilities in Indonesia are still low. PISA develops six categories of students' mathematical abilities that reflect students' cognitive abilities (OECD, 2019). It can be concluded that the problem-solving ability on high-level questions in Indonesian students is still not good.

Based on the description of the background, the researcher was motivated to conduct this study to describe the level of students' metacognition in solving mathematical problems.

METHOD

This type of research is descriptive qualitative research that aims to observe, describe, analyze, and describe the situation that occurs. This study uses qualitative data that is described to get a picture of the level of students' metacognition in solving mathematical problems on set material. Metacognition describes the process by which students plan, monitor, and evaluate (Sumarno, 2020). Subjects were selected from class VII B students at SMP Negeri 2 Sukodadi, Lamongan Regency. The instrument used in this research data collection is in the form of problem-solving ability tests, interviews, observations, and documentation. The researcher conducted a math problem-solving ability test in the class. From the results of these tests, the researchers found the problem-solving abilities of class VII B. To focus on data analysis, 3 students were selected who represented problem-solving abilities, namely high, medium and low. Furthermore, researchers will conduct interviews with the subject to determine the level of metacognition namely reflective use, strategic use, and aware use.

RESULT AND DISCUSSION

Based on the results of the problem-solving ability test on the set material conducted by 32 students of class VII at SMP Negeri 2 Sukodadi, the level of problem-solving ability and level of students' metacognition are shown in the Table 1.

The results of this study indicate that the metacognitive activity carried out when the subject solves the problem shows diversity. This diversity occurs when the subject solves a relatively challenging mathematical problem. The challenging nature of the problem being solved encourages the subject to re-optimize the process of metacognition. Furthermore, it will discuss the level of students' metacognition in solving mathematical

problems based on the research results that have been obtained and will be compared with existing theories and research.

Table 1. Level of problem-solving ability and the level of students' metacognition

The level of mathematical problem-solving ability	The number of students	Metacognition level of students	Description
High	7	Reflective Use	6 students
		Strategic Use	1 student
Medium	5	Strategic Use	5 students
Low	20	Strategic Use	3 students
		Aware Use	17 students

a. Metacognition Level of Students' Reflective Use

The results of the metacognitive process analysis carried out on subjects with high mathematical problem-solving abilities showed that the metacognitive activities carried out were complete. Subjects performed all the steps of Polya (1981) in solving the given problem very well. Subjects can explain the information contained in the questions, can understand what the questions are asking well, can choose the appropriate strategy, can reveal the reasons for their thinking process, re-check, can conclude the answers, and are confident in the solution. The subject's ability to realize and organize their thinking during the problem-solving process is very good. This is in line with previous research, namely students who have good metacognitive abilities when solving problems will have a good impact on the learning process and achievement (Ormrod, 2009).

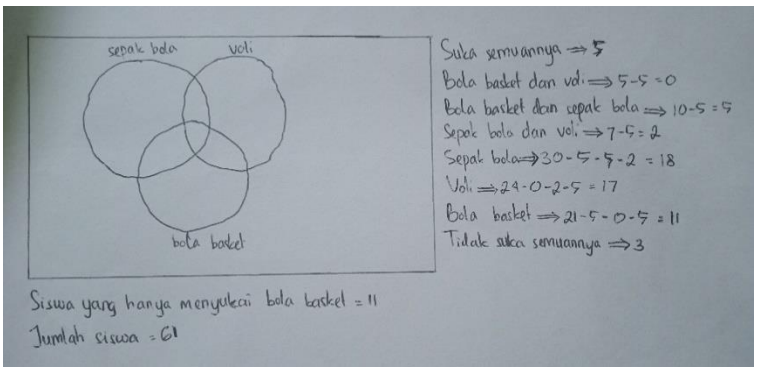

Figure 1. Student's Answer Sheet Reflective Use

b. Metacognition Level of Strategic Use Students

The results of the metacognition process analysis were carried out on subjects with mathematical problem-solving abilities who were showing that metacognitive activities

were carried out well. Subjects were only able to carry out the steps of Polya (1981) without re-examining the solution that had been completed. Subjects can explain the information in the questions clearly, understand what the questions ask for well, choose the appropriate strategy, express the reasons for their thinking process, are confident in the answers obtained, and conclude but do not re-check the solution. This means that metacognition has a very important role in problem-solving. Therefore, implementing metacognitive strategies will help students solve mathematical problems (Mufida et al., 2020; Özsoy & Ataman, 2009).

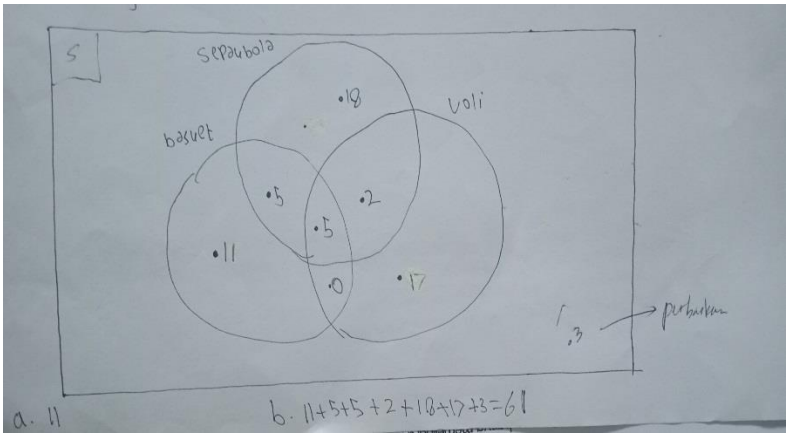

Figure 2. Strategic Use Student Answer Sheet

c. Metacognition Level Aware Use Students

The results of the metacognitive process analysis carried out on subjects with low mathematical problem-solving abilities indicate that metacognitive activities are carried out quite well. The subject was only able to carry out a few steps Polya (1981) well, this was caused by the subject who had difficulty thinking about the concepts used (confusion over choosing the method to be used after understanding the problem). Subjects can clearly state the information on the questions, can understand the questions in the questions well, but cannot express the reasons for their thought processes because of confusion when choosing a settlement plan so they are not optimal in carrying out the settlement plan. The subject also did not re-check the results of the completion. Students who have high metacognitive abilities are much better at solving math problems when compared to students who have low metacognitive abilities (Bas, 2016; Fitria et al., 2016).

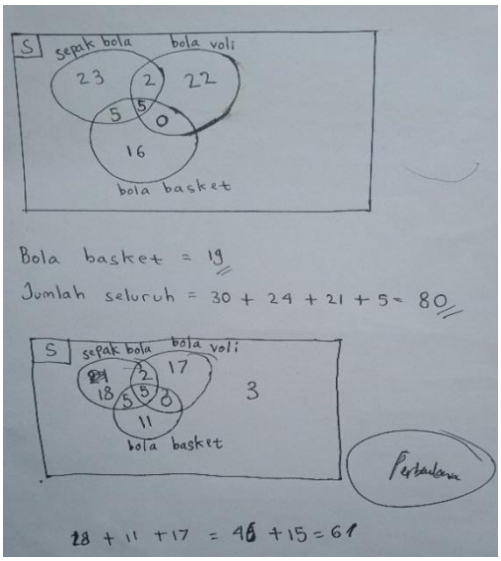

Figure 3. Aware Use Student Answer Sheet

Research conducted in class VII B located at SMP Negeri 2 Sukodadi Lamongan Regency obtained the results that the students' metacognition levels consisted of reflective use, strategic use, and aware use. In this class, there is no level of tacit use metacognition, because basically, this class is class VII which is special from other VII classes at SMP Negeri 2 Sukodadi. Class VII B is an achievement class, it can be interpreted that those in this class are the chosen students of the hundreds of other class VII students. Before entering school, there was an impromptu science and language math test, so that in the end the students who excelled in class VII B were selected. Therefore, in this class, the average ability tends to be medium-high.

Based on the discussion above, it is found that the students have metacognition that tends to be moderate to high in solving mathematical problems, both at the planning, monitoring, and evaluation stages. The following is a table comparing the metacognition levels of students in solving mathematics problems at each stage.

Table 2. Differences in Students' Metacognition Levels

Metacognition Stage	*Reflective Use*	*Strategic Use*	*Aware Use*
Planning	• students understand the questions well because they can identify important information in the questions • students know strategies to solve problems • students can explain strategies to solve problems	• students understand questions because they can express the problem well • students do not have difficulty or confusion in counting • students can explain what they have written	• students understand the problem because they can express problems • students have difficulty and confusion because they think about the strategy to be used • students only explain part of what's written
Monitoring	• the students did not experience any misconceptions or means used • the student can give reasons to support his thinking	• students are aware of misconceptions and how to calculate and can correct • the student can give reasons to support his thought	• the student's conceptual errors and how to calculate but cannot correct them • students experience confusion because they cannot continue with what they are going to do
Evaluation	• students evaluate each step written down • students believe in the results obtained	• students who do not evaluate or do evaluations will appear confused if the results obtained do not evaluate	• students do not evaluate • students evaluation but are not sure of the results obtained

CONCLUSION

Based on the above discussion, it can be concluded on the analysis of students' metacognition in mathematical problem solving that is metacognition Use Reflective level students in solving mathematical problems, including very good. Subjects from this category carry out more and more complete metacognitive activities in problem-solving. The subject involves all metacognitive activities, namely planning, monitoring, and evaluating at each stage of problem-solving. Meanwhile, students' metacognition at the Strategic Use level in solving mathematical problems is quite good. This is because the subject of this category performs metacognitive activities quite completely. The only stage that does not completely involve the type of metacognitive activity is the stage of making a problem-solving plan, namely the subject does not involve the type of monitoring activity and is less thorough in applying the concepts that have been thought out. Furthermore, the metacognition performed by Aware Use level students in solving mathematical problems is relatively incomplete. The subject's ability is still lacking in realizing and organize his knowledge during the problem-solving process. The subject also does not understand the problem so the calculation is relatively wrong.

REFERENCES

Anggo, M. (2011). Pemecahan Masalah Matematika Kontekstual untuk Meningkatkan Kemampuan Metakognisi Siswa. *Edumatica : Jurnal Pendidikan Matematika*, *1*(2), 35–42. https://doi.org/10.22437/edumatica.v1i02.182

Bas, F. (2016). Pre-Service Secondary Mathematics Teachers' Metacognitive Awareness and Metacognitive Behaviours in Problem Solving Processes. *Universal Journal of Educational Research*, *4*(4), 779–801.

Firdaus, A., & Shodikin, A. (2022). Analisis Berpikir Kreatif Siswa dalam Pemecahan Soal Cerita pada Materi Pecahan Berdasarkan Jenis Kelamin. *Jurnal Eksakta Pendidikan (JEP)*, *6*(1), 61–68. https://doi.org/10.24036/jep/vol6-iss1/646

Fitria, C., Sujadi, I., & Subanti, S. (2016). Analisis Kesulitan Metakognisi Siswa dalam Memecahkan Masalah Sistem Pertidaksamaan Linear Dua Variabel Ditinjau dari Tipe Kepribadian Guardian, Artisan, Rational, Dan Idealist Kelas X SMKN I Jombang. *Jurnal Pembelajaran Matematika*, *4*(9), 824–835.

Mufida, S. N., Sigit, D. V., & Ristanto, R. H. (2020). Integrated project-based e-learning with science, technology, engineering, arts, and mathematics (PjBeL-STEAM): Its effect on science process skills. *Biosfer: Jurnal Pendidikan Biologi*, *13*(2), 183–200. https://doi.org/10.21009/biosferjpb.v13n2.183-200

Novita, T., & Widada, W. (2018). Metakognisi siswa dalam pemecahan masalah matematika siswa sma dalam pembelajaran matematika berorientasi etnomatematika Rejang Lebong. *Jurnal Pendidikan Matematika Raflesia*, *3*(2), 67–81. https://doi.org/10.33369/jpmr.v3i2.6288

OECD. (2019). *PISA 2018 Assessment and Analytical Framework*. Paris: OECD Publishing. https://doi.org/10.1787/b25efab8-en

Ormrod, J. E. (2009). *Psikologi Pendidikan Membantu Siswa Tumbuh dan Berkembang* (Jilid 1). Jakarta: Erlangga.

Özsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 68–83.

Polya, G. (1973). *How to Solve It: A New Aspect of Mathematical Method*. Princeton, NJ: Princeton University Press.

Polya, G. (1981). *How to Solve It*. Princeton, NJ: Princenton University Press.

Schleicher, A. (2019). *PISA 2018 Insights and Interpretations*. Paris: OECD Publishing. https://doi.org/10.1787/b25efab8-en

Sumarno, W. K. (2020). The Role of Metacognitive Strategies and Awareness in Writing Task Performance. *INELTAL Conference Proceedings*, 109–115. http://ineltal.um.ac.id/ineltal-2020-proceedings/

Sumarno, W. K., Kusumaningrum, W. R., & Nurhayati, E. (2022). The effects of knowledge and regulation of cognition on the students' writing skills in a metacognitive process-oriented writing instruction. *Journal of Language and Linguistic Studies*, *18*(1), 523–536. https://doi.org/10.3316/informit.400286453976228

Sunendar, A. (2017). Perangkat Pembelajaran Matematika Berbasis Teori Kecerdasan Majemuk Apa dan Bagaimana Mengembangkannya. *Jurnal THEOREMS (The Original Research of Mathematics)*, *1*(2), 1-12. https://doi.org/10.31949/th.v1i2.373

Wulandari, D., & Minarni, A. (2018). Analysis of Students Metacognition Abilityin Mathematical Problem Solving On Problem Based Learning in SMA Negeri 1 Binjai. *International Journal of Research & Method in Education*, *8*, 32–40. https://doi.org/10.9790/7388-0801023240.