Advances in Social Science, Education and Humanities Research, volume 488
Proceedings of the 5th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2020)

Analysis of Students' Metacognition-Based Mathematical Reasoning Abilities in Guided Discovery Learning

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ABSTRACT
This study aims to analyze: the level of students' metacognition-based mathematical reasoning skills in guided discovery learning, a description of the answer process for students' metacognition-based mathematical reasoning abilities in guided discovery learning, the difficulties of students' metacognition-based mathematical reasoning processes in guided discovery learning. This research is a descriptive qualitative research. The results of the study are as follows: there are 5 students who have a high category of mathematical reasoning ability with a reflective use level of metacognition of 2 students and 3 students of metacognition at the strategic use level; There are 13 students who have a moderate level of mathematical reasoning ability with strategic use level metacognition totaling 11 students and metacognition level aware use totaling 2 students; There are 10 students who have a low category of mathematical reasoning skills with a level of aware use metacognition totaling 7 students and 3 students at the tacit use level. The student answer process is observed based on mathematical reasoning abilities, it is concluded that: students with high-level mathematical reasoning skills with reflective use and strategic use level metacognition with answer processes that meet the reasoning stages, students with moderate level mathematical reasoning skills with metacognition at the strategic use level that process Students' answers fulfill the reasoning stage, while students with metacognition with the aware use level, some students do not reach the reasoning stage, students with low-level mathematical reasoning skills with metacognition levels of aware use and tacit use with answer processes that do not meet the reasoning stage. Students who experience difficulties experienced by students at moderate and low levels include the difficulty of facts, concepts, principles, and procedures.

Keywords: *reasoning, metacognition, guided discovery*

1. INTRODUCTION

Mathematics is a science that plays an important role in education. Mathematics is universal which has the characteristics to demand reasoning, logical, analytical, systematic, critical, innovative, and creative thinking. According to Cockrof (Abdurrahman, 2012) argues that mathematics needs to be taught to students because (1) it is always used daily, (2) all fields of study require appropriate mathematical skills, (3) is a strong, short and clear means of communication, (4) can be used to present information in a variety of ways, (5) increase logical thinking skills, accuracy, and spatial awareness and, (6) provide the ability to solve challenging problems. Sinaga (2007) states "There are many factors causing learning difficulties. For example, those that come from outside the student, for example the learning process related to the curriculum, how to present the subject matter, and the learning approach carried out by the teacher. So that in studying there are those who feel afraid, some are bored and some are allergic to maths lessons. As a result, students are not able to be independent and do not know what to do so that students' mathematical reasoning abilities are of low quality when learning takes place.

Ronawati (2011) states that lowest average percentage achieved by Indonesia students is in the cognitive domain at the reasoning level, namely 17 %. In line with preliminary research in class VIII-1 Junior high school Parulian 1 Medan that students' mathematical reasoning ability in solving problems is stated in the low average category.

Children with learning difficulties generally have low metacognition skills (Abdurrahman, 2012).

According to Weden, if students have developed their cognitive regulation skills and knowledge, it means they are using metacognition and they are academically superior. So it is very important to see the relationship between student achievement and their metaconitive knowledge and skills (Akman & Alagoz, 2018).

From the above statement, it is necessary to apply a guided discovery learning model. Amin firmly (Suriadi, 2006) argues that a "discovery" activity is an activity or learning designed in such a way that students can discover concepts and principles through their own mental processes. Guided discovery learning models can direct and guide students to be able to understand concepts and mathematical thinking, explain the relationship between concepts and apply concepts or algorithms, in a flexible, accurate, efficient, and precise manner, in problem solving and can use reasoning on patterns and properties, manipulate mathematics in making generalizations, compiling evidence, or explaining mathematical ideas and statements to improve students' mathematical understanding and reasoning abilities.

So, the guided discovery model learning is a suitable model to be applied to analyze students' mathematical reasoning abilities based on metacognition. In addition, the guided discovery model is one of the learning models directed in the application of the curriculum in Indonesia today. Based on the above problems, the researcher is interested in conducting research on "Analysis of Mathematical Reasoning Ability Based on Student Metacognition in Guided Discovery.

2. THEORETICAL STUDIES

2.1 Mathematical Reasoning Ability

Brodie, (2010) states that, “Mathematical reasoning is reasoning about and with the object of mathematics”. Mathematical reasoning: thinking through math problems logically in order to arrive at solutions. It involves being able to identify what is important and unimportant in solving a problem and to explain or justify a solution.

Mathematical reasoning indicators according to Hasratuddin (2018) are as follows:

1) Be able to submit conjectures
2) Provide reasons or evidence for the truth of a statement
3) Draw conclusions from a statement
4) Checking the validity of the argument
5) Finding patterns in a mathematical phenomenon
6) Provide an alternative to an argumentUnits

2.1.1 Metacognitive

According to Flavell (in Jayapraba, 2013) metacognition is “one’s knowledge concerning one’s own cognitive processes and products or anything related to them”. In this case, metacognition is considered as knowledge about one's own cognitive processes and results or anything related to cognitive processes.

NCREL (2007) suggests three basic elements of metacognition specifically in dealing with tasks, namely: developing action plans, organizing or monitoring actions, and evaluating actions.

The success and success of a person in solving math problems is very much dependent on being aware of their thought processes about what they know and how they do it. Successful students are students who can consciously monitor and control their learning strategies. However, each student has different abilities in dealing with problems.

Swartz and Perkins (Laurens, 2010) state that there are four levels of awareness thinking, namely tacit use, aware use, strategic use, and reflective use. Tacit use is the use of thought without awareness. Aware use is the conscious use of thinking. Strategic use is the use of strategic thinking. Reflective use is the use of reflective thinking.

2.1.2 Student Learning Difficulties in Learning Mathematics

According to Abdurrahman (2012) student learning difficulties can be caused by two factors, internal and external. The main cause of learning disabilities is internal factors, namely the possibility of neurological dysfunction, while the main cause of learning problems (lerning problems) is external factors, that is among others, in the form of wrong learning strategies, management of learning activities that do not generate children's learning motivation. Likewise with the difficulty in learning mathematics, there are several factors that cause it.

Begle (in Siahaan, 2006) describes that mathematical objects in difficulty consist of four types, that is: facts, concepts, procedures, and principles.

2.1.3 Guided Discovery Model

Bruner (Dahar, 1996) states that discovery learning is compatible with the active seeking of knowledge by humans, and that in itself gives better results. Trying to find solutions to problems on your own, and the knowledge that goes with them, results in knowledge that is truly meaningful. Learning discovery can lead to confidence in students to express ideas or ideas on the material being studied. In discovery learning, students do not receive all knowledge information from the teacher, but try to find what has been set in the learning objectives.

Students must play an active role in the learning process that occurs in the classroom.

Castronova (Suriadi, 2006) argues that there are four main focuses of the advantages of guided discovery learning compared to ordinary learning, namely: (1) motivation (2) memory (3) achievement and (4) transfer / transfer of knowledge. Discovery learning enables students to search for information that satisfies their curiosity. This learning provides opportunities for students to explore their desires and creates a more engaging learning environment. Students are more motivated than students taught by the usual method.

So the guided discovery referred to in this research is the process by which students think, observe, digest, understand, make guesses, explain, analyze so that they can construct and find their own general principles with guidance and instructions from the teacher and worksheets, in the form of questions. who steered.

3. METHOD

This research is a descriptive qualitative research using the case study method. According to Moleong (2016), qualitative research is research that intends to understand what phenomena are experienced by research subjects such as behavior, perception, motivation, action, and others. Holistically and by means of description in terms of words and language, in a specific natural context and by making use of various natural methods.

This research was carried out in one class, namely in class VII-1 of Parulian 1 Medan Junior High School with 28 students with mathematics teaching material, namely comparison, in the 2020/2021 school year. Metacognition-based mathematical reasoning ability test instrument of students with four questions of reasoning descriptions and metacognition questions in each question.

Data analysis techniques in qualitative research using the Miles & Huberman data analysis steps are shown in Fig. 1.

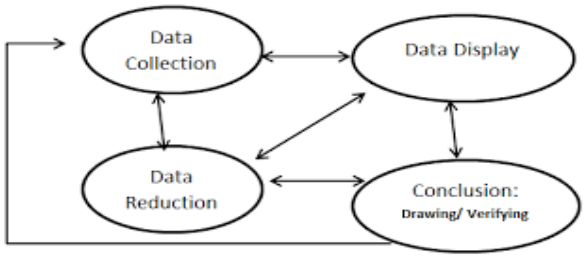

Fig. 1. Data Component Analysis of Miles & Huberman Model

Based on Fig. 1 above, after collecting data, the researcher anticipates it before doing data reduction. Each student's score is determined based on the test results, namely the mathematical reasoning test. All test results are collected for review and scored according to scoring guidelines.

For the determination of the minimum standard based on the minimum completeness criteria $\geqslant 2.67$. The value of students' knowledge and skills is determined by the following formula:

$$\text{Student scores} = \frac{\text{Score obtained}}{\text{Maximum score}} * 4$$

Based on this view, the results of tests of mathematical reasoning abilities can be presented in the criteria interval in Table 1 below:

Table I. Students' Mathematical Reasoning Ability Levels

Interval Skor	Kriteria
3,18 ≤ SKPM< 4,00	High
2,18 ≤ SKPM< 3,17	Moderate
0,00 ≤ SKPM< 2,17	Low

Meanwhile, to determine criteria and analyze student metacognition test data descriptively at the end of the lesson, and presented in the following criteria interval.

Table II. Interpretation Of Students' Metacognition Levels

No	Interpretasi Metakognisi Siswa	Kriteria Metakognisi
1	3,41 – 4,00	*Reflective Use*
2	2,67 – 3,40	*Strategic Use*
3	1,33 – 2,66	*Aware Use*
4	0,00 – 1,32	*Tacit Use*

To check the validity of the data, data triangulation techniques will be used. According to Moleong (2016), triangulation is a technique of checking the validity of data by utilizing something outside the data, for checking or as a comparison to that data.

4. RESULT AND DISCUSSION

4.1 Descriptions of Students' Mathematical Reasoning Ability Based on Metacognition

Based on the results of the students 'metacognition-based mathematical reasoning ability test, the students' mathematical reasoning ability and metacognition level were obtained as follows:

Table III. Descriptions of Students' Mathematical Reasoning Ability Based on Metacognition

Students' Level of Mathematical Reasoning	Total Students	Student Metacognition Level	Information

High	5	Reflective Use	2 students
		Strategic Use	3 students
Moderate	13	Strategic Use	11 students
		Aware Use	2 students
Low	10	Aware Use	7 students
		Tacit Use	2 students

4.2 Subject Collection

Of the 28 students, 6 were selected to be interviewed. The selected subjects who were interviewed were as follows:

Table IV. Selected subjects for interviewing students' metacognition-based mathematical reasoning ability.

No	Student Code	Subject Appointment	
		Level of Reasoning	**Metacogeneity level**
1	S-7	High Ability	*Reflective Use*
2	S-12	High Ability	*Strategic Use*
3	S-5	Moderate ability	*Strategic Use*
4	S-27	Moderate ability	*Aware Use*
5	S-19	Low proficiency	*Aware Use*
6	S-23	Low proficiency	*Tacit Use*

In the learning process carried out for three meetings in class VII-1 of Parulian 1 Medan Junior High School that student activity is getting better after the Guided Discovery learning model is applied compared to previous learning which still uses conventional learning in the form of lectures or explaining theory only. While learning emphasizes a student-centered learning model, it also requires that students' metacognition-based mathematical reasoning abilities can be trained, accustomed to, and cultured properly through interactions between students and teachers.

The reasoning process of students based on reasoning indicators consists of the ability to perform mathematical manipulation, the ability to check the validity of an argument, the ability to draw conclusions. The students' difficulties in this study were inseparable from difficulties in mathematical objects in facts, concepts, principles and procedures. In the opinion of Shah (2002) states, the phenomenon of a student's learning difficulties is usually evident from the decline in academic performance or learning achievement.

The difficulties in this study, in line with Begle's opinion (in Siahaan, 2006) about the difficulty of students in solving problems on mathematical objects, consist of four types, namely (1) facts, (2) concepts, (3) procedures, (4) principles. In discussing the difficulties in students in this study related to their reasoning process. Students with high category reasoning abilities who are at the level of metacognition reflective use and strategic use, are able to solve the problems given and on average are able to achieve reasoning indicators.

In line with the results of research by Maharani & et al. (2017) stated that students with high abilities in the reasoning process in the preparation stage understand problems and have the knowledge to solve problems. In other words, that high ability students do the reasoning process well.

Students of the category of mathematical reasoning ability are at the strategic use and aware use metacognition level, where they are able to provide information from the questions by making it known and what is asked of the questions. So, it can be said that they do not experience any difficulties in this process because they understand the facts of the problem.

Students with moderate category mathematical reasoning ability with strategic use metacognition do not need long time to settle the problem to find ideas by generating the same and different findings. so that they do not have difficulty in determining ideas.

The difficulty in the procedure is the inability of students to solve the problem in describing the steps to solve it. Students whose mathematical reasoning abilities are in the moderate category with the metacognition level of strategic use, generally they are able to verify the answers to the solution of each problem.

Students with moderate category of metacognition level aware use. Based on the ability of students to provide information by being known and asked and understanding the problems given, it can be said that students with moderate ability to reason do not experience difficulties in facts. However, these students need a long time to settle or reflect on the problem in finding ideas about the concept of solution that will be changed. However, the concept of the problem which is transformed into a new concept in order to facilitate the solution is an incorrect concept resulting in a wrong answer.

Furthermore, in the process of reasoning in solving, students who have moderate category mathematical reasoning skills with a metacognition level of aware use, the initial ideas become solutions and solve problems but they experience difficulties in determining the right solution formula, in addition to the resolution procedures that are not in accordance with the rules. . In the final stage, they do not re-check the answer sheet for the problem it resolves.

Based on the research results of Setiawani & et al (2019), students who are in the medium category are able to understand problems well. They can identify the known and questioned elements, and the adequacy of those elements needed. In addition to identifying known data or data being asked correctly, students can also convey it in their own way. Although it is a bit complicated to convey it, but the essence of the problem can be conveyed correctly.

In the metacognition of students who have mathematical reasoning abilities, the category is at the strategic use and aware use metacognition level. However, among students with moderate reasoning abilities, their thinking awareness is more dominant at the strategic use metacognition level. In addition, there are students with the metacognition level of aware use, which means that students use low-awareness thinking.

Furthermore, students with low categories of mathematical reasoning ability with metacognition levels of aware use and tacit use have difficulty solving problems. In the process of reasoning, only a few students with low category mathematical reasoning abilities are able to provide information on the elements of each problem by providing known information and the problems asked in the questions, then understanding the facts. However, more of them are unable to solve there are some problems that are not done at all due to a lack of understanding of the problems and difficulty in facts.

Furthermore, students with low category mathematical reasoning abilities with metacognition levels of aware use and tacit use, need a long time to settle problems to find ideas. So that for problem-solving solutions based on the ability to reason in solving and developing problem solving, it was found that there were difficulties for students in solving problems. The difficulties found when solving problems are difficulties in determining the right concept, difficulty in understanding the concept of the problem, difficulty in applying the solving formula (principle), difficulties in calculating operations and solving procedures that are not in accordance with the rules. Thus low-ability students are not able to double-check the completion of their answers and do not provide information or final conclusions from each answer.

In line with the opinion of Maharani (2017), it is stated that students in the lower category have experienced difficulties. They do not understand the math problems and assignments given. Moreover, they have no information or knowledge with which to solve problems. As a result, students are not clear in implementing ideas to solve problems and the solutions obtained are also wrong.

Students with low category mathematical reasoning ability with the level of metacognition aware use means that in solving problems based on students' thinking awareness by using low-conscious thinking. Meanwhile, students with tacit use metacognition level means solving problems based on the students' thinking awareness by using unconscious thinking.

This is in line with research by Lestari & et al (2018) which states that the lower group can understand the problem by writing what is known from the problem. Further, they can use concepts / formulas and realize misconceptions but they don't know how to fix them. Generally the lower group students make more misunderstanding and confusion in choosing the solution strategy than the upper group students

5. CONCLUSION

Based on the results of data analysis, it can be concluded that the process of mathematical reasoning in guided discovery, namely (1) students with high category reasoning abilities, do not experience difficulties, (2) students with moderate category reasoning abilities, students have difficulty finding new concepts because students are unable to produce different ideas, (3) students with low category reasoning abilities, students have difficulty understanding the facts of this problem and difficulties in developing solutions in solving problems and difficulties at the verification stage due to not being able to re-check and the procedures used are not systematic and not according to the rules of mathematics. Meanwhile, students with high and moderate abilities who are at the reflective use and strategic use metacognition level have a good awareness. Meanwhile, students who are capable of being aware of use metacognition level are less aware of their thinking in solving problems. Low-ability students with metacognition levels of aware use and tacit use are very low in realizing they will solve problems so that they are more dominant in solving without good awareness

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