ANALYSIS OF STUDENT'S MATHEMATICAL REASONING ABILITY IN LEARNING INDEPENDENCE ON GEOMETRY MATERIALS

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Abstract

One of the standards of competence included in the default development process is the ability to reason, which is one of the skills to be developed. In resolving potentially challenging problems, students need to develop the ability of a student's mathematical reasoning. It is, therefore essential to improve students' mathematical reasoning ability. The purpose of this study is to describe how junior high students use mathematical reasoning to solve geometry problems with their learning independence. This study used a descriptive qualitative research methodology using 30 class VIII junior high school students in Bekasi as research subjects. The methods used to obtain information include written tests for mathematical reasoning abilities, independent learning questionnaires, and interviews to find out whether the answers given are correct as they are and to strengthen the results of the previous written test. The results showed that students with the highest mathematical reasoning abilities also had a high level of learning independence from all subjects in this study. However, students who have not fully met the indicators of mathematical reasoning ability have good learning independence.

Keywords: mathematical reasoning, independent learning, geometry

Abstrak

Salah satu standar kompetensi yang termasuk dalam proses pengembangan standar adalah kemampuan penalaran, yang merupakan salah satu keterampilan yang harus dikembangkan. Dalam menyelesaikan masalah yang dianggap menantang, sangat penting bagi siswa untuk mengembangkan kemampuan penalaran matematis siswa. Oleh karena itu, sangat penting untuk meningkatkan kemampuan penalaran matematis siswa. Tujuan dari penelitian ini adalah untuk mendeskripsikan bagaimana siswa smp menggunakan penalaran matematis dalam menyelesaikan masalah geometri dengan kemandirian belajar mereka. Penelitian ini menggunakan metodologi penelitian kualitatif deskriptif dengan menggunakan 30 siswa kelas VIII SMP di Bekasi sebagai subjek penelitian. Metode yang digunakan untuk memperoleh informasi meliputi tes tertulis untuk kemampuan penalaran matematis, angket kemandirian belajar, dan wawancara untuk mengetahui apakah jawaban yang diberikan benar apa adanya dan untuk memperkuat hasil tes tertulis sebelumnya. Hasil penelitian menunjukkan bahwa siswa dengan kemampuan penalaran matematis tertinggi juga memiliki tingkat kemandirian belajar yang tinggi dari semua subjek dalam penelitian ini. Namun, siswa yang belum sepenuhnya memenuhi indikator kemampuan penalaran matematis memiliki kemandirian belajar yang baik.

Kata kunci: penalaran matematis, kemandirian belajar, geometri

INTRODUCTION

Every student should take mathematics because it is an important subject. One of the skills to be developed and one of the competency standards included in the standards development process is reasoning ability. Improving this ability is important because mathematics places special emphasis on thinking processes, not just the results of analysis or perception (Agusti et al., 2023). Therefore, mathematical knowledge must be obtained by

students as early as possible. The ability to reason mathematically is an important talent for all students, especially junior high school students.

The foundation for learning mathematics is the ability of mathematical reasoning. This reasoning capacity is closely related to examples of coherent, scientific, and assertive reasoning. Someone will be able to reach a conclusion or make decisions about everyday life if they have good reasoning (Dinda Kurnia Putri et al., 2019). If someone who studies mathematics has not yet developed the ability to think logically, then for him, mathematics is only a lesson in playing with numbers, formulas and algorithms, and mathematics as a series of lessons following the completion process. Mathematical material and mathematical reasoning cannot be separated because reasoning is understood through learning mathematics, and mathematical material is understood through reasoning (Izzah et al., 2019).

How important it is to have mathematical reasoning skills when learning mathematics, making it easier for students to solve or try to solve problems that are considered difficult. Students' abilities to investigate, analyze, and organize material and design appropriate ways to draw conclusions or formulate new claims are aspects of students' mathematical reasoning abilities, which will continue to have a good impact on their mathematics learning (Meilina Arifin & Tsurayya, 2022). However, there is still a lack of students' capacity for mathematical reasoning abilities towards independent learning (Isnaeni et al., 2018). In accordance with the Regulation of the Minister of National Education of the Republic of Indonesia No. 36 of 2018, students are expected to be able to fulfill the objectives of learning mathematics while at school. In addition to mathematical reasoning abilities, independent learning abilities are also important for students to have. The soft skill that must be developed by students is independence in learning mathematics. Independent learning is needed in order to master learning material in all subjects, including mathematics (Susanto et al., 2022).

Student learning is very dependent on student learning independence. Because every student has different characteristics and enthusiasm for learning. Learning independence emphasizes student activity with a sense of full responsibility for their own success. Learning that does not depend on outside help does not always mean learning on its own. Students can try to solve difficulties on their own rather than waiting for help from peers or teachers when doing so (Ira Fitria Rahayu & Indrie Noor Aini, 2021). Many students still find it difficult to

study independently and respond to teacher questions when they study mathematics in class. The result is a decline in academic results, reliance on schoolwork and a sense of responsibility as a student.

Geometry material is a math lesson that is difficult for students to understand (Siregar et al., 2020). The difficulty in understanding geometry students lies in the basic concepts and application of formulas in solving problems (Fauzi & Arisetyawan, 2020). There are several mathematical materials that can be used in current issues related to reasoning abilities in the process of learning mathematics. Flat sided geometric shapes is one of the materials. In order to apply the principles of geometry to problems that arise in everyday life, it is essential for students to be well versed in geometry. When studying this geometry, students must translate the language of life into the language of mathematics and interpret the results of their calculations according to the problems given to get the solution. Someone who has a strong understanding of abilities will easily gain an understanding of a concept and can connect concepts creatively in order to reach solutions when faced with problems (Masfingatin et al., 2020).

METHODS

This research method uses qualitative research with a descriptive approach to describe the mathematical reasoning abilities of junior high school students on student learning independence in solving problems related to geometry. According to (Dr. Umar Sidiq & Dr. Moh. Miftachul Choiri, 2019), qualitative research is research that gives rise to inventions or discoveries that are impossible to produce when using statistical calculation methods or quantitative methods.

This research was conducted in one of the schools in Bekasi for the 2022/2023 school year with a total of 30 students in grade VIII. The instrument consists of essay test sheet with four questions about flat sided geometric shapes used to collect data about students mathematical reasoning abilities and 23 questionnaire items about independent learning. Mathematical reasoning ability tests are given to students after students complete the learning independence questionnaire. In addition, research information was also obtained through interviews to find out that the answers given were correct as they were and to strengthen the results of the previous written test.

A total of 23 statements in the independent learning questionnaire sheet were given to students to measure the level of independent learning. Students need to choose between 10 negative and 13 positive statements from the independent learning questionnaire. The Likert scale will be used to measure student learning independence. The four responses on the Likert scale are strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS). These statements are separated into positive and negative categories. The learning independence questionnaire uses indicators, namely: 1. Learning Initiative and Intrinsic Learning Motivation, 2. Diagnosing Learning Needs, 3. Setting Learning Goals, 4. Managing and Controlling Performance/Learning, 5. Viewing Difficulties as Challenges, 6. Searching for and Utilizing Relevant Learning Resources, 7. Selecting and Implementing Learning Strategies, 8. Evaluating Learning Processes and Outcomes, and 9. Self Efficacy (self-concept).

In giving learning independence scores, students are required to respond to statements with one answer. Scoring guidelines can be seen in Table 1 below: (Gusnita et al., 2021)

Table 1. Guidelines for Scoring the Independent Learning Questionnaire

Statement	4	3	2	1
Positive	Strongly Agree	Agree	Don't agree	Strongly Disagree
Negative	Strongly Disagree	Don't agree	Agree	Strongly agree

Students use the ideas and concepts of flat sided geometric shapes to answer mathematical reasoning questions that are presented as geometry material. The choice of material for flat sided geometric shapes is done because the material has already been studied. The indicators of mathematical reasoning ability used in this study are: (Indriastuti & Kristiyani, 2019).

Table 2. Indicators and Aspects of Reasoning Ability

Mathematical Reasoning Indicator	Aspects of Mathematical Reasoning
Submitting a Conjecture	Students can state the purpose or problem being asked as well as describe the information that is known
Performing Mathematical Manipulation	Students can determine problem-solving strategies
Arranging evidence and giving reasons for a truth	Students can apply mathematical ideas and techniques to solve problems and explain how certain mathematical ideas relate to questions (given at interview)

Mathematical Reasoning Indicator	Aspects of Mathematical Reasoning
Check the validity of an argument	Models, facts, characteristics, and relationships can be used by students to provide explanations
Draw a conclusion	Students can draw conclusions from solutions using problem solving techniques that have been used

The assessment for the mathematical reasoning test sheet has criteria for each indicator with the aim of facilitating the analysis of students' mathematical reasoning. Furthermore, the following are the assessment criteria used to evaluate the results of students' mathematical reasoning tests: (Saputri et al., 2017).

Table 3. Mathematical Reasoning Scoring Rubric

Score	Criteria
4	Can give impeccable responses and display every evidence of a methodical, logical and complete thought
3	Can provide an appropriate response but only show some of the indicators required by the question
2	A solution that has more than one reasoning signature is desirable and is at least somewhat accurate
1	Improper conclusions are drawn or inappropriate parts of reasoning questions are discussed Wrong answer; however, the response (solution) has at least one sign of good thinking
0	No answer Wrong answer, the answer (solution) relies on the wrong methodology or doesn't include logical clues at all

RESULTS AND DISCUSSION

Results from the student learning independence questionnaire and interview data were included in the data collection of this study. The results of the student questionnaire are assessed according to the scoring guidelines. The following categories are used to group students:

Table 4. Student Name According to Category

No.	Student's Name	Category
1	SKA	High
2	KNA	Moderate
3	HSL	Low

The results of students' attempts to solve a given geometric problem are scored, and this information is used to analyze their mathematical reasoning abilities. Then 3 students will be taken according to the category to be interviewed.

The test results given to the research subjects revealed indicators of students' mathematical reasoning abilities. The test findings could be used to measure how well students' mathematical thinking abilities were. Students can be considered to have achieved reasoning abilities if they have been able to master these abilities. The following results are categorized as high, medium, and low:

1. Analysis of Students' Mathematical Reasoning Ability with High Learning Independence

   Questions that have been given to students can be answered and meet all reasoning indicators. They are able to quickly understand the meaning and purpose of the questions. This is evident through student learning outcomes in answering questions, even though certain things have not been done correctly, especially when expressing mathematical statements graphically and providing explanations for answers. However, in other indicators these students have shown very good abilities and perfect answers. Students who are able to learn on their own effectively monitor, assess, and manage their learning process usually have superior reasoning abilities.

2. Analysis of Students' Mathematical Reasoning Ability with Moderate Learning Independence

   The objectives and questions of this problem are generally challenging for students in the medium group to understand. This can be seen from the way students answer questions. Students have the ability to read questions by identifying the information provided, but still cannot graphically convey mathematical statements as stated in the questions. In compiling pictures, students

also did not show how or a systematic process. As a result, even though the solution may be correct, the justification for the conjecture may be lacking or unclear. Students exhibit unclear and incomplete reasoning weaknesses when faced with a problem that requires gathering evidence or reasoning from multiple solutions. In addition, because students provide immediate responses rather than demonstrating the validity of arguments through proper processes, they are unable to evaluate the truth or validity of those arguments. Even though students can read a problem by identifying the information provided and solving it, their conclusions or in other words their solutions may seem very good. Students who have reached a moderate level of learning independence can suggest and convey relevant ideas and concepts in response to questions. As a result, it can be said that students who are in the independent learning group have adequate mathematical thinking skills. Teachers can provide helpful feedback in error analysis and error correction to assist students in solving problems comprehensively and fluently. In addition, teachers can also provide guidance that emphasizes the application of mathematical concepts.

3. Analysis of Students' Mathematical Reasoning Ability with Low Learning Independence

Students who fall into this category have below average thinking skills. The majority of the questions given were beyond their ability to solve. Therefore, students who are in the low category can be concluded to have poor mathematical reasoning indicators based on their mathematical reasoning abilities. Not all students with a low level of learning independence also have a low level of mathematical reasoning ability, this is very important to emphasize. This is due to the fact that children with limited learning independence are not yet able to recognize what is needed, what is already known, and how to approach a problem. Incorrect findings were also obtained as a result of deficiencies in the settlement process. The challenges presented in the questions are still beyond the ability of students. To solve difficulties, children who lack independent learning still need a lot of help.

Based on the explanation above, the ability to think mathematically and independent learning are interrelated. All indicators for mathematical reasoning abilities can be fulfilled by students who show a high level of learning independence. Students are proficient in identifying and deciphering patterns in mathematical difficulty. Thus, students can make conjectures, carry out mathematical manipulations properly and well, and are able to provide reasons for a settlement process. Students can also do calculations correctly and plan the best strategy according to the concept used for flat sided space material. Furthermore, these students can make accurate conclusions. This shows clearly how independent learning influences children's talent to be proficient in solving mathematical problems.

Students with a moderate level of learning independence successfully fulfill 4 indicators in question number 1 and 2 indicators in questions numbers 2 and 3 and 1 indicator in question number 4. Students can detect known information and make the right hypothesis. Students can also create mathematical models that fit the existing information. Based on the known information in the question, this student can also plan and find patterns to solve problems.

Student able to complete calculations and use concepts to compile evidence for the correctness of answers to question number 1. However, students were still not quite right in answering questions number 2 and 3. In question number 2 the answers given by the students were almost correct, it's just that there was an error in the completion process so that the student's answers were not quite right with the reasons given. Whereas in question number 3 students have tried to finish well but the answers produced are not quite right. In question number 4 students were only able to make assumptions but could not solve the problem. Students have difficulty formulating or completing their answers correctly, as well as answering questions.

Students with low learning independence were only able to complete the four indicators in question number 1. In question number 2 students had tried to answer the question but the answers were wrong and did not meet the four indicators of mathematical reasoning. This is because students only answer using logic. Students did not answer at all on question number 3 because students did not understand what was meant in the question. In number 4 students were only able to complete one indicator out of four indicators. Students have tried to answer the questions but students could not make accurate predictions in

answering question number 4, but succeeded in doing so in answering question number 1. Even though this student could not solve problem number 4, students could make conjectures in answering question number 4 but students were unable to find patterns or plan. calculation well in solving the problem. Students also cannot apply the concept of flat sided geometric shapes and cannot correctly interpret the answers given in the questions.

The degree of learning independence impacts a person's capacity to resolve difficulties, according to the research findings discussed above. Students use mathematical reasoning to solve problems more successfully the more independent they are in learning. This finding is in line with the research of Khaerunnisa and Adirakasiwi which found a relationship between students' mathematical reasoning abilities and learning independence (Khaerunnisa & Adirakasiwi, 2021). This can be seen in the following table, which compares students with high, medium, and low levels of learning independence based on mathematical reasoning abilities.

Table 5. Comparison of Student Ability According to Category

No	Indicator	Students with High Learning Independence	Students with Moderate Learning Independence	Students with Low Learning Independence
1.	Submitting a Conjecture	Information that is known and requested in the problem can be mentioned by students	Information that is known and requested in the problem can be mentioned by students	Information that is known and requested in the problem can be mentioned by students
2.	Performing Mathematical Manipulation	In questions 1, 2, and 4, students are able to perform mathematical manipulations and choose the right solution. Students are less precise in manipulating mathematics in question number 3	Only for question number 1 students can manipulate mathematics and find the best solution. In questions 2, 3, and 4, students' ability to manipulate mathematics is lacking	In questions 1 and 4, students are able to manipulate mathematics and choose the right solution. Students are unable to manipulate mathematics on numbers 2 and 3
3.	Arranging evidence and giving reasons for a truth	In questions 1, 2, and 4, students are able to correctly and accurately identify patterns or	In questions 1, 3, and 4, students can recognize patterns or formulate plans to fix problems	Students have difficulty recognizing patterns or formulating acceptable and

		plan steps to solve problems	accurately and precisely	effective problem-solving strategies
4.	Check the validity of an argument	Students are able to accurately and completely describe the solution to the problem	Students are quite capable of accurately and clearly explaining problem solutions	Students are not able to explain the solution to the problem correctly
5.	Draw a conclusion	Students can draw conclusions from solutions using problem solving techniques that have been used	Although the student's approach to solving problems can provide solutions, it is not appropriate to draw conclusions from these solutions	Students have difficulty solving problems accurately and cannot draw conclusions from their research.

The justifications mentioned above lead to the conclusion that having good independent learning skills does not necessarily guarantee high mathematical reasoning abilities. Although students often have good mathematical reasoning abilities, they also have sufficient learning independence. In other words, increasing student learning independence can improve their mathematical reasoning abilities.

CONCLUSION

Based on the results of the analysis above, student independence can be classified into three, namely high, medium, and low. Students with high learning independence can fulfill the five indicators of reasoning abilities properly and precisely. Students who show average reasoning ability have good learning independence. However, students often experience difficulties in understanding the purpose of the problem and the questions asked. Students with low learning independence have difficulties and become a challenge in itself to solve problems which can be said that students are weak in mathematical reasoning.

It should be underlined that students with good learning independence still perform relatively well on indicators of mathematical reasoning ability, despite the fact that exam results are not always predictive of children with strong mathematical reasoning abilities. In other words, as students become more independent learners, their capacity to think mathematically will also grow. Students' ability to reason mathematically is influenced by the

level of independence in learning. This will affect the development of students' mathematical thinking abilities by increasing their capacity for independent learning.

ACKNOWLEDGMENTS

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