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Profile of Mathematical Reasoning Ability of Students of SMK Ma'wataibin Pagelaran in Solving Problems of Arithmetic Rows and Rows

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Abstract

This study describes the profile of students' mathematical reasoning ability in solving arithmetic rows and series problems. Based on the results of observations and interviews with the mathematics teacher of class X SMK Ma'wataibin Pagelaran Malang, information was obtained that 83% of students in the class tended not to be able to conclude the answer. This descriptive research uses a qualitative approach. The sample of this research is 19 students of class X SMK Ma'wataibin Pagelaran. They then selected one each in the high, medium, and low-level categories. Then, interviews were conducted with each subject to explore deeper information. The test instrument used is 1 question that contains four indicators of mathematical reasoning ability. The test results obtained that students in the high mathematical reasoning ability category amounted to 7 students, with a percentage of 36.85%. Students in the moderate mathematical reasoning ability category amounted to 8 students, with a rate of 42.10%. Students in the low mathematical reasoning ability category amounted to 4 students, with a rate of 21.05%. Based on the results of the data analysis, it is shown that high-category students fulfill four indicators of reasoning ability according to their abilities. Medium-category students correctly fulfill three indicators of mathematical reasoning ability: writing conjectures, doing work, and providing reasons/evidence. Low-category students only fulfill one indicator of mathematical reasoning ability, namely writing conjectures.

INTRODUCTION

Education is a process in which humans can develop their potential through learning. Article 31 Paragraph 1 of the 1945 Constitution states that everyone has the right to learn and everyone has the right to education. Handayani (2020) explains that education is essential to human life. Most people get their education at school, but some parents teach their children at home today. Students and teachers interact to achieve a goal (Fitri, 2021). Education is an effort to maintain the culture inherited byprevious generations. Education can change the future by teaching humans to userationality to solve problems in everyday life.

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Improving the quality of education in the 21st century has several demands that students must master. Good quality education can support the country in achieving progress (Anggraini, 2021; Munasiah et al., 2020). In the twelve-year education process from elementary to high school, many subjects include mathematics. However, few students think math is complicated, so this subject is often ignored (Anggraini, 2021; Puka et al., 2021). This assumption is what makes math uninteresting. This results in mathematics learning objectives that cannot always be achieved in every process (Chisara et al., 2018).

Mathematics must exist at every level of education, closely related to life in the surrounding area. Indirectly, math is used in every activity for complex things (Yolanda & Wahyuni, 2020). Mathematics is a compulsory subject that must be taught. Every student at the secondary level of education is required to study mathematics (Kemendikbud, 2016). Life also requires essential competencies that exist in mathematics (Ekstam et al., 2018). Therefore, it is appropriate for mathematics learning in schools to be carried out with totality for the learning objectives to be achieved.

Students must study mathematics at all school levels to improve their ability to think logically, analytically, systematically, critically, and creatively. (Maulyda, 2019). According to the *National Council of Teachers of Mathematics* (NCTM), five primary standards focus on mathematics learning: problem-solving, communication, reasoning and proof, connection,and representation. From these standards, mathematical reasoning appears to be an essential problem-solving component.

According to Maulyda (2019), mathematical reasoning is reasoning related to mathematical objects to understand mathematics and use this understanding to solve problems. However, reasoning is a process that helps conclude (Ruslan & Santoso, 2013). Mathematics focuses here on branches such as statistics, algebra, geometry, and others. Mathematical reasoning ability is the ability to think logically and make conclusions based on the results of solving mathematical problems. Mathematical reasoning ability is essential in learning mathematics (Oktaviana et al., 2021).

If students fulfill the criteria of mathematical reasoning itself, they are considered to have completed the mathematical reasoning process. Some signs of mathematical reasoning ability, according to the Regulation of the Director General of Education and Culture of the Ministry of National Education No. 506/C/Kep/PP/2004, are as follows: (1) Write down the initial hypothesis; (2) Perform mathematical calculations; (3) Draw conclusions, and compile evidence; (4) show the correctness of the solution; (5) make conclusions about the results of the answer; (6) check the validity of arguments; (7) find patterns or properties of mathematical phenomena to make generalizations.

Based on the survey results, Indonesia ranks 74th out of 79 countries in the PISA competition (OECD, 2019). These results explain that students' ability to solve math problems, especially in numeracy literacy, is still very lacking. The average score obtained is still below the average of 79 other countries, namely for reading 371, math 379, and science 396 (Andrianti & Rahayu, 2022). Indonesia is one of the countries with low numeracy literacy skills for students (Kaka et al., 2021). This is because students find it

difficult tosolve math problems (Saputra et al., 2023). In addition, students are also not accustomed to solving problems like those on the PISA test (Ate & Lede, 2022). So, based on the results of PISA and TIMSS, it can be seen that there is a gap in students' numeracy literacy skills (Diva et al., 2022).

Based on the results of observations and interviews with class X mathematics teachers at SMK Ma'wataibin Pagelaran Malang in September 2023, information was obtained that students are given various types of contextual mathematics problems during mathematics learning. The problems given vary from low, medium, and high levels, and there are even problems that train students' higher-level abilities. This study was conducted to describe the mathematical reasoning ability of grade X students at SMK Ma'wataibin Pagelaran Malang when solving problems related to arithmetic seriesand sequence material.

METHOD

This descriptive research uses a qualitative approach. The sample is class X students of SMK Ma'wataibin Pagelaran, consisting of 19 students. The main focus of this research is students' mathematical reasoning on the material of arithmetic rows and series. Interviews and written tests were conducted to collect comprehensive data. The test used in this study consists of one question that includes four indicators of mathematical reasoning ability. After successfully obtaining the test results, the next step is thoroughly analyzing the data.

The first step was to analyze the students' answers using the predetermined indicators of mathematical reasoning ability. These students were then grouped by ability level, namely low, medium, and high groups, for further analysis. This research also involved further interviews with several students selected based on the results of student answers. The interview process was conducted to gain in-depth insight into their answers. Table 1 below shows the mathematical reasoning indicators used in this study:

Table 1. Indicators of Mathematical Reasoning Ability

Indicator of Mathematical Reasoning Ability
Writing down initial guesses
Perform math calculations
Provide evidence or reasoning for the correctness of the solution
Summarize the answer

This study uses the mathematical reasoning ability assessment rubric made by Sulistiawati.

Table 2. Rubric for Assessment of Mathematical Reasoning Ability

Score	Criteria
4	The overall answer is correct.
3	There was one significant error in the answer.
2	There were some significant mistakes, but most of the answers were correct.

1	Even if the answer is incomplete, at least one argument is correct.
0	No answer at all, or an answer not based on process or argument.

Data analysis techniques used included reduction, presentation, and conclusion drawing. Students' mathematical reasoning ability was classified into high, medium, and low categories. Students' mathematical reasoning ability was categorized based on the assessment scale determined by the Ma'sum as follows:

Table 3. Categories of Mathematical Reasoning Ability

Category	Value Criteria
High	80 ≤ score achieved < 100
Medium	60 ≤ score achieved < 80
Low	0 ≤ score achieved < 60

RESULTS AND DISCUSSION

This study focuses on the mathematical reasoning ability of class X students at SMK Ma'wataibin Pagelaran in solving problems related to arithmetic series and sequence material. Through the test data, the results of student scores on the mathematical reasoning ability test are presented in Table 4.

Table 4. Student Score Results

Number of Students	Highest Score	Lowest Score	Average
19	87,5	25	57,56

Table 4 above illustrates that some students in class X of SMK Ma'wataibin Pagelaran Malang have achieved the KKM (Minimum Graduation Criteria)set at 75. From these data, it can be concluded that a number of students still have not reached the KKM. In general, class students have mathematical reasoning skills in the medium category. The results of the student's mathematical reasoning ability are then described in detail in Table 5.

Table 5. Results of Categorization of Mathematical Reasoning Ability

Category	Value Criteria	Number of Students	Percentage
High	80 ≤ score achieved < 100	7	36,85%
Medium	60 ≤ score achieved < 80	8	42,10%
Low	0 ≤ score achieved < 60	4	21,05%
Total		19	100%

Table 5 provides a clear picture of students' mathematical reasoning ability distribution in each category. The mathematical reasoning ability of students in class X varies, ranging from high, medium, and low categories. Students who have high mathematical reasoning ability are 36.85%, in the medium category 42.10%, and in the

low category 21.05%. Overall, the mathematical reasoning ability of class X students is in the medium category. This analysis is expected to be the basis for identifying things that might be done to support the development of students' mathematical reasoning skills.

The following are the results of the analysis of the answers of research subjects from each category of mathematical reasoning ability, namely students in the high category (ST), students in the medium category (SS), and students in the low category (SR). This analysis focuses on their ability to conclude the results of the answers to the mathematical reasoning ability test and to detail the indicators that have been determined. The following are the results of the analysis of the answers to the three categories:

a. High Mathematical Reasoning Ability Category (ST)

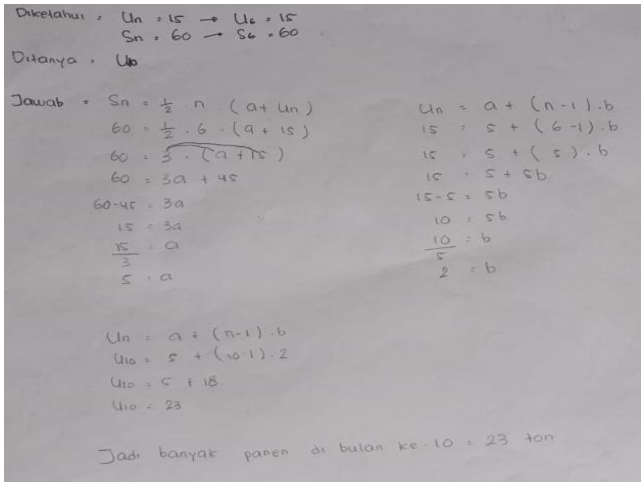

Figure 1. ST's answer results

Figure 1 above shows that students in the high mathematical reasoning ability category can solve problems correctly. Students in the high category show solid mathematical reasoning ability. Four indicators of mathematical reasoning ability are well met. This shows that the student has sufficient ability to do so. ST students can write conjectures and perform calculations correctly. Thus, they can use the working steps according to the arithmetic sequence formula to obtain the final answer and make a conclusion.

Based on interviews with high-category students (ST), ST students can understand the problems associated with the problem, write what is known and questioned by the problem, and correctly explain the process and conclusions of their work. ST also felt confident with the results of his work. ST students also carried out the steps well, understood the arithmetic sequence formula and could conclude confidently. The interview results with ST students illustrate that they have mastered the material and can apply knowledge and mathematical reasoning skills well. Based on these findings, it can be concluded that students in the high mathematical reasoning ability category have met all the criteria for mathematical reasoning ability.

b. Category of Mathematical Reasoning Ability Medium (SS)

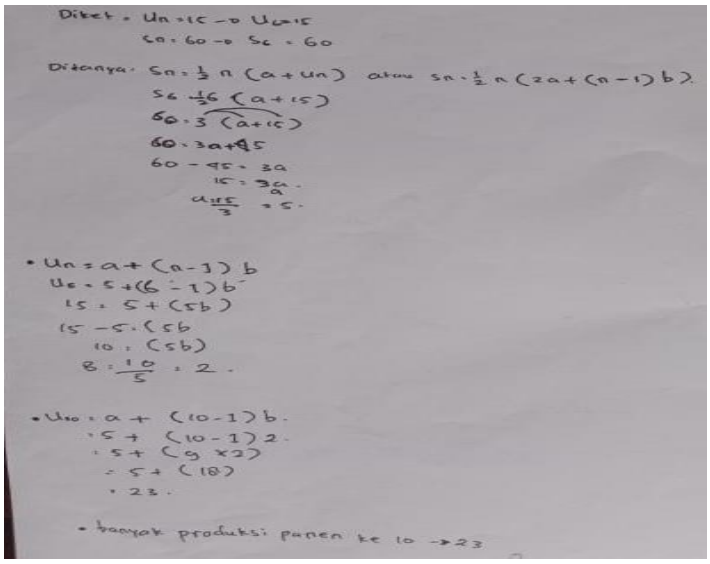

Figure 2. SS Answer Results

Based on Figure 2, students in the medium category have good mathematical reasoning skills. SS can fulfill three criteria: writing conjectures, doing work, and providing reasons or evidence. SS has also solved the problem questions and can show the work process and results, as shown in Figure 2. However, he is still less careful when collecting data from questions. This caused an error in the indicator of concluding the answer, which should have written 'the amount of harvest in the 10th month is 23 tons' annum SS wrote 'the amount of production of the 10th harvest = 23'.

Based on the results of interviews with moderate category students (SS), information was obtained that SS students understood aspects of the questions asked. However, because they were less careful, it resulted in errors at the end of the conclusion. Although SS students have understood the formula of an arithmetic sequence and can solve the problem according to the steps of the work, there are still errors that affect the accuracy of the conclusion. Thus, it can be identified that student SS fulfills all the criteria of mathematical reasoning ability but is not perfect.

c. Mathematical Reasoning Ability Category Low (SR)

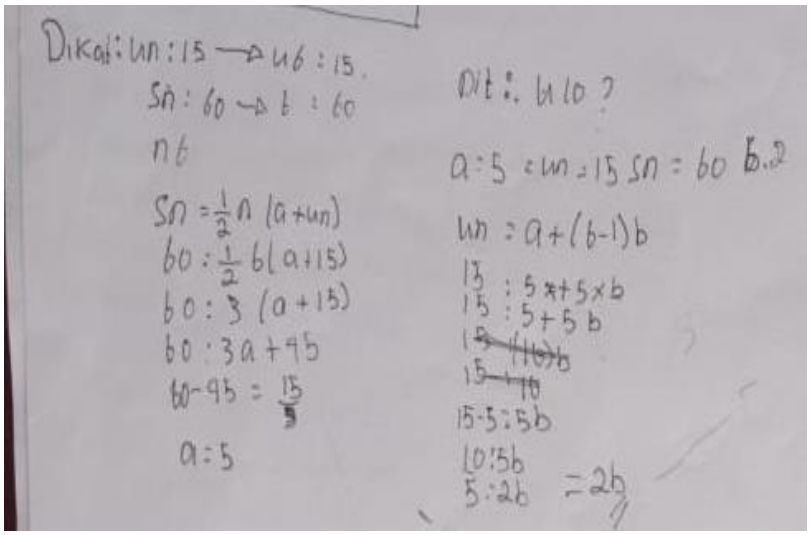

Figure 3: SR's answer results

Figure 3 above shows that students in the low mathematical reasoning ability category still failed to digest the question. As a result, SR could complete the first step but did not continue or reach a conclusion. Students in the low category show limitations in terms of mathematical reasoning ability. SR only managed to fulfill one of the four indicators of mathematical reasoning ability: the ability to write conjectures.

The interview results with the low-category student (SR) revealed that the student still did not understand some of the formulas needed to solve problems related to arithmetic series and sequence. SR's inability to fulfill the criteria of mathematical reasoning ability can be explained by the fact that this student could not continue their work because they forgot the formulas related to arithmetic rows and series and did not understand the information in the problem. Based on this, it can be concluded that SR has not been able to fulfill all indicators of students' mathematical reasoning ability.

The following is shown in Table 6 regarding the summary of the mathematical reasoning ability of high, medium, and low-ability students.

Table 6. Summary of Students' Mathematical Reasoning Ability Results

No.	Subject	Indicator of Mathematical Reasoning Ability			
		Writing down conjectures	Perform calculations	Provide reasons	Summarize
1	ST	√	√	√	√
2	SS	√	√	√	-
3	SR	√	-	-	-

Based on Table 6, it can be concluded that students with the initials ST can include the answer Correctly. However, students with the initials SS in the medium category cannot fully conclude the answer correctly on the arithmetic rows and series material. This is because there are errors in the completion process. Although SS students have carried

out the steps of work and explained their understanding, some minor errors still result in the conclusion of the test being less accurate.

Students with the initials SR, who have a low level of mathematical ability, are unable to conclude the results of the answers on the material of arithmetic rows and series. This is due to his inability to write and explain the known and asked information. Even though they have completed the work process, they cannot come to an effective conclusion. These results illustrate that students in the high category have good inferential skills. In contrast, students in the medium and low categories need special attention to improve their mathematical reasoning skills on the material of arithmetic ranks and series. The Mathematical reasoning ability of class X students of SMK Ma'wataibin Pagelaran varies when solving arithmetic rows and series problems. Students in the high category have a better understanding and application of all indicators of mathematical reasoning ability, and students in the medium category have pretty good abilities. Students in the low category may show limitations in mathematical reasoning skills that require additional development. Research Oktaviana et al. (2021) said that students with good mathematical reasoning ability could solve all the items using four indicators of mathematical reasoning ability; students with moderate mathematical reasoning ability can only solve the items using two indicators of mathematical reasoning ability, namely compiling evidence, writing the correct answer, and also providing reasons or evidence for the correctness of the solution.

CONCLUSION

Based on the results and discussion, it can be concluded that the mathematical reasoning ability of class X students at SMK Ma'wataibin Pagelaran can be grouped into three categories: high, medium, and low. From a total of 19 students, the results showed that seven students (36.85%) were included in the high mathematical reasoning ability category, eight students (42.10%) were in the medium mathematical reasoning ability category, and four students (21.05%) were in the low mathematical reasoning ability category. High-category students fulfilled all four indicators of mathematical reasoning ability according to their ability level. Medium-category students could fulfill three indicators well according to their abilities: writing conjectures, doing work, and providing reasons/evidence. However, there was an inaccuracy in writing the answer conclusion. Low-category students can only fulfill one indicator by their abilities: writing conjectures.

Based on the conclusion, teachers need special attention to training and familiarizing students with various mathematical problems that encourage the analysis process to develop students' mathematical reasoning skills. This can help students increase their accuracy and skill in compiling answers and conclusions. This effort is critical to stimulating the development of students' mathematical reasoning skills in all categories.

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