Analysis of students' mathematical reasoning ability in class IX in solving SPLDV problems

Wilya Rahma Tresna *, Kiki Nia Sania Effendi
Mathematics Education, Universitas Singaperbangsa Karawang, Jl. HS. Ronggowaluyo, Telukjambe Timur, Karawang 41361, Indonesia
* Corresponding Author. Email: 1910631050171@student.unsika.ac.id

Received: 20 June 2022; Revised: 14 August 2022; Accepted: 14 January 2023

Abstract: This study aims to determine the mathematical reasoning ability of students in one of the State Junior High Schools in Karawang Regency in solving two-variable system of linear equations. The method used is a descriptive method with a qualitative approach. The subjects in this study were 32 students of class IX E. The data collection technique was carried out by giving a mathematical reasoning ability test sheet in the form of a description of 4 questions. The data analysis technique used in this study is based on Miles and Huberman's data analysis technique which consists of data reduction, data presentation, and drawing conclusions. The results of this study indicate that the test scores of students' mathematical reasoning abilities are classified as very low, because there are only 2 students who achieve the KKM score. Then also indicated by the percentage value there are 2 students with a percentage of 6% in the high category, 23 students with a percentage of 72% in the medium category and 7 students with a percentage of 22% in the low category.

Keywords: Analysis; Mathematical ability; Reasoning; SPLDV


INTRODUCTION

Mathematics is part of basic knowledge that can be used as a supporting tool, especially in aspects of education and aspects of everyday life. Because of this, mathematics is a compulsory subject for students from elementary to high school level. The existence of learning mathematics in schools certainly has a function for students, one of which is as a means to develop their ability to think logically, critically, creatively and collaboratively (Sariningsih & Kadarisma, 2016). Many students have a stigma that mathematics is material that is quite difficult to understand, this of course has implications for student learning outcomes that are not in accordance with the achievements (Julaeha & Kadarisma, 2020). Students also view that mathematics is a boring subject because mathematics has an abstract nature, has many symbols and formulas (Rodliyah et al., 2021). Therefore, to be able to solve a mathematical problem, students are required to have hard mathematical skills, one of which is mathematical reasoning ability. Regarding these conditions, it is hoped that through reasoning abilities students can assume that mathematics is a logical study (Nurjanah et al., 2019). Thus, students will really believe that they can understand, prove, evaluate a mathematical problem, and can do something related to reason if needed.

Mathematics learning in schools is directed so that students can master good reasoning skills in working on a math problem. This is supported by Sumartini (2015) who revealed that mathematics education in schools is designed to have good reasoning abilities for students,
especially when solving math problems. Therefore, mathematical reasoning abilities are defined as a reference and vision for learning mathematics which is proof that reasoning abilities need to be mastered by students (Konita et al., 2019). This is in line with Sumarmo (1987) that learning mathematics is intended for students so that they can develop reasoning competence, recognize the benefits of mathematics, build self-confidence, be objective, and think openly in dealing with a problem in the future that will continue to be different. This statement states that reasoning is necessary to create a mathematical idea, showing the actual facts. In other words, it can be said that mathematical reasoning abilities become a basis or foundation for students to be able to construct understanding in learning mathematics (Cahya et al., 2021).

Mathematical reasoning is a habit of thinking which, if properly and consistently developed, can make it easier to communicate mathematics both written and orally (Fitrianna & Novtiar, 2019). According to Supartini (2015) expressing reasoning is a way of thinking in concluding or in making new ideas based on previous ideas that have been proven true or have been checked for validity. According to Pawesti (2017) mathematical reasoning is the ability to study, unify, make arguments correctly, and solve a non-routine problem. The indicators of mathematical reasoning ability according to Sumarmo (1987) include: (1) drawing conclusions, (2) making statements with modeling, evidence, properties, and related contexts, (3) estimating answers by writing down the stages using analogies and generalizations, (4) prove or check the truth of the generalizations that have been made before. With these reasoning indicators, students are expected to be able to use their reasoning to solve a mathematical problem.

In contrast to this, the facts state that students have not been able to master reasoning skills properly. This is shown in the research of Yurianti et al., (2014) which shows that the state of the level of student achievement scores in understanding and mathematical reasoning abilities is still relatively low, not a few students face problems in relational interpretation and thinking. So it can be said that students face difficulties in reasoning tests. Then it was also shown from the test results at one of the junior high schools in the odd semester of class VII students showing that as many as 20% of students could do reasoning questions (Burais et al., 2016). In addition, from teacher interviews conducted in research Putri et al., (2019) the results obtained were that students' mathematical reasoning abilities were relatively low because at that school students were still not used to solving problem-oriented questions. This will become a problem, because if students experience difficulties in developing their reasoning abilities, it will result in learning outcomes that are not in accordance with the achievements.

The low mathematical ability of students in reasoning is caused by several factors, such as in the ongoing mathematics learning process which is more dominated by the teacher and there are only a few students who are active (Mariyam & Wahyuni, 2016). This is relevant to the explanation of Nurjanah et al., (2019) that only a few students are active during learning, while other students are passive and tend to just listen and write from the teacher's explanation. This can result in students' knowledge being limited because students can only interpret what is taught by the teacher and do not develop their reasoning abilities (Putri et al., 2019). So the learning process will only take place in one direction. It is also concluded from the research of Suprihatin et al., (2018) that some students still do not meet the indicators of mathematical manipulation, this occurs because students are rarely trained to work on a problem related to everyday problems and learning that is less universal.

Based on previous data, it shows that students' mathematical reasoning abilities are relatively low, therefore students need to get used to solving problems related to everyday life, especially in SPLDV material. This is supported by research by Yanah & Hakim (2022) that SPLDV material requires mathematical reasoning skills to be solved, because in daily practice there are many calculation problems that can be solved by implementing or applying SPLDV. In addition, Putri & Isnaingrum (2021) also mentioned in their research that a system of two-variable linear equations is one of the subjects of mathematics that requires stages of completion in many ways, so good reasoning skills are needed in order to solve this problem. As explained by Kotto et al., (2022) mathematical reasoning ability is one of the abilities that
needs to be mastered so that students can understand mathematical problems through applying mathematical properties and patterns, doing mathematical modeling, collecting facts or explaining statements to draw conclusions, so that learning mathematics be more meaningful. So, with this background, the researcher is quite interested in analyzing the mathematical reasoning abilities of junior high school students and aims to find out and describe how the results of the answers to students' mathematical reasoning abilities, especially in class IX, in solving SPLDV problems.

**METHOD**

This type of research uses a descriptive method with a qualitative approach. The descriptive method is used to describe or describe the information to be obtained (Sugiyono, 2015). The qualitative approach is used to describe a research process that produces written sentences from the subject data studied (Moleong, 2013). This aims to find out and to describe the results of the mathematical reasoning abilities of junior high school students in solving an SPLDV problem.

This research was carried out at one of the public junior high schools in Kutatawaluya District in the odd semester of the 2022/2023 school year with subjects taken using a purposive sampling technique, namely class IX E with a total of 32 students. The purposive sampling technique was used in this study because it was based on several considerations or specific goals from the researchers so that the subjects could meet the required criteria (Fitriyah & Haerudin, 2021). The required subject criteria are that students have been taught by the teacher or have received learning related to SPLDV material in class, and consist of students with learning activities in high, medium and low classifications. The data collection method applied is through the provision of test questions to students. Then the instrument applied is a mathematical reasoning ability test instrument totalling 4 items in the form of story problems in SPLDV material based on indicators of reasoning ability adopted and validated from Thesis Nurhalin (2022). Data analysis was applied based on Miles & Huberman, (1992) including data reduction, data presentation and drawing conclusions. Next, the research subjects taken were grouped based on reasoning abilities with high, medium, and low levels, through a categorization method based on Arikunto (2010) which is presented in Table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Value Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>( Value \geq (\bar{x} + SD) )</td>
</tr>
<tr>
<td>Medium</td>
<td>((\bar{x} - SD) \leq Value &lt; (\bar{x} + SD))</td>
</tr>
<tr>
<td>Low</td>
<td>( Value &lt; (\bar{x} - SD) )</td>
</tr>
</tbody>
</table>

**RESULTS AND DISCUSSION**

The data obtained is in the form of test results, or the value of students' mathematical reasoning abilities in solving a description problem on the material system of two-variable linear equations. The test results are presented in Table 2.

<table>
<thead>
<tr>
<th>The Quantity of Students</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>8.33</td>
<td>87.5</td>
<td>35.29</td>
<td>16.53</td>
</tr>
</tbody>
</table>

Table 2 shows the results of the test acquisition that there are several students who have not reached the Minimum Completeness Criteria Score, in which the school sets the KKM in mathematics lessons in class IX, which is 65. However, minimum score obtained by students is only 8.33 and the maximum value obtained is 87.5 with an average score of 35.29 and a standard deviation of 16.53. Based on the results of the tests given, the students' mathematical
reasoning ability in class IX E was relatively low, because only 2 out of 32 students managed to achieve the KKM score. This means that it can be said that some students are less able to solve a mathematical reasoning ability problem in the SPLDV problem. The results of this acquisition are supported by research conducted by Diniyah et al., (2018) showing that as many as 75% of students get a reasoning ability score that is classified as lacking because they have not been able to reach the KKM. In addition, it is also relevant to the results of research from by Yurianti et al., (2014) namely the value of students’ mathematical reasoning abilities in the SPLDV subject is still relatively poor, because only 56% of students can solve the problem out of 33 students.

Then in determining the results of the level of categorization of mathematical reasoning abilities in this study, the rules proposed by Arikunto (2010) will be used. The results of this categorization apply to class IX E at one of the SMPNs in the Kualtayla District. The following is a description of the percentage of subjects in Table 3.

<table>
<thead>
<tr>
<th>Category</th>
<th>Value Criteria</th>
<th>The Quantity of Students</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Value (\geq 51,82)</td>
<td>2</td>
<td>66%</td>
</tr>
<tr>
<td>Medium</td>
<td>18,76 (\leq) Value (&lt; 51,82)</td>
<td>23</td>
<td>72%</td>
</tr>
<tr>
<td>Low</td>
<td>Value (&lt; 18,76)</td>
<td>7</td>
<td>22%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>32</td>
<td>100%</td>
</tr>
</tbody>
</table>

Based on the previous description regarding the acquisition of data analysis, the purpose of this research is to find out the mathematical reasoning abilities of students at one of the State Junior High Schools in Kutawaluya District in completing the mathematical reasoning ability test with the subject matter SPLDV containing four description questions based on indicators of mathematical reasoning ability

Test item number 1 relates to the indicator for submitting an allegation. Students are given a problem, namely they are asked to make conjectures based on their opinion whether Hani’s spending money if buying a dozen gel pens will be less than IDR 20,000? Then, regarding the solution, students can work on it with SPLDV using the substitution elimination method based on the written information, namely Agnia pays for 3 highlighters and 5 gel pens at a price of Rp. 37,500, while Peppy pays for 2 highlighters and 4 gel pens at a price of Rp. 28,000. Then if you have got the results of the answers, students must provide conclusions. The following is one of the solutions students worked on in Figure 1.

![Figure 1. High category student answers](image-url)

Based on Figure 1, it can be seen that the answers of students in the high category have met the indicators, namely by writing information that is known or asked in full and assuming two equations into mathematical modeling namely \(3x + 5y = 32,500\) and \(2x + 4y = 28,000\) and carrying out the calculation process using the elimination method as a completion step to get a result of \(y = 4,500\), then students can also make conjectures to draw conclusions by
writing down the money spent by Hani to buy 1 dozen gel pens for more than 20,000. This analysis is in accordance with Ardianti et al., (2019), namely students with high group levels meet the indicators of making conjectures by writing complete and correct answers.

Based on Figure 2 students in the medium category are sufficient to fulfill the indicators. Seen in the answers, students did not write down information that was known as well as what was asked. Students immediately perform calculations using the elimination method before writing a complete mathematical model. However, students get the correct calculation results, namely \( y = 4,500 \) from the equations \( 3x + 5y = 32,500 \) and \( 2x + 4y = 28,000 \). In addition, students have also correctly and completely prepared conjectures to draw conclusions from Hani’s spending of money, this agrees with Nurfalah et al., (2021), that is, in the answers of students with moderate classification, students do not write down the parts that are known or do not record information in detail. Then, students also did not record the questions referred to in the problem. In other words, students have difficulty in making mathematical models and have not been able to interpret the problem as a whole.

Based on Figure 3 students in the low category have not been able to fulfill the indicators. Seen in the answers, students do not use solutions with a system of two-variable linear equations. Students immediately carry out original calculations with multiplication operations without writing mathematical models, not writing known or asked statements, and not making conjectures to draw conclusions. So, it can be said that students do not understand the problem. Based on the analysis of these answers, it is relevant in the research of Wahyuni et al., (2019) where students with low classification have not been able to work on the questions presented.

Test item number 2 relates to the indicator of doing mathematical manipulation. Students are given a problem that is asked to make a mathematical model in determining how much mascara and eyebrow pencils are sold today. Then regarding the solution, the information written in the problem can be applied with SPLDV, namely writing, today a cosmetics shop seller managed to sell as many as two dozen mascara and eyebrow pencils. She earned IDR 1,140,000 from the sale with the price of one mascara IDR 60,000 and the price of one eyebrow pencil IDR 30,000. After that, elimination of substitution is carried out to determine the results.
obtained and conclude them. The following is one of the solutions students worked on in Figure 4.

![Image of Figure 4](image)

**Figure 4.** High category student answers

Based on Figure 4 students in the high category have not been able to fully meet the indicators. In the answers, students have written information that is known or asked, then students have done mathematical modeling from the previous statement, namely $60,000x + 30,000y = 1,140,000$ and reduced to $6x + 3y = 1,140,000$ , so students have done the math manipulation correctly. However, students have not applied arithmetic operations correctly and completely, so they have not been able to provide conclusions and cannot complete the final results. In addition, Erfani et al. (2020) stated that some students in the high classification made mistakes in the composing steps due to a lack of accuracy in calculation operations.

![Image of Figure 5](image)

**Figure 5.** Medium category student answers

Based on Figure 5 students in the medium category have not been able to fully fulfill the indicators properly, it can be seen that students do not record statements in the questions. However, students have succeeded in manipulating statements into mathematical modeling, namely $60,000x + 30,000y = 1,140,000$. Students do not apply arithmetic operations correctly and completely, so they do not write conclusions. This is in line with Lesmana & Effendi (2022) that in the moderate category student answers, experience errors in arithmetic operations and do not write conclusions.

![Image of Figure 6](image)

**Figure 6.** Low category student answers

Based on Figure 6 students in the low category have not been able to fulfill the indicators. Just like in the previous indicators and questions, students did not record known or asked...
statements, so students could not write mathematical manipulations of statements. In addition, students only perform multiplication arithmetic operations without compiling the right steps to carry out calculations to draw conclusions. Based on this, the same as the research of Suprihatin et al., (2018) states that the interpretation of questions that are not correct, results in solutions that are also not entirely correct. Therefore, this has an impact on indicators performing mathematical manipulation that will not appear.

Test item number 3 relates to indicators of drawing conclusions, gathering facts and providing arguments for the validity of the solution. Students are given problems that are asked to prove whether the value of \( K \neq 2 \) is correct and asked to provide reasons for proving it. Then regarding the solution, in collecting facts students can use the information written in the problem, namely writing with SPLDV in equations \( 8a + b = k \), \( 2a + 10b = 20 \), and \( a + 20b = 40 \). After that, elimination of substitution is carried out to compile evidence and get the right results and conclude with arguments for the validity of the settlement. The following is one of the solutions students worked on in Figure 7.

![Figure 7. High category student answers](image)

Based on Figure 7, the answers of high category students have met the indicators, by recording information known or asked about information on questions \( 8a + b = k \), \( 2a + 10b = 20 \), \( a + 20b = 40 \) and \( k = 10 \). Then students have compiled evidence by applying substitution patterns to prove that it is true if the value of \( k = 2 \). The final step is for students to write down the reasons or proof of truth for the conclusion that the value of \( K \neq 2 \) is wrong, the correct one is the value of \( k = 2 \). This is the same as Siahaya et al., (2021) in the analysis of the answers the subject in the high category has a good understanding of the problem and is able to reach indicators in carrying out mathematical manipulation, collecting facts and providing arguments for the validity of the solution at its completion in interviews that the subject can explain the stages detailed and precise solutions.

![Figure 8. Medium category student answers](image)

Based on Figure 8 students in the medium category do not meet the indicators, because from the student’s answers they only empty their answer sheets, so it can be said that students
have not interpreted what is meant by the problem. In line with Nurhalin & Effendi (2022) that students do not provide answers to questions in drawing conclusions, gathering facts and providing arguments for the validity of solutions tend to scribble on these questions.

Based on Figure 9 students in the low category do not meet the indicators. It can be seen that students do not understand the meaning of the problem, therefore students write answers not with a linear equation of two variables. Based on the analysis, according to research by Anggraini & Rejeki (2021) that subject T2 has poor abilities in building mathematical reasoning abilities and is unable to express mathematical statements verbally or in writing, collect facts, and provide arguments for the validity of solutions, and draw conclusions logical.

Test item number 4 relates to indicators checking the validity of arguments. Students are given a problem, namely they are asked to indicate whether it is true that the price of one portion of roasted chicken rice is Rp. 20,000 and one portion of rendang rice is Rp. 15,000. Then regarding the solution, the information written in the problem can be applied to SPLDV, namely writing, at a Nasi Padang restaurant, the first customer buys 12 roasted chicken rice and 6 rendang rice for a total of IDR 234,000, while the second customer buys 3 grilled chicken rice and 4 rice. rendang with a total of IDR 96,000. After that, elimination of substitution is carried out to check the correctness of the two equations and conclude the two equations correctly and completely. The following is one of the solutions students worked on in Figure 10.

Based on Figure 9 students in the low category do not meet the indicators. It can be seen that students do not understand the meaning of the problem, therefore students write answers not with a linear equation of two variables. Based on the analysis, according to research by Anggraini & Rejeki (2021) that subject T2 has poor abilities in building mathematical reasoning abilities and is unable to express mathematical statements verbally or in writing, collect facts, and provide arguments for the validity of solutions, and draw conclusions logical.

Test item number 4 relates to indicators checking the validity of arguments. Students are given a problem, namely they are asked to indicate whether it is true that the price of one portion of roasted chicken rice is Rp. 20,000 and one portion of rendang rice is Rp. 15,000. Then regarding the solution, the information written in the problem can be applied to SPLDV, namely writing, at a Nasi Padang restaurant, the first customer buys 12 roasted chicken rice and 6 rendang rice for a total of IDR 234,000, while the second customer buys 3 grilled chicken rice and 4 rice. rendang with a total of IDR 96,000. After that, elimination of substitution is carried out to check the correctness of the two equations and conclude the two equations correctly and completely. The following is one of the solutions students worked on in Figure 10.

Based on Figure 10, it can be seen that the answers of students in the high category have met the indicators, namely by writing known statements and asking complete questions by doing mathematical modeling $12x + 6y = 234,000$ and $3x + 4y = 96,000$. Then the students have also checked the truth of the two statements completely and correctly using elimination and substitution until it is proven true that the price of 1 portion of grilled chicken rice is Rp. 20,000 and 1 portion of rendang rice is Rp. If fuel is proven wrong, students also write down the correct and complete conclusions from the results of the previous proof. Based on this, in research Purwaningtyas (2019) argued that students in high groups were able to write down the stages in solving problems and write conclusions from the entire solution correctly so that they were able to check the validity of the results of the answers.
Based on Figure 11 shows the answers of students in the medium category have been quite capable of fulfilling the indicators. It can be seen that students have given mathematical modeling $12x + 6y = 234,000$ and $3x + 4y = 96,000$. Students choose a step by directly doing calculations using elimination and substitution with the correct answer results, namely $x = 12,000$ and $y = 15,000$ without writing examples or mathematical modeling from the problem information, and students have also written conclusions, but the statements in these conclusions are still a bit incomplete. Students should write correct sentences for the price of 1 serving of rendang rice Rp. 15,000. This is relevant to Wahyuni et al., (2019) from the results of the analysis of student answer sheets in the medium category in the indicator of checking the validity of an argument which is quite good.

Based on Figure 12 students in the low category do not meet the indicators. It can be seen in the answers, students first wrote down the stages of completion by doing calculations that were not correct, because these students did not use the elimination and substitution method in solving the problem. So it can be said that these students do not understand well the information about the questions, this is the same as research Jelita & Zulkarnaen (2020) that students in the low reasoning group have not interpreted the explanations contained in the questions and cannot do them correctly.

From the previous presentation based on the results of the analysis of the answers, there were some students who were unable to work on a two-variable linear system problem, especially in the mathematical manipulation indicators based on the problem information. This happens because students do not interpret the problems contained in problems or questions, so that if students have not been able to do mathematical manipulation of a problem, students cannot determine the steps in solving it until they cannot draw conclusions and only tend to work from origin and make mistakes in calculations.. In line with research Jelita & Zulkarnaen (2020) low reasoning ability is because students do not understand the questions, so that in solving them many are original and unable to explain again. Students also have not been able to find the right solution steps to construct arguments. This is also in line with research Hariyanti & Khotimah (2022), which found that from the results of the answers to each item, male students have not been able to compile evidence based on the validity of an argument and have not been able to conclude logically. Based on this, students need to get used to working on questions related to mathematical reasoning abilities in order to train students' ability to solve problems. This is reinforced in research Afinadhita & Abadi (2022) which
explains that students' processes for thinking in mathematical reasoning should be practiced repeatedly in many contexts in the subject matter of mathematics, so that students get used to problems of mathematical reasoning.

CONCLUSION

Based on the results of the research and previous presentations, students' mathematical reasoning abilities in solving problems with a system of linear equations of two variables from subjects taken in class IX E at one of the Public Middle Schools in Kuta Luya District totaling 32 students can be concluded as low. This can be seen from the analysis of the answers of many students who are still not able to work on the questions correctly and completely, do not meet the indicators, and based on the score of the mathematical reasoning ability test which only gets students with a minimum score of 8.33 and an average of 35.29 if compared to the KKM for mathematics subjects still cannot be achieved.

REFERENCES


