

Analysis of Students' Mathematical Reasoning Abilities in Solving Linear Equation in Two Variables on Android Game Called Ganjaran

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Abstract

Game Penjelajah Ruang (The Space Exploration Game, Ganjaran) is a learning media in the form of an Android-based educational game to practice the mathematical reasoning skills of class VIII students on SPLDV questions. This article describe students' mathematical reasoning abilities especially in solving SPLDV based on Ganjaran. The students' mathematical reasoning ability can be seen from the results of working on the SPLDV questions by students which are made based on mathematical reasoning indicators. The subjects of this study were students of class VIII SMP Negeri 2 Krian as many as 4 students who had played the Ganjaran. The research method used is descriptive qualitative research. The test instrument used is SPLDV reasoning questions on 5 items with short answers. From the results of the study, it was concluded that the reward can train students' mathematical reasoning skills on the SPLDV material with an average value of 56.25 which is quite sufficient. Overall, the mostly indicator mastered by students is indicator c (drawing conclusions, compiling evidence, providing reasons or evidence for the truth of the solution), while the less is indicator a (proposing conjectures).

Key words: Linear Equation in Two Variables, Students' Mathematical Reasoning.

Analisis Kemampuan Penalaran Matematis Siswa dalam Menyelesaikan Soal Penalaran SPLDV pada *Game* Penjelajahan Ruang (Ganjaran) berbasis Android

Abstrak

Game Penjelajahan Ruang (Ganjaran) merupakan *game* edukasi berbasis android yang dikembangkan secara khusus untuk melatih kemampuan penalaran matematika siswa. Penelitian ini bertujuan untuk mendeskripsikan kemampuan penalaran matematis siswa dalam menyelesaikan soal SPLDV yang tersaji pada Ganjaran. Kemampuan penalaran matematis siswa dapat dilihat dari hasil pengerjaan soal SPLDV oleh siswa yang dibuat berdasarkan indikator penalaran matematis. Subjek penelitian ini adalah 4 siswa kelas VIII SMP Negeri 2 Krian. Metode penelitian yang digunakan adalah penelitian deskriptif kualitatif Instrumen tes yang digunakan adalah soal penalaran SPLDV pada Ganjaran sebanyak 5 butir dengan jawaban singkat. Dari hasil

penelitian diperoleh kesimpulan bahwa Ganjaran dapat melatih kemampuan penalaran matematis siswa pada materi SPLDV dengan nilai rata-rata sebesar 56,25 dan masuk kategori cukup. Secara umum, indikator kemampuan penalaran matematis yang banyak dikuasai siswa adalah indikator menarik kesimpulan, menyusun bukti, memberikan alasan atau bukti terhadap kebenaran solusi, sedangkan indikator penalaran matematis siswa yang kurang dikuasai siswa adalah indikator mengajukan dugaan.

Kata kunci: Soal SPLDV, Kemampuan Penalaran Matematis.

INTRODUCTION

Mathematics is one of the important subjects in developing students' reasoning abilities. This is in line with the statement of the National Council of Teachers of Mathematics (NCTM) which states that developing reasoning abilities is a general goal of learning mathematics (Astiati, 2020). This is also in line with the Regulation of the Minister of National Education number 22 of 2006 concerning content standards. The regulation states that students are expected to be able to use reasoning on patterns, traits, perform mathematical manipulations in making generalizations, compiling evidence, or explaining ideas from mathematical statements. In addition, it is stated in the Regulation of the Minister of Education and Culture Number 68 of 2013 that core competencies-4 (KI-4) for grade VIII and IX students are processing, presenting, and reasoning in the concrete realm (using, parsing, assembling, and modifying, and making) and abstract realms (writing, reading, counting, drawing, and composing) according to what is learned in school and other sources that have similarities in point of view/theory. Thus, it can be concluded that learning mathematics can train and develop students' reasoning abilities.

Reasoning is a thought process that tries to invite the reader to a conclusion by connecting facts and evidence (Afri, 2019). The same thing was conveyed by Kusumah, that reasoning is an attempt to conclude with certain steps to show the relationship between two or more things based on the nature or law that is recognized as true (Ario, 2016). Special reasoning abilities related to mathematics that are concluded based on efforts to find a relationship between a thing that has been defined with other statements based on facts and evidence are known as mathematical reasoning (Basir, 2015).

Mathematical reasoning ability can be measured through its indicators. The indicators of mathematical reasoning ability (KPM) according to the Regulation of the Director General of Education at the Ministry of National Education Number

506/C/Kep/PP/2004, are as follows (Wardhani, 2008): (a) propose allegations; (b) perform mathematical manipulations; (c) draw conclusions, compile evidence, provide reasons or evidence for the correctness of the solution; (d) draw conclusions from the statements; (e) checking the validity of an argument; (f) finding patterns or properties of mathematical phenomena to make generalizations (Wardhani, 2008; Siswanah, 2016). According to Sumartini, to reveal mathematical reasoning abilities, it is necessary to look at how the conjecture is arranged, the answer process, the analogies used, and generalizations (Sumartini, 2015). To reveal these indicators, appropriate materials are needed to train students' mathematical reasoning abilities.

One of the important mathematics material to be studied in developing mathematical reasoning skills of eighth semester junior high school students is the Two Variable Linear Equation System (SPLDV). In everyday life, the concept of SPLDV is widely used as a solution to calculation problems. In other words, through this material it is possible to develop contextual story questions. In solving SPLDV problems, it is necessary to pay attention to several stages of completion, starting from mathematically modeling the problem or doing representations to choosing the right method to solve it. Some of the ways that are taught to students in completing the SPLDV are by depicting graphs, the elimination method, the substitution method, and the combined method of these methods. In using these methods, students must have the ability to understand the questions first, then shape them into SPLDV modeling (Muslimin & Sunardi, 2019). If students are already at that stage, then the potential to be able to solve problems related to SPLDV is more open.

There are many ways that can be done to train students' mathematical reasoning skills. Wicaksana developed APOS-oriented learning assisted by a monopoly game, the result of this learning was that this learning succeeded in improving students' mathematical reasoning abilities (Yoga Wicaksana, 2016). Different things were done by Bernard who chose to develop a game based on Adobe CS4 (Martin Bernard, 2014). Moreover, Rohmah chose to combine cooperative learning with online games to improve students' reasoning abilities (Aenu Rohmah, 2016). In contrast to the research that has been mentioned earlier, this study used learning media in the form of Space Exploration Games (Rewards). Unlike the games mentioned above, Rewards is made with the android platform so that it can be played on student gadgets. One of the features in Rewards is

about SPLDV, which is quite a lot and interesting to work on. There are 5 SPLDV reasoning questions and 10 SPLDV questions with a short answer system and true false answers. By playing Rewards, students can learn while playing games so that they can attract students' interest in learning. Researcher The content in this article aims to train students' mathematical reasoning skills in solving SPLDV reasoning problems in the Android-based Space Exploration Game (Rewards).

RESEARCH METHODS

This research was conducted in the even semester of the 2020-2021 academic year at SMP Negeri 2 Krian with the research subjects being 4 students of class VIII students who were taken randomly. While the object under study is the students' mathematical reasoning ability. Sources of data were obtained from class VIII students of SMP Negeri 2 Krian who had played the Android-based Space Exploration Game (Rewards) as many as 4 students at random. The test instrument in this study was a 5-point SPLDV reasoning question with a short answer. The data obtained in the form of student work on the test answer sheets about mathematical reasoning abilities. Furthermore, the data was analyzed more deeply with reference to mathematical reasoning indicators and scoring rubric guidelines modified from Thompson.

The scoring guidelines used can be seen in Table 1 (Muslimin & Sunardi, 2019).

Table 1. Research Activity Implementation Schedule

Score	Indicator
4	The answer is perfect and looks at all the reasoning indicators systematically and correctly
3	The answer is correct, but only a few of the desired reasoning indicators are seen
2	The answer is partially correct and contains more than one reasoning indicator that the question wants
1	Wrong answer, the response (completion) is not completed in its entirety but contains at least one indicator of correct reasoning
0	Wrong answer, response (solution) is based on the wrong process or does not contain any reasoning indicators

RESULTS AND DISCUSSION

In this study, data were obtained through tests that included the Rewards game. The test was held on May 5, 2021. The subjects were 4 students who had played the reward and were chosen randomly. Five SPLDV reasoning questions are given in the Rewards

game application with a time of 60 minutes. Next, the students' answers are scored according to the scoring rubric, the student's answer scores are then converted to qualitative values based on their height category. The final results of students' mathematical reasoning abilities can be seen in Table 2.

Table 2 Value of Students' Mathematical Reasoning Ability

Student scores	Category	Frequency	Percentage
$86 \leq score \leq 100$	Very high	0	0%
$71 \leq score < 86$	High	1	25%
$56 \leq score < 71$	Enough	1	25%
$41 \leq score < 56$	Low	2	50%
$0 \leq score < 40$	Very Low	0	0%
Total students		4	100%
Total Student Score		225	

Based on Table 2, it can be seen that the average score obtained by students for this mathematical reasoning ability test is 56.25. These results indicate that the students' mathematical reasoning ability is quite sufficient. Furthermore, the results of the analysis of each student's answer to the mathematical reasoning indicators used in this study will be explained.

The first subject (S1) managed to answer 4 of the 5 questions given. These questions are question number 1, question number 2, question number 3, and question number 4. The results of the analysis show that on the Propose a Allegation indicator, it is found that S1 can write down what is known and asked. However, of the four answers, the writing is not quite right. S1 writes down what is known directly using a mathematical model. Likewise, what is asked, S1 writes directly using a mathematical model. In the Indicator of Performing Mathematical Manipulation, it is found that S1 can arrange calculations in a predetermined way so that they find answers. One of them can be seen from the solution to problem number 2, where S1 can determine the value of x using the elimination method. Furthermore, in determining the value of y, S1 substitutes the already known value of x. In general, S1 tends to use the combined method (elimination-substitution) in finding answers. In the indicators of Drawing Conclusions, Compiling Evidence, Providing Reasons or Evidence for the Truth of the Solution. Data obtained that S1 can compile the evidence that has been obtained correctly as material in determining the answer to the final question/solution. One of them can be seen from the completion of problem number 2, the values of x and y that have been obtained are used to determine

the value of $x+2y$ so that they can find out the price of additional goods. While on the indicator of Drawing Conclusions from Statements, it was found that S1 was able to draw final conclusions quite well. It's just that for question number 4, S1 did not write down the final conclusion. So the answer to question number 4 is not perfect.

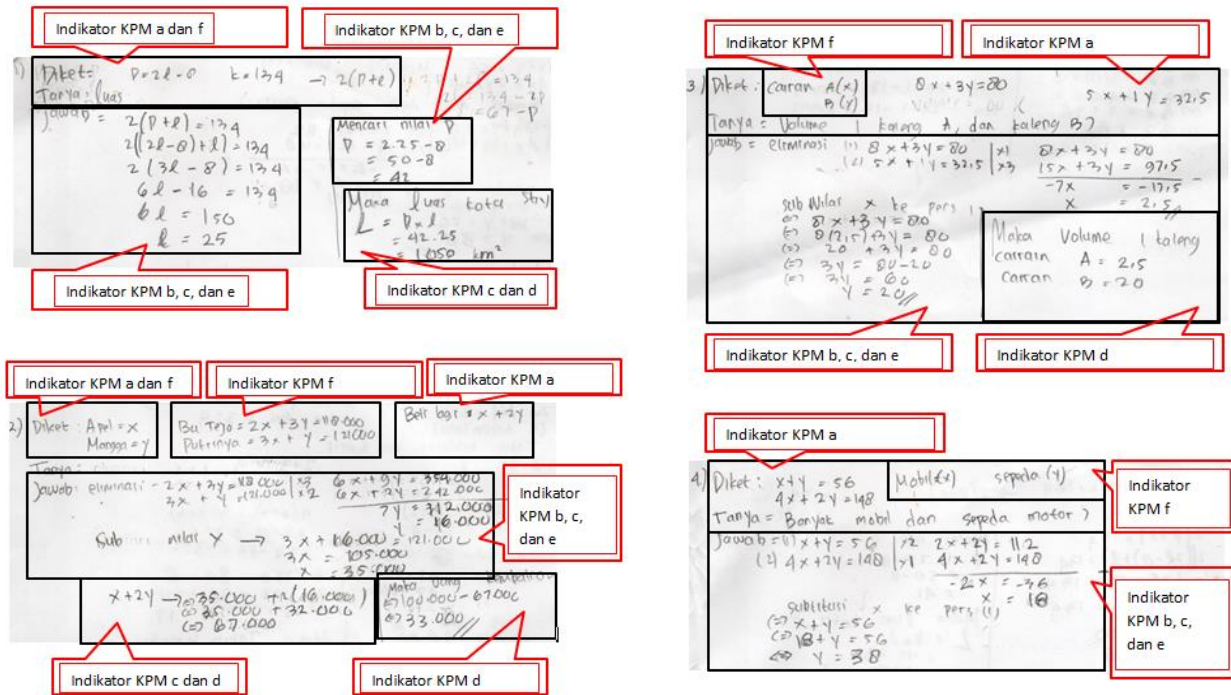


Figure 1. First Subject Answer Sheet

In Figure 1, it is described that the Indicator Checks the Validity of an Argument, it is found that S1 in the process often re-examines the answers that have been written. So the resulting answer is correct. The last indicator is Finding Patterns or Characteristics of Mathematical Symptoms to Make Generalizations, S1 can write an example of an object into a variable so that it can be used to determine mathematical models and solutions. However, answer number 1, S1 does not write the examples for length and width at the beginning of the work. This can lead to misinterpretation, so that the answer to S1 number 1 becomes less than perfect.

The second subject (S2) managed to answer 4 of the 5 questions given. In the Suggestion indicator, S2 does not write down what is known and what is being asked. However, from the four answers, S2 wrote down what was known directly using a mathematical model. Likewise, what is asked, S1 writes directly using a mathematical model. Thus, S2 does not show the aspect of making conjectures in working on the problem. While on the indicator of Performing Mathematical Manipulation, Masters can

arrange calculations in a predetermined way so that they find answers. One of them can be seen from the solution to problem number 3, where S2 can determine the value of x using the elimination method. Furthermore, in determining the value of y , S2 substitutes the known value of x into the equation $8x+3y=80$. In general, S2 tends to use the combined method (elimination-substitution) in finding answers.

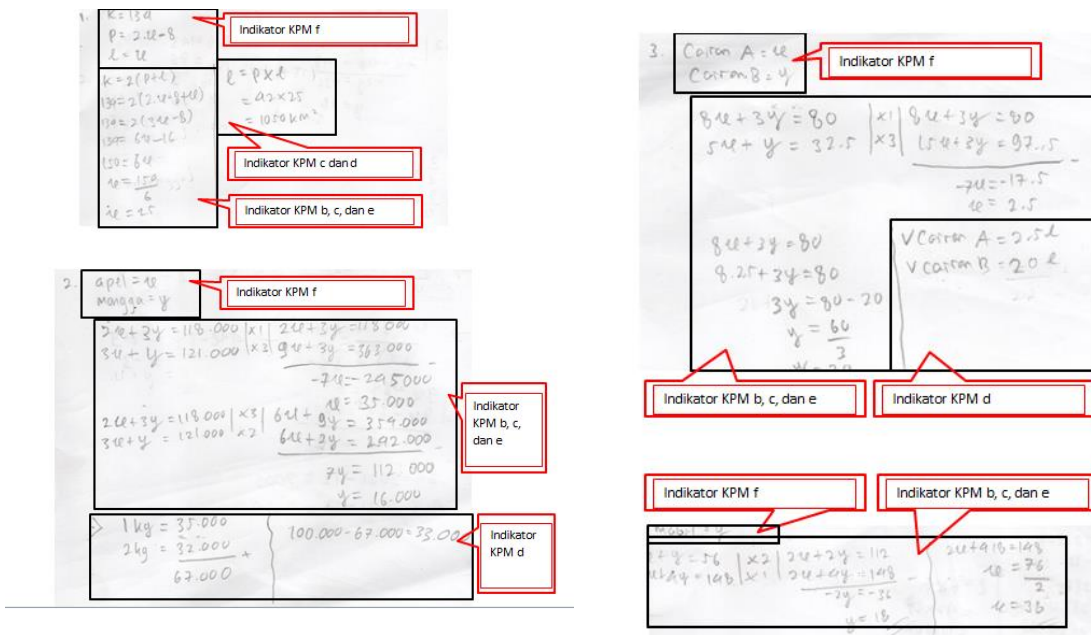


Figure 2. S2 Answer Sheet

In Figure 2, information on the indicators of Drawing Conclusions, Compiling Evidence, Giving Reasons or Evidence for the Truth of the Solution, it is found that S2 can arrange the evidence that has been obtained correctly as material in determining the answer to the final question/solution. One of them can be seen from the completion of problem number 2, the values of x and y that have been obtained are used to determine the price of 1 kg of apples and 2 kg of mangoes. For the answer to question number one, S2 did not clearly write down how to get the values of p and l , but directly wrote down the value of L by substituting the values of p and l with the numbers 42 and 25. In the indicator Drawing Conclusions from the Statement, it was found that S2 was less able to draw conclusions end well. The four answers do not contain a conclusion sentence. Of course this is not in accordance with the aspect of drawing conclusions from the statement by S2. So the answer written is not perfect. Indicators Checking the Validity of an Argument, it was found that in the process of S2, they often re-checked the answers that

had been written. So the resulting answer is correct. However, the writing steps still need to be improved by paying attention to the steps for writing the right answer. Furthermore, on the indicator Finding Patterns or Characteristics of Mathematical Symptoms to Make Generalizations, it is seen that S2 only writes down the example of an object into a variable in questions number 2 and 3 so that it can be used to determine mathematical models and solutions. For questions number 1 and 4, S2 did not write it down. It is feared that this will lead to errors in interpreting the answers.

The third subject (S3) managed to answer 4 of the 5 questions given. Furthermore, judging from the Making Allegations indicator, it can be seen that S3 did not write down what was known and asked properly. In question number 1, S3 only writes what is known from the problem in the form of a mathematical model. In addition, in questions number 2, 3, and 4, S3 did not write it down. This is not appropriate in writing the answer to the question because it misses several stages that need to be written. In the indicator of Performing Mathematical Manipulation, it was found that S3 can arrange calculations in a predetermined way so that they find answers. One of them can be seen from solving problem number 4, where S3 can determine the value of A using elimination. Furthermore, in determining the value of B, S3 substitutes the known value of A into the equation $A+B=56$. In general, S3 tends to use the combined method (elimination-substitution) in finding answers. While on the indicators of Drawing Conclusions, Compiling Evidence, Providing Reasons or Evidence for the Truth of the Solution, Doctoral Doctorate can arrange the evidence that has been obtained correctly as material in determining the answer to the final question/solution. One of them can be seen from the completion of problem number 2, the values of x and y that have been obtained are used to determine the price of 1 kg of apples and 2 kg of mangoes.

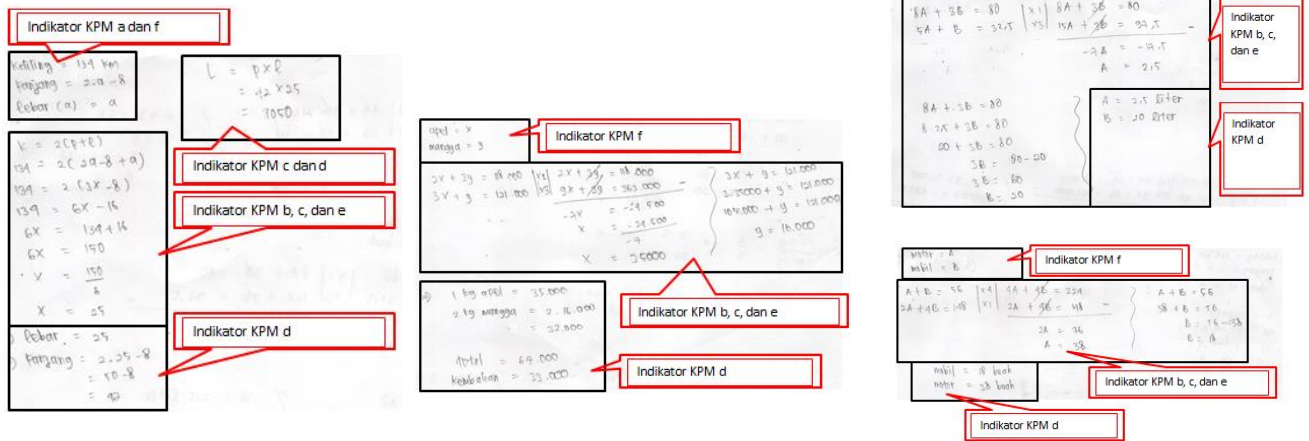


Figure 3. S3 Answer Sheet

Based on Figure 3, it is obtained a description of the indicator Drawing Conclusions from the Statement, it was found that S3 did not write a conclusion sentence as the final answer. So the answer to the four questions is not perfect. In the indicator of Checking the Validity of an Argument, S3 in the process often re-examines the answers that have been written. So the resulting answer is correct. In the last indicator, Find Patterns or Properties of Mathematical Symptoms to Make Generalizations. S3 can write an example of an object into a variable so that it can be used to determine mathematical models and solutions. However, answers to numbers 1 and 3, S3 did not write examples at the beginning of the work. This can lead to misinterpretation, so that the answers to S3 numbers 1 and 3 are less than perfect.

The fourth subject (S4) managed to answer 3 of the 5 questions given. Judging from the Asking Allegations indicator, S4 did not write down what was known and what was asked. However, S4 writes down what is known directly using a mathematical model. Likewise, what was asked, S4 wrote directly using a mathematical model. This means skipping one of the stages of writing the correct answer. Meanwhile, judging from the indicators of Performing Mathematical Manipulation, it can be seen that S4 can arrange calculations in a predetermined way so that they find answers. One of them can be seen from the solution to problem number 2, where S4 can determine the value of x using the elimination method. Furthermore, in determining the value of y , S4 substitutes the known value of x into equation 2. In general, S4 tends to use the combined method (elimination-substitution) in finding the answer. Furthermore, on the indicators of Drawing Conclusions, Compiling Evidence, Providing Reasons or Evidence for the Truth of the

Solution, it can be seen that S4 can compile the evidence that has been obtained correctly as material in determining the answer to the final question/solution. One of them can be seen from the completion of problem number 2, the values of x and y that have been obtained are used to determine the value of $x+2y$ so that they can find out the price of additional goods.

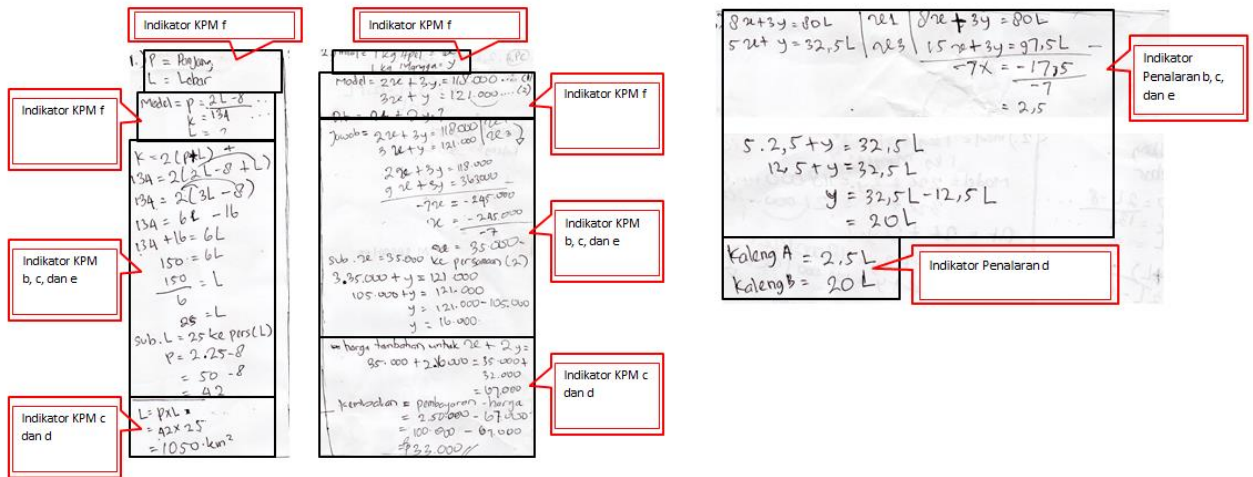


Figure 4. S4 Job Results

In Figure 4, information on Indicators of Drawing Conclusions from the Statement shows that S4 did not write the final conclusion sentence. So the answer to the third question is not perfect. In the indicator of Checking the Validity of an Argument, it was found that S4 in the process often re-examines the answers that have been written. So the resulting answer is correct. The last indicator Finding Patterns or Characteristics of Mathematical Symptoms to Make Generalizations shows that S4 can write an example of an object into a variable so that it can be used to determine mathematical models and solutions. However, answer number 3, S4 does not write the examples for cans A and cans B at the beginning of the work. This can lead to misinterpretation, so that the answer to S4 number 3 becomes less than perfect.

The results of data analysis obtained information that indicators of mathematical reasoning ability that many students mastered were indicators of drawing conclusions, compiling evidence, providing reasons or evidence for the correctness of the solution. This is in line with Mushtafa's research which shows that indicators of mathematical reasoning ability to draw conclusions, compile evidence, provide reasons or evidence for the truth of the solution have a fairly good category and sufficient have the highest

frequency of 33.33% (Musthafa et al., 2014). While the indicator of mathematical reasoning ability that is less mastered by students is the indicator of submitting conjectures. This is in line with Asdarina's research which shows that the indicator of mathematical reasoning ability proposes a very low category which is at an average of 26.94% (Asdarina & Ridha, 2020). In general, the reward game is proven to be used as a medium to train students' mathematical reasoning skills. This is in line with the results of previous research that online games, better than manual games (Yoga Wicaksana, 2016) and technology-based games (Aenu Rohmah, 2016; Martin Bernard, 2014), can be used to train and improve students' mathematical reasoning skills.

CONCLUSION

From the results of the study, it was concluded that the reward can train students' mathematical reasoning skills on the SPLDV material with an average value of 56.25 which is quite sufficient. Overall, the indicator of mathematical reasoning ability that is mostly mastered by students is indicator c (drawing conclusions, compiling evidence, providing reasons or evidence for the truth of the solution), while the indicator of mathematical reasoning of students who are less mastered by students is indicator a (proposing conjectures).

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