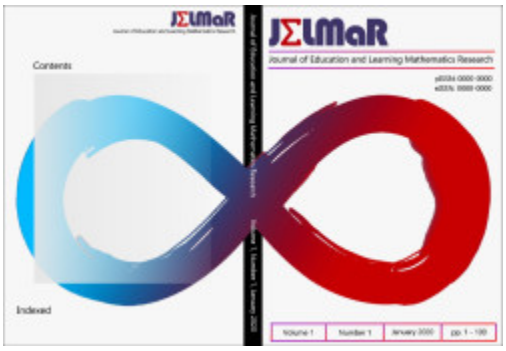

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Integration of Symbolab AI in Problem-Based Learning: Analysis of Students' Mathematical Reasoning

[1]Inka Verandera Nugraha, [2]Ely Susanti
Mathematics Education Study Program, Teacher Training and Education Faculty,
Sriwijaya University
Email: inkeyverandera@gmail.com

***Abstract**: This study aims to determine mathematical reasoning abilities through problem-based learning with the assistance of AI Symbolab on the topic of systems of linear inequalities in two variables. The subjects of the study were class X students at SMA Negeri 1 Palembang. This research is a qualitative descriptive study that uses observation, test, and interview data collection techniques. In analyzing observation data, the researcher will create a brief description based on the results of interviews or field notes. For test data analysis, the researcher will describe the subjects' abilities in mathematical reasoning, and for interview data analysis, the researcher will transcribe the interview results into written form. The research results show that the implementation of problem-based learning on the material of systems of linear inequalities in two variables, assisted by AI Symbolab, can develop students' mathematical reasoning abilities. This is evident from the students' ability to present mathematical statements in writing through mathematical models, propose several conjectures in their answers, conduct mathematical manipulations using AI Symbolab, compile evidence or reasons for the correctness of the solutions to the conjectures put forward, and draw conclusions from the steps they have taken.*
Keywords: mathematical reasoning ability, problem-based learning, systems of linear inequalities in two variables, AI symbolab

INTRODUCTION

Mathematical reasoning is a logical and systematic thinking process to solve problems logically (Salam & Salim, 2020). This process involves analyzing, generalizing, synthesizing or integrating non-routine problems, as well as relating pre-existing concepts (Konita et al., 2019), into empirical reality, accompanied by an explanation of the of concepts (Biagioli, 2020).

Mastering mathematical reasoning skills is essential for learners especially to solve mathematical problems, which are related to real-life activities (Mandasari, 2021). In addition, mathematical reasoning helps students remember facts, rules and problem-solving steps (Hansen, 2022). Then mathematical reasoning helps measure the extent to which learners explore their thinking and understanding of mathematical learning (Nurlinda et al., 2024), as well as allowing students to think logically in drawing general and specific conclusions during the learning process (Oktaviana & Noor Aini, 2021).

Students' reasoning ability on the material of the Two-Variable Linear Inequality System is not optimal, with 48.39% of students in the sufficient category. This shows that the mathematical reasoning ability of high school students on this material is still low, with many students having difficulty understanding the concept of inequality, drawing inequality graphs, and determining areas for solving inequality (Rahmawati & Astuti, 2022). In addition, the results of the mathematical reasoning ability test on the SPtLDV material are still low, with only 4% of students having high ability (Jais et al., 2023). Based on the interviews, the mathematical reasoning skills of grade X students on this material are still low, with students having difficulty describing the solution set area and feeling unfamiliar in asking conjectures when solving reasoning problems.

Students' reasoning abilities are relatively low due to several factors, including the lack of use of technology in learning(Tampubolon et al., 2022). Students often cannot understand the concepts used to solve problems properly and correctly, lack

understanding of the material that has been learned, feel less confident in solving problems, and lack of practice in working on problems (Inganah et al., 2023), which is students should be able to increase their self-confidence to improve their mathematical reasoning abilities (Susanto et al., 2022), students do not understand what they want to do (Syaripuddin et al., 2020) and students still tentto be passive and less enthusiastic in following the learning process (Ananda et al., 2020).

Previous research revealed problem-based learning models can help address students' weaknesses in reasoning by introducing them to problems that require reasoning, as well as helping students think logically systematically and thoroughly (Kotto et al., 2022). The problem-based learning model can also improve students' mathematical reasoning skills to make learning situations fun and make students not feel bored (Aulya & Purwaningrum, 2021) and also the problem-based learning model is quite helpful in students' mathematical reasoning on the material of two-variable linear equation systems (Azzahrah & Dwi Putra, 2023). Also, Good learning is learning that can make students active and involve students in thinking and reasoning a lot (Damayanti et al., 2020).

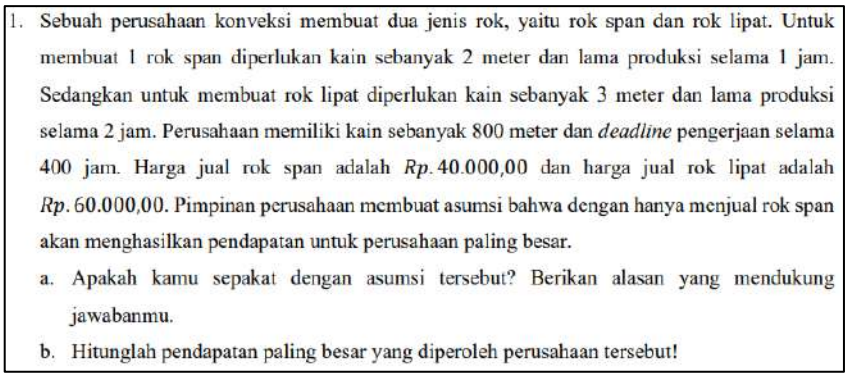
In addition, to improve students' mathematical reasoning skills, the use of appropriate learning media makes the learning process more effective. One of them is Symbolab. Symbolab is an artificial intelligence that can be used as an intermediary in mathematical reasoning related to SPtLDV with an easy process and the solution it produces is an answer along with its steps that can be learned and analyzed by students (Agustin, 2020a). The advantages of Symbolab in SPtLDV materials include providing step-by-step solutions that help students to understand the solution process, strengthen their understanding of SPtLDV concepts, recommendations for example problems, solutions presented using easy-to-understand language and also Symbolab helps visualize and understand complex mathematical concepts more easily (Wulan, 2023). Previous research has shown that students who learn to use Symbolab show an improvement in mathematical reasoning skills (Agustin, 2020b).

Therefore, the purpose of this study is to determine students' Mathematical Reasoning Ability Through *Problem Based Learning* on the material of the Symbolab AI-Assisted Two-Variable Linear Inequality System. After conducting Symbolab's AI-assisted problem-based learning, students are expected to present mathematical statements in writing, make conjectures, perform mathematical manipulations, compile evidence or reasoning against some of the truth of the solution and draw conclusions.

METHOD

This research is a descriptive study that uses qualitative and quantitative approaches, with the main focus on analyzing and explaining students' mathematical reasoning skills through a problem-based learning approach assisted by AI Symbolab. The subject of the study was class X students consisting of 36 people with heterogeneous characteristics and varying abilities, namely high, medium, and low. This research was carried out in the 2024/2025 school year at SMA Negeri 1 Palembang.

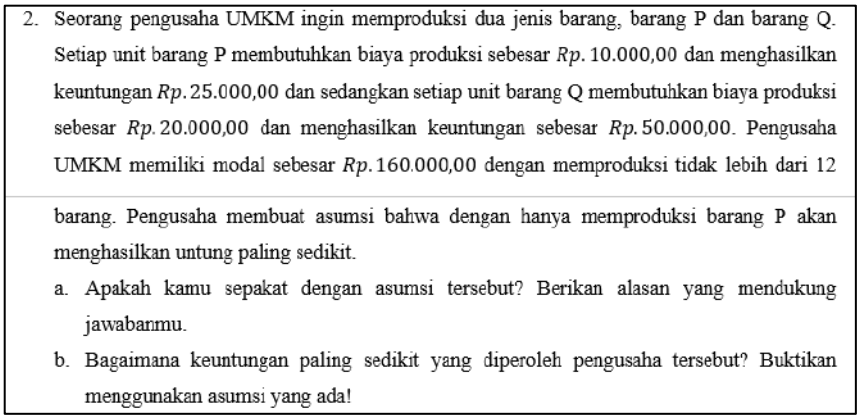
Descriptive research emphasizes more on the power of analyzing existing sources and data by relying on existing theories and concepts to be interpreted based on writings that lead to discussion (Mezmir, 2020). The techniques used in this study include: a) Observation, carried out using observation guidelines; b) Tests, used to measure students' ability to communicate their mathematical knowledge when performing mathematical reasoning; c) Interviews, which serve to add data related to students' mathematical reasoning skills, as well as obstacles and consequences that can be identified from the answers given in the description test. The test questions given are in the form of 3 questions related to indicators of mathematical reasoning ability of two-variable linear inequality systems. The following test questions were used in the research, namely:



1. Sebuah perusahaan konveksi membuat dua jenis rok, yaitu rok span dan rok lipat. Untuk membuat 1 rok span diperlukan kain sebanyak 2 meter dan lama produksi selama 1 jam. Sedangkan untuk membuat rok lipat diperlukan kain sebanyak 3 meter dan lama produksi selama 2 jam. Perusahaan memiliki kain sebanyak 800 meter dan *deadline* pengerjaan selama 400 jam. Harga jual rok span adalah $Rp.40.000,00$ dan harga jual rok lipat adalah $Rp.60.000,00$. Pimpinan perusahaan membuat asumsi bahwa dengan hanya menjual rok span akan menghasilkan pendapatan untuk perusahaan paling besar.
   a. Apakah kamu sepakat dengan asumsi tersebut? Berikan alasan yang mendukung jawabanmu.
   b. Hitunglah pendapatan paling besar yang diperoleh perusahaan tersebut!

Figure 1. Test Question Number 2

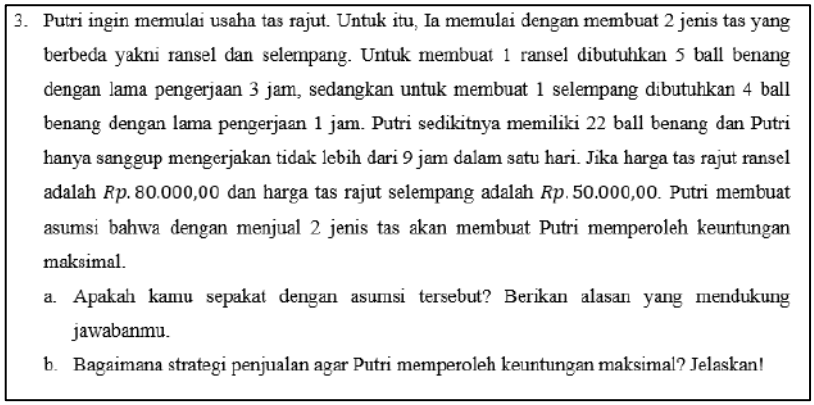
In question number 1, information is given related to the convection company that makes two types of skirts with fabric information and production time and selling price, then students will determine whether the assumptions given by the company are correct and determine the largest revenue obtained by the company. The process of solving this problem uses the five indicators of mathematical reasoning ability, here is the test question used number 2:



2. Seorang pengusaha UMKM ingin memproduksi dua jenis barang, barang P dan barang Q. Setiap unit barang P membutuhkan biaya produksi sebesar $Rp.10.000,00$ dan menghasilkan keuntungan $Rp.25.000,00$ dan sedangkan setiap unit barang Q membutuhkan biaya produksi sebesar $Rp.20.000,00$ dan menghasilkan keuntungan sebesar $Rp.50.000,00$. Pengusaha UMKM memiliki modal sebesar $Rp.160.000,00$ dengan memproduksi tidak lebih dari 12 barang. Pengusaha membuat asumsi bahwa dengan hanya memproduksi barang P akan menghasilkan untung paling sedikit.
   a. Apakah kamu sepakat dengan asumsi tersebut? Berikan alasan yang mendukung jawabanmu.
   b. Bagaimana keuntungan paling sedikit yang diperoleh pengusaha tersebut? Buktikan menggunakan asumsi yang ada!

Figure 2. Test Question Number 2

In question number 2, information related to the control of MSMEs that produce two types of goods with information on production costs, profits and capital, then students will determine whether the assumptions given by entrepreneurs are correct and determine the least profit obtained by entrepreneurs. The process of solving this problem uses the five indicators of mathematical reasoning ability, here is the test question used number 3:



3. Putri ingin memulai usaha tas rajut. Untuk itu, Ia memulai dengan membuat 2 jenis tas yang berbeda yakni ransel dan selempang. Untuk membuat 1 ransel dibutuhkan 5 ball benang dengan lama pengerjaan 3 jam, sedangkan untuk membuat 1 selempang dibutuhkan 4 ball benang dengan lama pengerjaan 1 jam. Putri sedikitnya memiliki 22 ball benang dan Putri hanya sanggup mengerjakan tidak lebih dari 9 jam dalam satu hari. Jika harga tas rajut ransel adalah $Rp.80.000,00$ dan harga tas rajut selempang adalah $Rp.50.000,00$. Putri membuat asumsi bahwa dengan menjual 2 jenis tas akan membuat Putri memperoleh keuntungan maksimal.
   a. Apakah kamu sepakat dengan asumsi tersebut? Berikan alasan yang mendukung jawabanmu.
   b. Bagaimana strategi penjualan agar Putri memperoleh keuntungan maksimal? Jelaskan!

Figure 3. Test Question Number 3

In question number 3, information related to the knitting bag business that will be made by Putri is given information on yarn needs, length of work and selling price, then students will determine whether the assumptions given by Putri are correct and determine a sales strategy so that Putri can get maximum profits. The process of solving this problem uses all five indicators of mathematical reasoning ability.

Quantitative data was obtained from written tests to measure students' mathematical reasoning skills, where the results of students' tests on the material of the two-variable linear inequality system were scored based on the scoring rubric. According to , the score is then converted into a value range of 0-100 with certain rules. (Rahayu & Zulkardi, 2018)

Table 1. Determination of Categories

Value	Category
80 – 100	Tall
50 – 79	Keep
0 – 49	Low

(Modification of Fatmawati & Murtafiah, 2018)

Quantitative data is used as a reference to select subjects from each category. The researcher determines the research subject based on the value of mathematical reasoning ability, which is measured using the value interval of each category. Then, qualitative data was obtained from observation, matching of written test results and interviews based on indicators of mathematical reasoning ability. Through this data, researchers will describe the results.

RESULT AND DISCUSSION

The research was carried out during two meetings using a problem-based learning model with the help of Symbolab's AI. Learning begins with an introduction, namely by greeting, praying, checking student attendance and conditioning students to learn. Furthermore, the researcher conveyed the learning objectives and conducted aperception related to the material of the two-variable linear inequality system. After that, the researcher gave students contextual problems and then explained the basic concept of the two-variable linear inequality system area and asked students to form a small group of 4 members. Furthermore, the researcher distributed LKPD 1 to all groups to be worked on and discussed with the group. The following are the stages of learning using *problem-based learning* carried out by students in groups.

1. Directing students to problems

   At this stage, the researcher orients students to read and understand the contextual problems in the LKPD meeting 1. The following are problem 1 and problem 2 in LKPD 1.

Figure 4. Orientation to LKPD 1 problems

At this stage, the researcher explained the basic concept related to the two-variable linear inequality system with the solution set area close to the point, namely related to its definition and general form. The researcher also provided opportunities for students to ask questions related to things that were not understood, students also

responded by asking questions related to signs of inequality. At this stage, the researcher directs students to present a mathematical statement in writing by presenting information related to entrepreneurs who produce two types of goods along with production costs, profits and capital with the aim of finding out whether only selling goods B will make entrepreneurs profit the most and also in problem 2, the researcher directs students to understand problem 2. The researcher directed students to present a mathematical statement in writing by presenting information related to clothing factories that produce two types of clothing along with the number of fabrics and production time with the aim of finding out whether only selling women's clothing makes the company get the least income.(0,0)

2. Directing students to learn

Next, the researcher guided students to present mathematical statements in writing. The researcher guides students to write down information related to the type of goods, production costs and profits in the form of tables. After writing down the information, the researcher directs students to equate the type of goods with a variable and then write down the form of inequality after the type of goods is supposed. Then, the researcher explained the requirements for the number of numbers in contextual problems, where in contextual problems the value produced should not be in the form of negative numbers, this is because in real problems, namely the amount of production, profit and capital must be in the form of numbers so that the solutions produced are relevant and can be applied in the context of the real world. Then, students are directed to write down the requirements for the number of numbers at this stage. The last step at this stage is to write down the goal equation, the researcher directs students to write information related to the selling price of each item with the variables for each item.

At the stage of presenting a mathematical statement in writing in problem 1, students are still lacking in writing down the information in the problem and do not write down the number requirement.

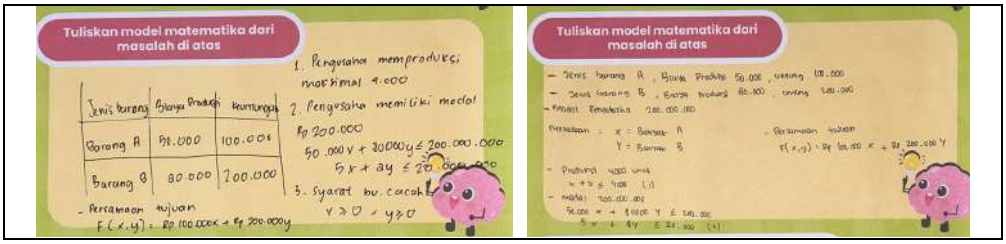


Figure 5. Answer to LKPD Mathematics Statement 1

Based on the results of the group's answers, it can be seen that there are groups that use modeling from the form of stories into mathematical models using tables and some who use a sentence. Both approaches can complement each other. The group that used tables had better reasoning skills in numerical data analysis, while students who wrote in sentence form had better reasoning skills in understanding concepts. However, there are groups that do not make a distinction between and . In problem 2, students can write a complete mathematical model.*xy*

Then, the researcher directs students to make a prediction of the answer that allows the solution of problem 1. At this stage, some students still have difficulty writing answer predictions, students are still unfamiliar with writing predictions. Researchers respond by helping students find possible solutions to problem 1. The researcher provides guidance for students to discuss with their group regarding ideas that allow mathematical solution of answers. The researcher also provided examples of predictions to provide a more concrete picture. After being given guidance and approaches, students can write down possible answers.

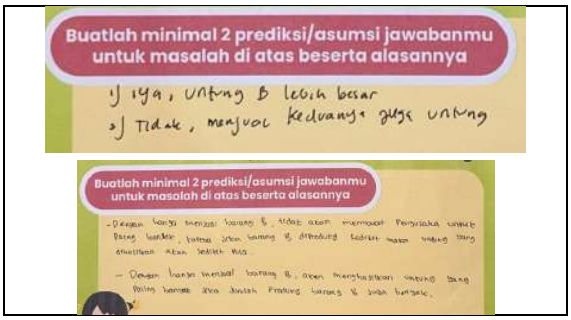


Figure 6. Answer to Submit LKPD Allegations 1

The various group answers reflect different levels of students' mathematical reasoning abilities. There are answers that are brief and do not provide in-depth explanations, and it can be said that the prediction is lacking in limited analytical reasoning. The other group's answers demonstrate the use of in-depth and logical analysis, it can be seen that the predictions are written mathematically and show a better understanding of the concept of profit. Students are able to explain the reasons behind the profits of item B and consider the combination of sales, it can be said that the answer uses strong logical and analytical reasoning. While the other group's answers showed a good understanding but with little flaw in explaining all possible options, it can be said that the predictions showed adequate use of analytical reasoning. In problem 2, students already show good and logical analysis showing better use of understanding and developed reasoning, with a more in-depth analysis of the factors that affect profits. In addition, there were groups that used mathematically in-depth explanations compared to other groups' answers

After writing down the predicted answer, the researcher directed students to scan the symbolab QR code and gave a little introduction related to the symbolab. The purpose of using symbolabs is to help students in completing the next stage, namely as an aid in shading the solution set area of the two-variable linear inequality system.

Figure 7. Scan symbolab LKPD 1

3. Guiding independent and group investigations

At this stage, the researcher directed students individually to explore the use of the symbolab application as an aid in working on a given problem. In this step, the symbolab plays a role in helping students in determining the shaded area, students can determine the cut-off point of the inequality, depict the settlement set area but still have difficulty shading the settlement set area, so the symbolab plays a role in helping students shade the settlement set area.

Furthermore, in groups, the researcher directed students to work in exchanging ideas and adding perspectives through collaboration if there were different answers. At this stage of using symbols, the results given by the symbols have a large scale, for the results that students describe after being enlarged, shaded and determined the cut-off point. The next step in the LKPD meeting 1 is the stage of determining the area of the inequality settlement set 1.

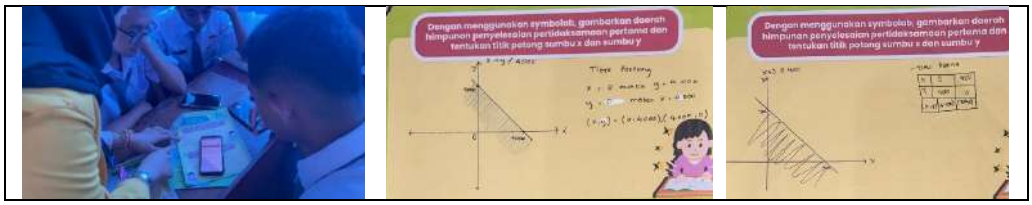


Figure 8. Answer to Stage 1 Mathematical Manipulation LKPD 1

By operating Symbolab, students are not only able to generate correct answers, but also improve their analytical and logical abilities. This app trains students in problem-solving, as well as helps students find concepts. Based on the group's answers, students can determine the cut-off point of the x-axis and the y-axis of inequality 1, then draw them and with the help of symbolabs, students can shade the area of the solution set correctly. Likewise in problem 2, symbolab can help students complete this step.

The next step is for students to determine the area of the solution set of inequalities 2 which also uses symbolabs in shading the area of the solution set.

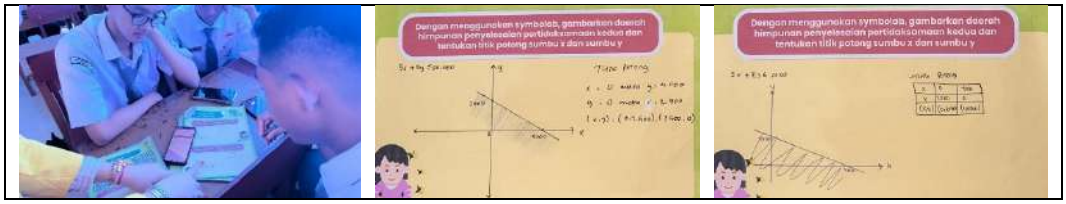


Figure 9. Answer to Stage 2 Mathematical Manipulation LKPD 1

Based on the group's answers, students can determine the intersection point of the x-axis and y-axis of inequality 2, then draw them and with the help of symbolabs, students can shade the area of the solution set correctly. In problem 2, symbolab also helps in completing this step.

When describing the solution set area using symbols, students are directed to draw the solution set area separately, using symbolabs to shade the solution set area 1 and using symbolabs to shade the solution set area 2. This is separated to aid in a clearer visualization of any shaded inequalities. Through this separation step, students can develop critical and analytical thinking skills through comparing the boundaries set by each inequality and evaluating how the two areas might interact if combined. By looking at each shaded area separately, students will better understand the limitations of the settlement set area of each inequality.

After using symbolabs to shade the areas of the set of solutions to inequalities 1 and 2, students are directed to draw the sum of all inequalities using symbols.

Figure 10. Answer to Stage 3 Mathematical Manipulation LKPD 1

Based on the group's answers, all groups can describe the combined area of the solution set of inequalities 1, inequality 2 and their conditions well and the correct picture. In problem 2, through the help of symbols, students can already describe the combined areas of the settlement set well.

To determine the cut-off point of the second inequality, students also use symbolabs in solving it. Through the solution set area in the symbolab, students can guess the intersection of the two inequalities. At this stage, some students still have difficulty in determining the cut-off point of the inequality, the researcher provides individual guidance by directing students to change the form of the inequality into an equation, then from the equation it can be substituted to determine the value of x and y. After obtaining the values of x and y, students will match the approximate location of the intersection in the symbolab with the results obtained. After being given individual guidance, students who have understood will explain to their group friends, at this stage students in groups exchange ideas and work together in finding solutions. Through group cooperation, students can complete the stage of describing the area of the settlement set.

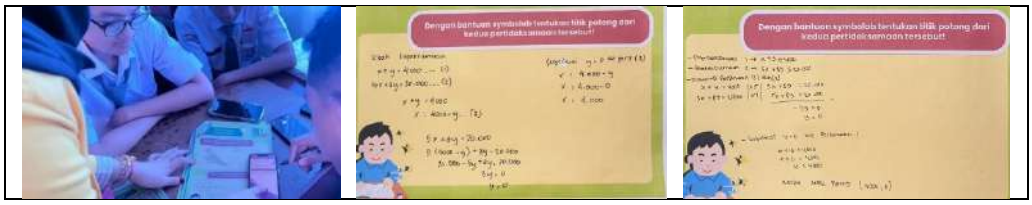


Figure 11. Answer to Stage 4 Mathematical Manipulation LKPD 1

Based on the answers above, students demonstrate good mathematical reasoning skills, albeit through different approaches. There are groups that determine the cut-off point using the substitution method and the combined method. Both managed to reach the correct answer, which reflects that mathematical understanding can be expressed through a variety of methods. The diversity of these approaches shows that students have flexibility in thinking and can choose the most appropriate strategy for the problem being solved. Based on these answers, it also shows that symbolab can help students develop their reasoning skills where students solve problems based on the stages in the LKPD in a structured and organized manner. In problem 2, students also use the substitution method and the combined method, through which students manage to achieve the correct answer.

Next, students explore the application of symbolab by trying out the dots in the solution set area. When students try to substitute the points in the solution set area using symbols, students can find the points that meet the critical points of the solution set area.

At this stage, there are still students who have difficulty determining which point is the critical point. The researcher directed students to try again the points in the settlement set area. After trial, the researcher asked students to observe the points that satisfied the inequality. After observation, the researcher directed the students to discuss the group in finding the shaded points on the settlement set area that the students had described, from the results of trying to use symbols.

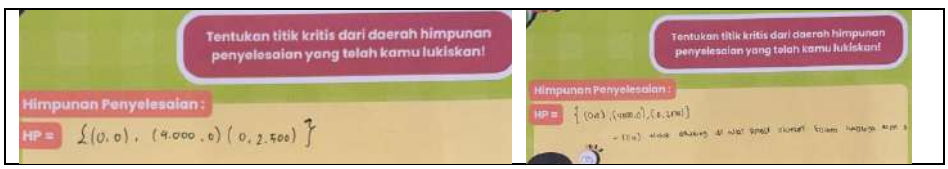


Figure 12. Answer to Stage 5 Mathematical Manipulation LKPD 1

Based on the answers above, students are able to write the set of solutions correctly and precisely, this reflects a combination of strong conceptual understanding, analytical skills, and critical thinking skills through the determination

of critical points using experiments from the symbolab application. This shows that students can apply mathematical knowledge to solve more complex problems. In problem 2, after being given guidance to experiment through the symbolab application, students are able to write the set of solutions or critical points correctly. From this critical point found, it will help students in compiling evidence for solutions to the problems in the question.

4. Developing and presenting works

Furthermore, students will apply knowledge and skills to find solutions to problems, namely through determining the value of objective functions. The researcher guides students to determine the value of the objective function based on the critical points obtained in the previous step. At this stage, there are students who have difficulty understanding the intention to determine the value of the objective function. The researcher directed students to write down the critical points obtained, then students were directed to substitute the critical points in the equation of goals that had been written at the beginning. Students respond by finding the value of the objective function of the critical point that exists through substitution.

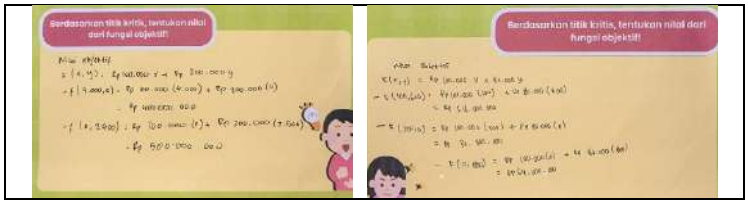


Figure 13. Answer to Prepare LKPD Evidence 1

Based on the answers above, students are able to write answers correctly and precisely. This shows students have a good understanding of reasoning, which allows them to structure evidence in the step of finding mathematical solutions effectively. In problem 2, students can also correctly determine the value of the objective function.

After determining the value of the objective function, students get the answer to the problem and can prove the correct answer from the prediction that has been written before.

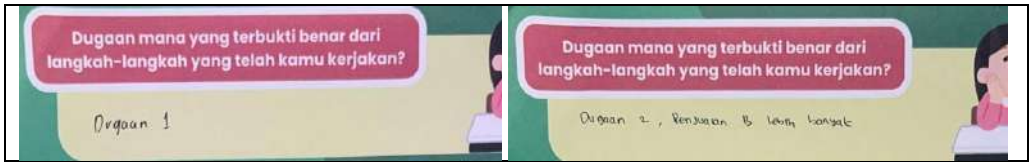


Figure 14. Answer Proving LKPD Allegations 1

Based on the answer above, from the answer predictions that have been written previously, one of the predictions written by the students is correct. There are groups that only write true conjectures and there are also groups that write true conjectures with a few conclusions from their conjectures. Students whose conjectures are proven to be correct show several significant reasoning skills, where through the step of preparing evidence, namely from determining the value of objective functions, students are able to evaluate assumptions and evidence that supports conjectures, students can achieve solutions to problems. In question 2, students can already write down the prediction of the answer that is proven to be correct.

The next stage is to draw conclusions based on the steps that have been completed. At the stage of drawing conclusions from problems, there are students who still do not understand conclusion writing. The researcher guides students to write down the

sound of the correct conjecture and the conclusion of what is the question in the problem, students write conclusions based on the direction of the researcher.

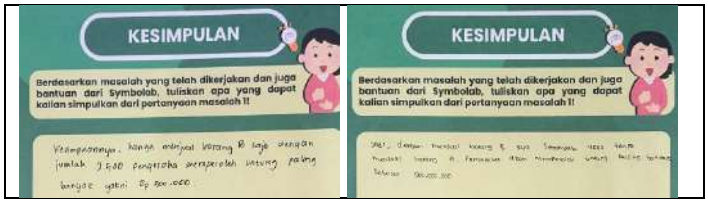


Figure 15. Interesting Answer to LKPD Conclusion 1

Based on the answers above, the diversity of conclusions written by students but with the same core solution. Students can conclude the problem well and correctly. This shows that students have the ability to analyze problems and ensure that the conclusions drawn are based on the evidence that has been found. In problem 2 as well, students can write conclusions with language diversity but with the same and correct solution core.

After working on problem 1 and problem 2 of LKPD 1, students are then directed to draw conclusions from the *problem-based-learning process*.

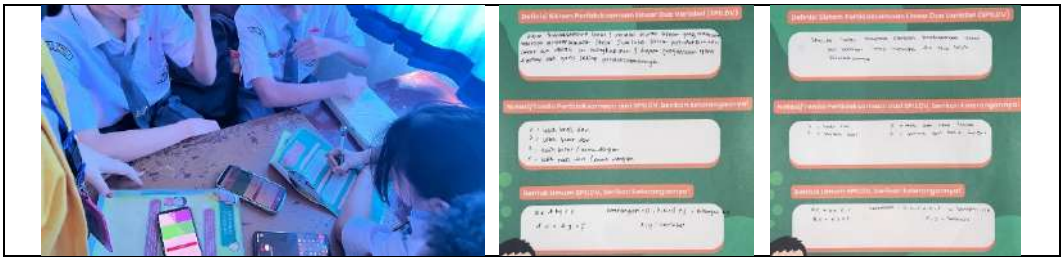


Figure 16. Conclusion of PBL LKPD 1

Based on the answers above, students can already conclude the learning obtained at the first meeting, even though with different language and writing, the answers written are correct. From definitions, notations and general forms, students must be able to use knowledge related to two-variable linear systems in solving contextual problems and be able to use their reasoning skills in the steps to solve the problem.

The last stage is to present the work, after all the steps have been completed, students in groups present solutions to the problems in front of the class. Students express orally. The researcher invited students from other groups to provide questions and comments related to the solutions presented. The other group of students responded by asking different answers to their group and discussing more appropriate answers.

5. Analyze and evaluate the problem-solving process

After the presentation and discussion, students will examine the process used in reaching a solution and students will evaluate if there are any errors in the steps taken in the process of reaching a solution. Students between groups discuss the differences in answers and discuss steps in the process of reaching a solution.

In the last stage of learning, the researcher provides a more in-depth explanation related to the two-variable linear inequality system with the solution area close to the point. The researcher conveys the definition, notation and general form of the two-variable linear inequality system.(0,0)

In the closing activity, the researcher gave students the opportunity to ask questions related to things that were still not understood. Furthermore, the researcher directed students to give conclusions from the two-variable linear inequality system.

Then, the researcher informed the material at the next meeting and the teacher ended the learning by saying greetings.

In the second meeting, what was done was problem-based learning assisted by Symbolab's AI. For the activities carried out the same as meeting 1, the difference lies in the material, namely the meeting 1 material of the two-variable linear inequality system with the area of the solution set approaching the point. In meeting 1, students were still busy exploring the symbolab application and students were still unfamiliar with solving problems by writing assumptions. Meeting material 2 is a two-variable linear inequality system with the area of the solution set away from the point. In meeting 2, several students were dissipated, which caused some groups to be less conducive to the learning process.(0,0)(0,0)

2. Tests

In the third meeting, a mathematical reasoning ability test consisting of three description questions was carried out to see the students' mathematical reasoning skills. The test uses material from a two-variable linear inequality system, with questions arranged based on indicators of mathematical reasoning ability and have been validated. Students' mathematical reasoning abilities are as follows.

Table 2. Average Scores of Students' Mathematical Reasoning Skills

Interval	**Frequency**	**Presented**	**Category**
80-100	12	33%	Tall
50-80	19	53%	Keep
0-49	5	14%	Low
Sum	36		
Average		67.47	
Category		Keep	

Modification (Fatmawati & Apostasy , 2018)

Based on table 2 above, it can be seen that the average score of students' mateamtic reasoning ability through *problem based-learning* assisted by AI Symbolab, which is 67.47 which is categorized as moderate.

High Level Capability (H1)

Subject H1 is a subject with a high level of ability because subject H1 is able to solve all three problems but there is a slight error in doing it due to time that has run out, subject H1 is able to present mathematical statements in writing, but is lacking in making conjectures, where the conjectures written are not mathematical, lacking in performing mathematical manipulation, namely subject H1 does not determine cut-off points and critical points.

Subject H1 is able to give indicators of compiling evidence or reasons for the truth of some solutions but there are still some shortcomings, where there are points that subject H1 should determine, but not determined by subject H1. Then H1 can draw conclusions well. Subject H1's answer is seen in figure 1.

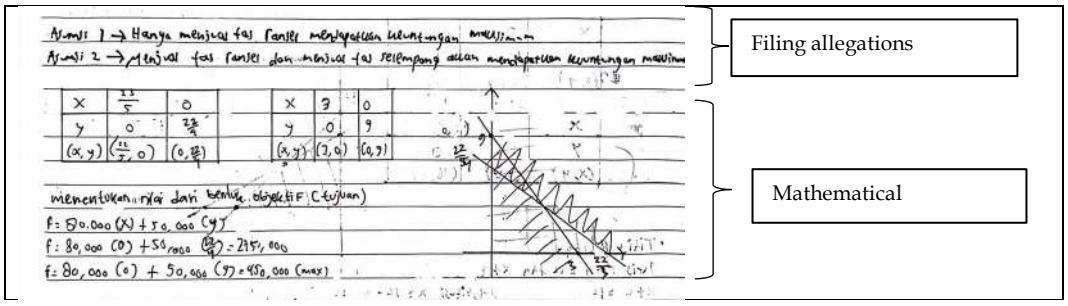


Figure 17. Subject H1 Answer

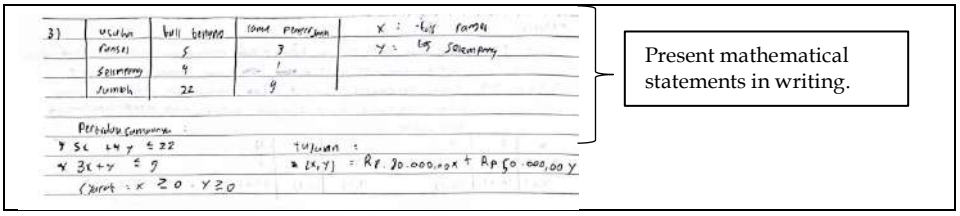
Based on the answers of subject H1 that have been written, subject H1 is lacking in making conjectures, this is because in the process of working on question number 3 the work time has almost run out, so that subject H1 is in a hurry to solve question number 3. Then in performing mathematical manipulations, subject H1 does not determine the cut-off point of the two inequalities and critical points, subject H1 understands how to determine both, but because time is up, subject H1 is in a hurry to write it down this is also the same cause in compiling evidence or reasoning for some truth of the solution, because subject H1 does not determine the cut-off point, then when determining the value of the objective function there is a point that is not determined by the value of the function objectives. This was reinforced by interviews with H1 subjects.

R: How does H1 write the conjecture on question number 3?
H1: I wrote down the conjecture not for mathematical reasons, because time was running out, so I was in a hurry and didn't have time to write down the reason anymore.
R : Then, for the next step, why doesn't H1 determine the intersection of the second inequality and its critical point?
H1 : Yes, ma'am, so is this step, because the work time is about to run out, I was in a hurry and forgot to determine both.
R: Well, do you think the value of this objective function is correct?
H1 : After I read it again, this is true but there is something missing because I did not specify the cut-off point earlier, so for the cut-off point I did not determine the value of the objective function.

High Level Abilities (H2)

Subject H2 is a subject with high ability, this is because subject H2 can solve problems number 1 and number 2 perfectly and bring up all indicators of mathematical reasoning ability, but in question number 3 subject H2 solves it incompletely because subject H2 has a mistake in answering question number 3.

Subject H2 solved problems in the problem quite well, this can be seen from the subject H2 did not meet the five indicators of mathematical reasoning ability in one of the questions. Subject H2's answer is seen in figure 18.



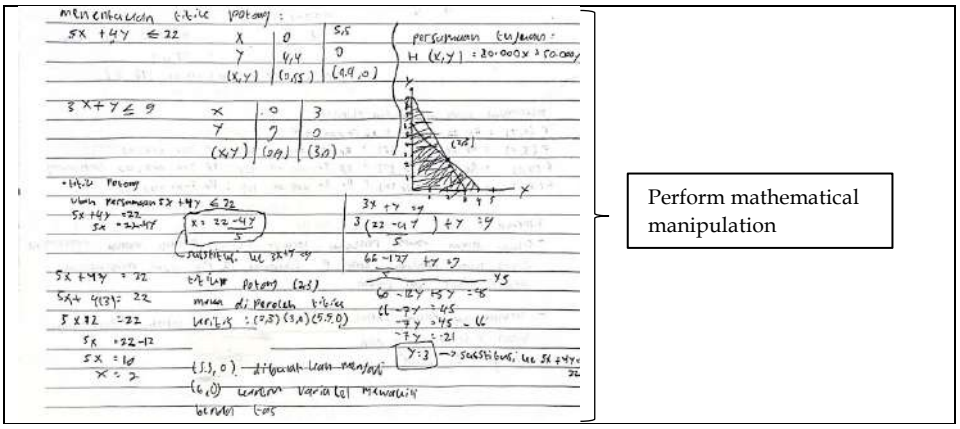


Figure 18. Answer 1 Subject H2

Based on the answers of subject H2 that have been written, subject H2 lacks in presenting mathematical statements in writing, this can be seen from the fact that subject H2 is wrong in writing the sign of inequality 1. In the indicator of making a conjecture, the subject H2 can fulfill it well. In the indicator of performing mathematical manipulation, the subject H2 can determine the cut-off point, but in describing the area of the solution set of subject H2 there is an error because the inequality sign written by subject H2 is wrong which also results in the critical point obtained is wrong.

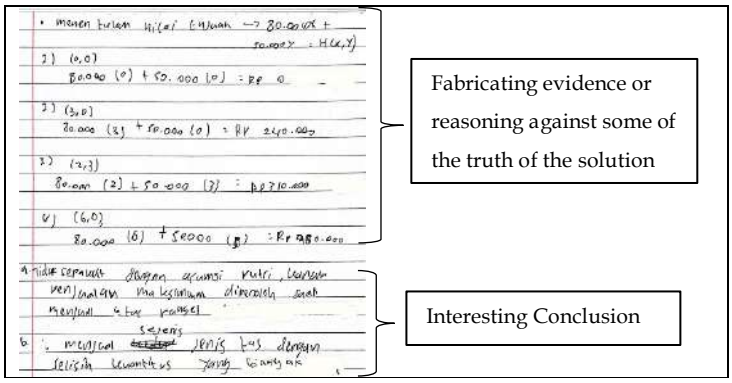


Figure 19. Answer 2 Subject H1

In the indicator of compiling evidence or reasons for some solution truth, subject H2 incorrectly determines the value of the objective function, this happens because the critical point obtained by subject H2 is wrong. Then, on the indicator of drawing conclusions, subject H2 also draws the wrong conclusion because the steps completed by subject H2 are also incorrect.

This happened because subject H2 was wrong in reading the question in the section "Princess has at least 22 ball threads", subject H2 misread it so that the sign of inequality written by subject H2 should be. This is reinforced by interviews with H2 subjects.≥

R : According to H2, is the inequality written correct?
H2: After I reread this question, it was wrong, because when I read the question in the "someikhnya" section I made a mistake, I wrote it down as it should have been ≤≥
R: So, what about the conclusion that H2 draws?
H2 : Of course it is wrong, because from inequality 1 the sign is wrong, so when shading the area of the settlement set is also wrong, the critical point, the value of the objective function and the conclusion that I draw are wrong.

Intermediate Ability (I1)

Subject I1 is a subject with moderate ability, this is because subject I1 can only complete 2 out of 3 test questions given. Subject I1 solved problems in the problem quite well, this can be seen from the subject I1 met the five indicators of mathematical reasoning ability. Based on the answers of subject I1 that have been written. Subject I1 can come up with indicators of mathematical reasoning ability, namely presenting mathematical statements in writing, making conjectures, performing mathematical manipulations, namely determining cut-off points, describing the area of the solution set and determining critical points. Then subject I1 can compile evidence or reasoning against some of the truth of the solution and draw conclusions from the steps that have been completed.

The reason subject I1 cannot solve problem number 2 is because subject I1 subject I1 solves problem number 3 where subject I1 solves the most difficult problem first, then solves problem number 1, both of them take quite a long time, so when they are still trying to understand problem number 2, the work time has run out. In addition, when interviewed, students stated that during practice, students are rarely given practice questions in the form of contextual questions, during practice teachers usually give questions that can be answered directly with formulas. Then based on the statement of subject I1, subject I1 did not follow the learning of meeting 2 well, subject I1 did not pay attention to contributing to the group discussion. This is clarified by an interview with the subject I1.

R : Has I1 ever worked on a problem like this before?
I1 : Never
R : What kind of questions do teachers usually give?
I1 : Usually we work on problems whose answers are directly using formulas only.
R : Well, in solving problems number 1 and 3, did I1 have any difficulties?
I1: I work on the problem that I consider the most difficult first, therefore I work on number 3 which takes a long time and then work on number 1.
R : Does I1 understand the problem in question number 2?
I1 : I am still trying to understand it, during the learning of meeting 2 yesterday I did not follow it well, I did not pay attention to the learning and did not cooperate in the group, so I had a little difficulty in understanding problem number 2

Intermediate Ability (I2)

Subject I2 is a subject with moderate ability, this is because subject I2 solved the three questions quite well. Subject I2 is able to complete all three questions, but in each question I2 does not write down the number requirement, does not write the answer assumption and does not determine the value of the objective function. Subject I2's answer is seen in figure 19.

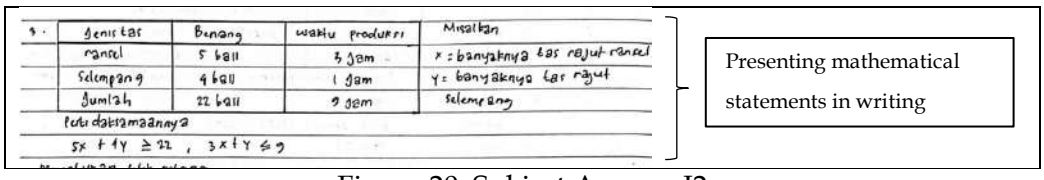


Figure 20. Subject Answer I2

Based on the answers of subject I2 that have been written. Subject I2 lacks in presenting indicators to present mathematical statements in writing, this can be seen from subject I2 not writing down the condition of the number. In the indicator of making a conjecture, subject I2 does not make assumptions for the solution of the problem so that I1 does not meet the indicator. In the indicator of performing mathematical manipulations, subject I2 can determine the cut-off point, draw the area of the settlement set and

determine the critical point. In the indicator of compiling evidence or reason for the truth of the solution, subject I2 does not meet it because subject I2 does not determine the value of the objective function. In the indicator of drawing conclusions, subject I2 draws conclusions well and correctly from the steps that have been completed.

Subject I2 does not write the condition of the number, because according to I2 it is not necessary to write it, all that is needed when describing it is that this is subject I2's lack of understanding of the basic concept of contextual problems. Subject I2 does not determine the value of the objective function is not written by subject I2 because from the critical point that subject I2 finds, subject I2 can draw conclusions from the given problem. This was clarified by an interview with subject I2.

R : Does I2 know the number requirement?
I2 : Yes, the one and .$x \geq 0 y \geq 0$
R : Well, why in modeling the problem, I2 does not write the number requirement?
I2: I don't think it needs to be written, it just needs to be shaded when it is drawn, so I don't write it.
R: Then, for the value of the objective function, why didn't I2 write it? How can I2 draw a Conclusion?
I2: From the critical point obtained when drawing the area of the solution set, I can already draw the conclusion, so I do not write the value of the objective function.

Low-Level Abilities (L1)

L1 subjects are subjects with low level of ability, this is because L1 subjects can only complete 2 out of 3 test questions given. The 2 test questions that L1 subjects can complete are also less perfect, this can be seen from the fact that L1 subjects do not meet the five indicators of mathematical reasoning ability. Subject L1's answer is seen in figure 20.

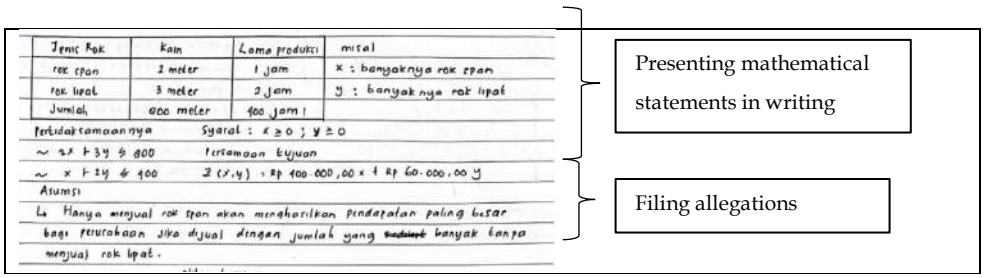


Figure 21. Answer 1 Subject L1

Based on the answers of the L1 subject that have been written, the L1 subject can come up with indicators to present mathematical statements in writing. In the indicator of asking a conjecture, the subject L1 only proposes one assumption that allows a solution to the problem.

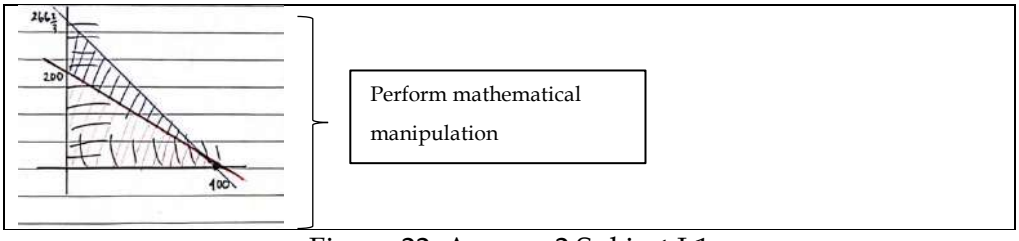


Figure 22. Answer 2 Subject L1

In the indicator of performing mathematical manipuls, the subject L1 does not specify the cut-off point and the critical point, the subject L1 can only describe the area of the solution set. Then on the indicator of compiling evidence or reasons for some solution

truth, the L1 subject can determine the value of the objective function and can draw conclusions from the steps that have been completed. Subject L1 can complete questions number 1 and number 2, subject L1 does not complete question number 3 because the work time has run out, where subject L1 has scribbled down possible answers but did not have time to copy them

Subject L1 only made one assumption because there was no direction to propose more than one assumption and because there was already an assumption in the question, this was a misunderstanding of the subject L1 in understanding the problem. Subject L1 only describes the area of the settlement set, subject L1 does not determine the cut-off point because subject L1 only understands to describe the area of the settlement set, where in the area of the set there is already a cut-off point and does not list the critical point because it is already known from the image, besides that it is also caused by the subject L1 does not contribute during the discussion in completing this step well. This was clarified by an interview with L1 subjects.

R: Why does L1 write down only one assumption?
L1 : Since there is no direction to write down more than one assumption, I think there are already assumptions given in the question.
R : Then, to draw the area of the solution set, why not determine the cut-off point and the critical point?
L1 : I only understand describing the area of the settlement set, because I learned from the symbolab yesterday, besides that the cut-off point is already drawn so I don't write it anymore.
R : During the group discussion yesterday, did you also complete this step?
L1 : I don't contribute much to determining the cut-off point, I only follow when describing the settlement set area.

Low-Level Abilities (L2)

L2 subjects are subjects with low ability, this is because L2 subjects can only complete 2 out of 3 test questions given. The 2 test questions that L2 subjects can complete are also less than perfect, this can be seen from the fact that L2 subjects do not meet the five indicators of mathematical reasoning ability. Subject L2's answer is seen in figure 21.

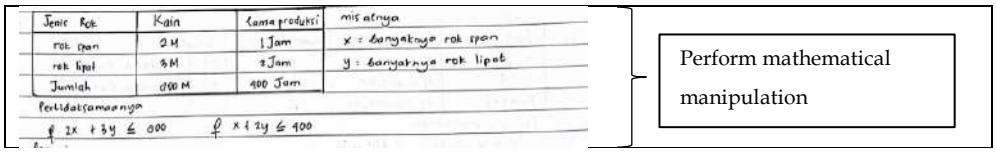


Figure 23. Subject L2 Answer

Based on the answers of the L2 subject that has been written, the L2 subject lacks in presenting mathematical statements in writing, this can be seen from the fact that the L2 subject does not write down the requirement for the number of numbers. Then on the indicator of making conjectures and performing mathematical manipulations, the L2 subject can fulfill it, this can be seen from the L2 subject writing 2 assumptions, determining the cut-off point, describing the solution set area and determining the cut-off point. In the indicator of compiling evidence or reasoning for some solution truth, subject L2 does not meet it because subject L2 does not determine the value of the objective function. On the Drawing Conclusions indicator, the L2 subject can draw conclusions from the steps that have been completed. Subject L2 completed questions number 1 and number 2 but did not complete question number 3 because subject L2 had run out of time, in the process of working on subject L2 had difficulty understanding the problem because during the learning process, subject L2 did not follow the discussion well.

Subject L2 did not write down the requirement of the number of numbers because he forgot to write it, in this case the subject L2 was not careful in presenting mathematical statements. Then the subject L2 does not determine the value of the objective function because the subject L2 can already prove his conjecture through the critical point in the settlement set area. This was clarified by an interview with L2 subjects.

R: Why doesn't L2 write the number requirement?
L2 : Oh yes, I forgot, but when I draw the area of the settlement set I shade the condition of the number of numbers.
R: How does L2 prove the assumption that L2 wrote is true?
L2: From the critical point in the settlement set area, I can prove the correct assumption and then draw the conclusion without having to calculate the objective function value one by one.
R: During group discussions, what did L2 do?
L2: I only occasionally express my opinion, ma'am, I just focus on exploring symbols.

From the results of the study, it was concluded that students' mathematical reasoning ability through problem-based learning of a two-variable linear inequality system assisted by AI symbolab was categorized as low. The causes of students' mathematical reasoning ability are categorized as moderate, including students having difficulty understanding problems well, where students do not understand the basic concepts to solve problems and students do not understand the purpose of the problem. So, students can only complete 2 out of 3 questions. This is in line with research (Vebrian et al., 2021) that students do not understand the information from the questions well.

In addition, students are rarely given practice questions that require reasoning skills in the process of solving them which results in students having difficulty solving problems, difficulty channeling ideas that allow solutions from solving and difficulty drawing conclusions from the steps that have been completed so that students cannot meet the indicators of making conjectures and indicators of drawing conclusions properly. This is in line with research (Fadillah, 2019) that students are rarely given practice questions whose completion requires high reasoning and thinking skills. From the rarity of being given questions that require reasoning skills, students have difficulty managing time to solve problems, which causes students to only be able to do 2 out of 3 questions because the work time has run out. Then, students are less careful and wrong in reading the questions which results in students making mistakes in understanding and writing down the information in the questions. This is in line with research (Lestari Pratiwi & Akbar, 2022) that students make mistakes because of students' inaccuracy in reading mathematical reasoning skills.

Based on some of the causes above, another cause of students' mathematical reasoning ability through problem-based learning of the two-variable linear inequality system assisted by AI symbolab is categorized as low because students do not follow problem-based learning well, where students do not actively contribute during learning. This is in line with research (Khairani et al., 2023) that there is an increase in the reasoning ability of students who follow problem-based learning well.

CONCLUSION

Based on the data obtained through observation of written tests and interviews, it can be concluded in general that the mathematical reasoning ability of students in grade X.11 of SMA Negeri 1 Palembang is in the medium category, because students do not understand the basic concepts to solve problems, students do not understand the purpose of the questions and students are rarely given questions that require reasoning skills in the process of solving them. Due to the rarity of being given questions that require

reasoning skills, students have difficulty managing time to solve problems. Then, the mathematical reasoning ability in the low category is caused by students who do not understand the basic concepts to solve problems, do not follow problem-based learning well, students do not actively contribute and are not involved in solving problems when group discussions and students run out of time. Furthermore, the mathematical reasoning ability in the high category, where students are able to meet the five indicators of mathematical reasoning ability and solve problems, only there are slightly wrong answers in working due to the lack of thoroughness of students.

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