Focus **ACT**ion **O**f **R**esearch **M**athematic
Volume 6, No. 02, July – December, 2023
Pages 140 - 158

ISSN: 2655-3511 (print)
ISSN: 2656-307X (online)
DOI:10.30762/f_m.v6i2.1862

Analysis of Learning Obstacles for Junior High School Students in Understanding SPLDV Concepts

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Keywords

Didactical Design Research, Epistemological Obstacle, Concept Understanding Ability.

ABSTRACT

Penelitian ini dilatarbelakangi oleh rendahnya kemampuan siswa dalam memahami konsep dari literatur pada SPLDV. Tujuan penelitian ini untuk melakukan eksplorasi mengenai *learning obstacle* yang dialami oleh siswa SMP ketika mereka mencoba memahami konsep SPLDV. Oleh karena itu, diharapkan kedepannya penguasaan konsep dasar SPLDV dapat tercapai secara optimal. Penelitian ini merupakan penelitian kualitatif dengan desain *Didactical Design Research* (DDR). Subjek dalam penelitian ini berjumlah 3 siswa yang dipilih berdasarkan *purposive sampling.* Instrumen penelitian yang digunakan yaitu tes pemahaman konsep dan pedoman wawancara. Analisis data dalam penelitian ini meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa siswa masih menghadapi sejumlah kesulitan dalam memahami materi spldv. Kendala-kendala yang dihadapi siswa antara lain yaitu (1) kesulitan dalam merumuskan ulang konsep sistem persamaan linear dua variabel dan kurangnya kemampuan untuk memberikan contoh SPLDV. (2)Kesulitan dalam menentukan titik potong saat membuat grafik SPLDV. (3) Kekeliruan dalam melakukan operasi hitung dan mengembangkan model matematika. (4) Kesulitan dalam merancang langkah-langkah yang diperlukan untuk menyelesaikan soal SPLDV. (5) Kesulitan dalam menyelesaikan soal yang berbeda dengan contoh soal yang diajarkan oleh guru. Hal ini menunjukkan adanya beberapa hambatan yang perlu diatasi dalam pembelajaran konsep SPLDV di tingkat SMP.

Didactical Design Research, Epistemological Obstacle, Concept Understanding Ability.

This research was motivated by the low ability of students to understand concepts from the literature on SPLDV. This research aims to explore the learning obstacles experienced by junior high school students when they try to understand the concept of SPLDV. Therefore, it is hoped that in the future mastery of the basic concepts of SPLDV can be achieved optimally. This research is qualitative research with a Didactical Design Research (DDR) design. The subjects in this research were 3 students selected based on purposive sampling. The research instruments used were concept understanding tests and interview guidelines. Data analysis in this research includes data reduction, data presentation, and concluding. The research results show that students still face several difficulties in understanding SPLDV material. The obstacles faced by students include (1) difficulties in reformulating the concept of a system of linear equations in two variables and a lack of ability to provide examples of SPLDV. (2) Difficulty in determining the intersection point when creating SPLDV graphs. (3) Errors in carrying out calculation operations and developing mathematical models. (4) Difficulty in designing the steps needed to solve SPLDV problems. (5) Difficulty in solving questions that are different from the example questions taught by the teacher. This shows that several obstacles that need to be overcome in learning SPLDV concepts at the junior high school level.

INTRODUCTION

Mathematics is a field of science that has a crucial role in life. This is knowledge that focuses on developing the ability to calculate, measure, and apply mathematical formulas in everyday situations (Hutagalung, 2017). In mathematics learning, student understanding of draft mathematics is very important (Annisa et al., 2023); Yulianah et al., 2020). Students' ability to understand concepts is the key to explaining and applying these concepts in various situations. With a good understanding of this concept, students can develop the ability to use it to solve mathematical problems (Febrianto et al., 2019; Yulianah et al., 2020). According to Hutagalung (2017) The ability to understand mathematical concepts involves several important aspects. This includes the ability to articulate mathematical concepts in their own

words, group mathematical objects, apply concepts through algorithmic processes, interpret ideas or concepts, and relate different concepts to each other. With a deep understanding of a mathematical concept, students have a better ability to solve problems correctly. Conceptual understanding is a student's ability to properly understand the processes, concepts and principles involved, and apply appropriate problem-solving. This material aims to develop students' abilities to understand each concept in depth, not just memorize it (Risnanto et al., 2019).

In understanding concepts, students have several important abilities. This includes the ability to explain concepts in their own words, group mathematical objects, apply concepts through steps algorithmic, interpret and connect different concepts, as well as the ability to solve mathematical problems correctly. Mathematical concepts usually form hierarchical structures, and in mathematics learning These concepts are interrelated so that they become the basis for other concepts. Therefore, understanding concepts is very important in learning mathematics so that it becomes more meaningful and effective (Ramli & Prabawanto, 2020; Risnanto et al., 2019; Rosita et al., 2019; Yanti et al., 2020).

Students are considered to have understood mathematical concepts when they have met the understanding indicators. However, in reality, there are still many students who experience difficulties in understanding mathematical concepts (Rahmadhani & Hilliyani, 2023). This can be seen when they are faced with exam questions, where most of them cannot solve them well. Even though comprehensive material and a variety of practice questions have been presented during classroom learning, some students still face obstacles in solving mathematical problems, which has an unsatisfactory impact on their academic results. The main cause of students' failure to understand concepts is their limited ability to explain the problems posed, often just copying text and example questions without understanding them first. New knowledge will be remembered by students longer if they can design their own concepts (Handayani & Anggraini, 2023).

In understanding concepts, students must be able to explain the content and solve problems according to the concepts they have learned. Indicators of concept understanding according to Pratiwi (2016) include (1) restating a concept; (2) Classifying certain objects according to their properties; (3) Providing examples and non-examples of a concept; (4) Presenting concepts in various forms of mathematical representation; (5) Developing necessary or sufficient conditions for a concept of using and utilizing and selecting certain procedures or operations; and (6) Applying concepts or algorithms in problem-solving. Based on the results of preliminary observations on class VIII junior high school students, some students still unable to solve questions related to the material SPLDV. Figure 1 below explains the difficulties students face when completing SPLDV using the substitution method.

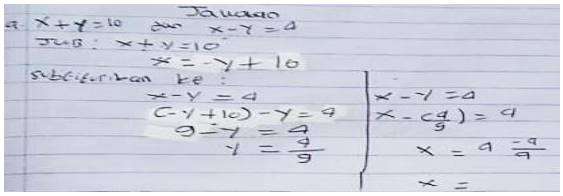

Figure 1. Results of student answers

Based on Figure 1, it can be seen that students have not been able to solve the problem completely. Students still do not understand the basic concepts of SPLDV. This material is closely related to algebraic operations, as well as finding the value of a variable. From the picture above, it can be seen that students made mistakes, namely that students made mistakes in operating subtraction $-y$ with y which caused errors in determining the value of variables y. Apart from that, students were also not able to determine the values of variables x because students were still confused about algebraic operations, resulting in students not being able to complete the answers correctly. Based on the results of interviews with students, it was revealed that the difficulties they experienced were caused by confusion in operating algebra. Operational obstacles faced by students are due to not understanding the techniques of algebraic calculation operations (Maarif et al., 2020).

According to the problem previously explained, it turns out that this

problem arises because students naturally face conditions that are often referred to as obstacles to learning (Yusuf et al., 2017). *Learning obstacles* are obstacles that can prevent students from completing the thinking process and understanding a concept (Rosita et al., 2020). In this context, *learning obstacles* can be divided into three main types, namely *epistemological obstacles* (obstacles related to student knowledge that have limited application contexts), *didactical obstacles* (obstacles that arise due to the teaching methods used by teachers), and *ontogenic obstacles* (obstacles related to students' mental readiness in the learning process) (Brousseau , 2002). Thus, further research is needed to examine in depth *the learning obstacles* faced by students in understanding the SPLDV concept. This will help in identifying the root of the problem and designing more effective learning strategies to overcome these obstacles.

Structured learning will help students understand lessons (Annisa et al., 2020). In this regard, this research aims to explore *the learning obstacles* experienced by junior high school students when they try to understand the concept of SPLDV. Through this research, it is hoped that it can provide a better understanding of the learning obstacles faced by students in mastering the basic concepts of SPLDV. With this better understanding, it is hoped that mastery of these concepts can be achieved optimally in the future, and can help in designing more effective learning approaches to overcome these obstacles.

METHOD

This research uses a qualitative method aimed at explaining the results of the analysis regarding *the learning obstacles* experienced by students in understanding the SPLDV concept. The research design used in this research is the *Didactical Design Research* (DDR) model research design. There are three stages in didactic design research, namely didactic situation analysis before learning in the form of hypothetical didactic design including ADP, metapedadidactic analysis, and retrospective analysis, namely linking the results of the hypothetical didactic situation analysis with the results of metapedadidactic analysis (Suryadi, 2013). The focus of this research is in the first stage with a didactic situation analysis to see *the learning obstacles* experienced by students in studying SPLDV material. This research method will help in identifying and designing more effective learning

strategies to overcome learning obstacles experienced by students in understanding the SPLDV concept.

The subjects of this research were 24 students in class VIII of one of the junior high schools in Cirebon district. Then three students were selected from these subjects using *purposive sampling*, namely selecting subjects based on high, medium and low test scores for interviews. The instruments used in this research were test instruments and interview guidelines. The flow of this research is that 24 students were given concept understanding ability test questions which were used to identify *learning obstacles* experienced by students related to SPLDV, then conducted interviews with three students to be explored and asked for clarification and received responses after working on the test questions that had been given previously related to *learning obstacles* that occur during learning. The data analysis technique in this research uses the Miles and Huberman model which consists of data reduction, data presentation and conclusion drawing (Sugiyono, 2019).

RESULTS AND DISCUSSION

This data was collected from students after taking a written test from a test instrument that had been prepared with five questions on conceptual understanding skills and interview results. Figure 2 shows the types of concepts understanding test scores.

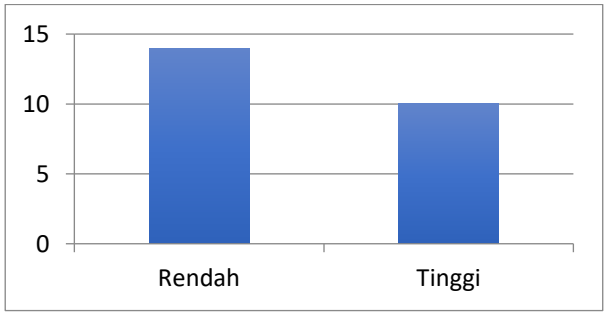

Figure 2. Categories of student test results

From Figure 2, the highest score was obtained by 10 students with a score of 75. Meanwhile, the lowest score was 30 for two students. The data obtained is in the form of written answer sheets which are the results of students' work related to the questions asked and interview guide sheets. This data is then analyzed to determine *the learning obstacles* faced by students based on interview results. The results of this research include several

learning obstacles related to the SPLDV concept as follows:

Student Answer Result 1:

Based on student 1's answer, student 1 still made several mistakes on questions 1, 2, and 5, while on questions 3 and 4 the students answered correctly. In question number 1 the explanation is good but there is still a lack of understanding of the SPLDV concept.

Question 1

Explain what is meant by SPLDV and choose the equations below that are not SPLDV.

a. $x + y = 4$
b. $x + y = 2$
   $2x + 3y = 7$
c. $x^2 + y^2 = 5$
   $x^2 + y^2 = 10$

An indicator of the ability to understand mathematical concepts in question number 1 is restating a concept. The following is an example of an error answer in number 1.

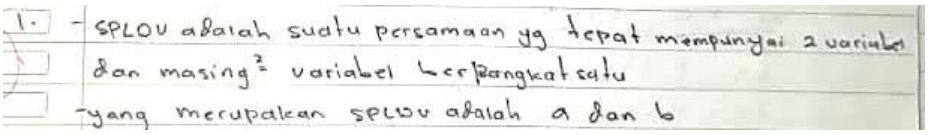

Figure 3. Error answer number 1

Based on Figure 3, students can interpret it well, but students are still incomplete in interpreting the definition of SPLDV where students only focus on the keywords having two variables and a power of one so that when students are asked to determine the examples included in SPLDV students are wrong in determining it. To dig deeper into the answers, researchers confirmed with interviews. The following is an excerpt from an interview conducted with Student 1 (S1):

Q: What do you know about SPLDV?

S1: SPLDV is an equation that has 2 variables and has a power of 1.

Q: Which ones a, b and c are included in SPLDV?

S1: a and b

Q: for a reason?

S1: because there are two variables x and y and their power is 1

Q: So what is the reason for B?

S1: there are x and y also and the power is 1, well in b there are 2 (while pointing to the equation), and in a it is only 1

P: oh, I see, so the SPLDV equation can have 2 or 1, right?

S1: yeah, like that

When students were interviewed, students stated that they still did not understand the material. Furthermore,

question number 2 still has not received a good interpretation, because it still has errors.

Question 2

Determine the solution set for SPLDV $xy = 2$ and $y = 4 - x$ using the graphical method

The indicator contained in question number 2 is the ability to present concepts in various forms of mathematical representation such as figure 4.

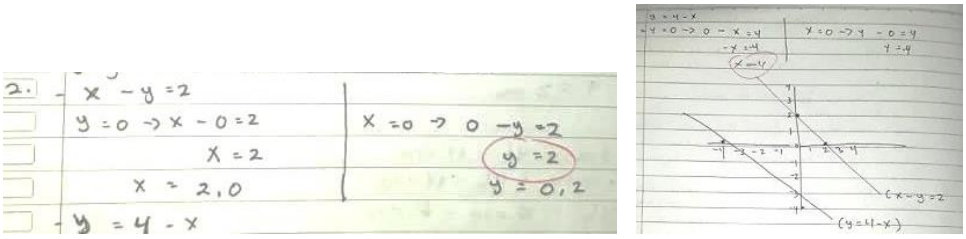

Figure 4. Error answer number 2

Based on Figure 4, students still experience obstacles in solving questions correctly. One of the mistakes students make is their inability to correctly identify the intersection point between $x\ axis$ and $y\ axis$ using the substitution method. This resulted in his inability to find the intersection point of the two-line equations, which should be the solution set of (SPLDV). To explore students' answers more deeply, researchers conducted interviews. The following is an excerpt from an interview with student 1 (S1) .

Q : Try to explain how to solve problem number 2

S1 : So number 2 what is being asked is the solution set of SPLDV $x - y = 2$ and $y = 4 - x$ using the graphical method, so that's the way to do it, if you want to make a graph, find the intersection point first.

Q : How do you find the intersection point?

S1 : The method is to change the x to 0 and then enter it into the equation and then get 1 point, then change the y to 0 and then enter it into the equation and then get 1 point again and then make the graph.

Q : Why do you have to change x and y to 0? Is it okay to replace the number with 1?

S1 : I don't know why, I think I can, ma'am

Q : Well, where did you get $y = 2$ from?

S1 : that's ma'am from 0 minus $y = 2$, because 0 minus y the result is – y so what you're looking for is y which means the negative has moved to the right so it's -2

Q : But here S1 writes 2, not -2, why?

S1 : Wow, when I was working on question number 2, I was in a hurry, ma'am, so I forgot to write down the negative.

During the interview with the student, it was stated that the student felt rushed when answering question number 2, which resulted in errors in the answer he wrote. Furthermore, question number 5 received a good interpretation, but still had errors.

Question 5

A parking attendant gets a parking fee of Rp. 25,000 from 3 cars and 5 motorbikes, while from 4 cars and 2 motorbikes, he got Rp. 24,000. If there are 20 cars and 30 motorbikes, the amount of parking money earned is

The indicator for question number 5 is applying concepts or algorithms in solving problems as in Figure 5.

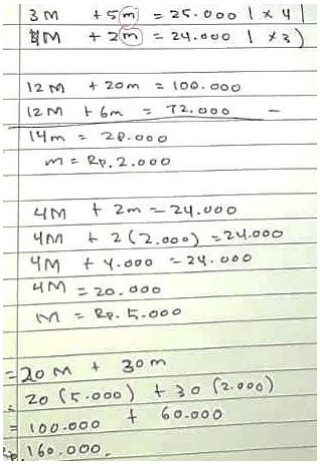

Figure 5. Error answer number 5

From the students' answers shown in Figure 5, it can be seen that the students have been able to interpret the questions well, but there are still errors in determining the appropriate mathematical model to deal with the problems in the story. The mistake made by students was not being inclusive in writing the variable variables for motorbikes and cars, using the variable M for both. Students should provide different variables for motorbikes and cars so that there is no confusion in determining the parking price for both. To explore students' answers more deeply, researchers conducted interviews. The following is an excerpt from the interview with S1:

Q : What do you know from question number 5?

S1 : if there are 3 cars and 5 motorbikes, the parking fee will be 25,000, then if there are 4 cars and 2 motorbikes parked, the parking fee will be 24,000

Q : So what was asked?

S1 : If there are 20 cars and 20 motorbikes parked, how much money will you get?
Q : OK, how do you solve it?
S1 : That's using elimination, ma'am
Q : So now pay attention to S1's answer here, what is the letter M here?
S1 : That's an example, right ma'am
P : Yes, for example, there are cars and motorbikes there, so what is M for example?
S1 : I'm also confused, ma'am, which M is for ma'am, hehe, because I still don't understand the analogy, ma'am, that's why I wrote all M.

The results of interviews with students also indicated that students still felt confused in determining the correct mathematical model for the problem. Apart from that, students are also not included conclusion required. Difficulties experienced by several other students in completing Question number 5 also reflects the challenges students face in understanding mathematical concepts.

Student Answer Results 2:

Based on student 2's answer, student 2 still made several mistakes in questions 1, 2, 3 and 5, while in questions 4 students answered correctly. In question number 1, students still made mistakes. The following is an example of an error answer in number 1.

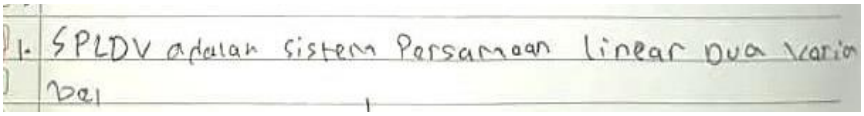

Figure 6. Error answer number 1

Based on Figure 6, students have not been able to interpret answer number 1 correctly. The problem experienced by students is that they only write the abbreviation of SPLDV but not the definition and students also do not write down examples of SPLDV. To find out more about the results of students' answers, the researcher confirmed it with interviews. The following is an excerpt from the interview with student 2:

Q : What do you know about SPLDV?
S2 : SPLDV is a system of linear equations with two variables
Q : Yes, what does that mean?
S2 : I don't know, ma'am, I'm confused, I don't understand

The results of student interviews show that students still do not understand the meaning of SPLDV so they cannot answer correctly. Students do not fully understand the concept of SPLDV. Furthermore, question number 2 still does

not have a good interpretation, because it still has errors.

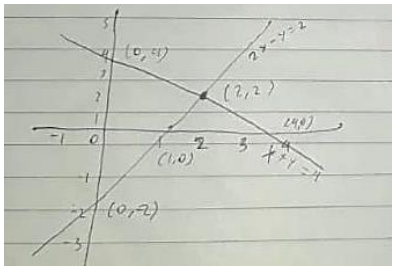

Figure 7. Error answer number 2

Based on Figure 7, students still face obstacles in solving question number 2 correctly. One of the mistakes students make is determining the intersection point of the two lines in the wrong way. Apart from that, students also do not explain correctly how to determine the intersection point through the x-axis and y-axis of the two lines. In an interview with the student, he said that he tried to determine the intersection point of the x-axis and y-axis directly without making calculations first because he thought that this would be faster in solving the problem. However, the results he wrote were still inaccurate due to a lack of detail and inaccuracy in making the drawing, which ultimately resulted in an error in determining the intersection point of the two lines. Furthermore, question number 3 still contains several errors.

Question 3

The price of 5 pencils and 2 books is Rp. 26,000, while the price for 3 pencils and 4 books is Rp. 38,000. If Nia buys 2 pencils and 4 books, how much money does Nia have to pay?

An indicator of the ability to understand mathematical concepts in this problem is the ability to develop necessary or sufficient conditions for a concept by using exploiting and selecting certain procedures or operations. Figure 8 is an example of an answer to error number 3.

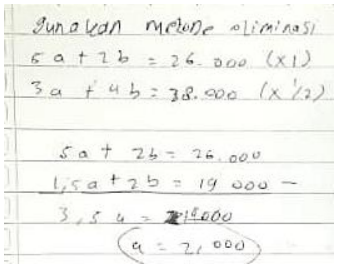

Figure 8 . Error answer number 3

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Based on the results of the students' answers above, several errors need to be corrected. One of the mistakes made by students is an error in the subtraction operation, which results in an error in determining the value of a using the elimination method. Apart from that, students also don't understand how to solve it completely, so they only write half of the answers before continuing to the next step. Apart from that, students also did not provide sufficient information for variables a and b in their answers. The results of interviews with students revealed that students did not write down the steps used in detail, and students also experienced errors in operations. reduction which results in errors in determining the value of a or the price of a pencil. Therefore, it can be concluded that *the learning obstacles* encountered by students include difficulties in calculating operations and arranging sequences when solving problems.

Student Answer Results 3:

Based on student 3's answer, student 3 made several mistakes in questions 1, 2, 3, 4 and 5. In question 1, the student made a mistake. The following is an example of an error answer in number 1.

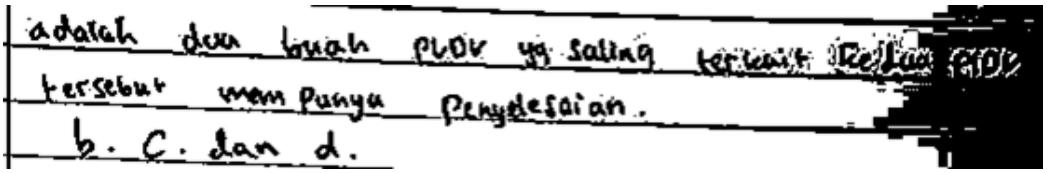

Figure 9. Error answer number 1

From picture 9, students have not been able to complete answer number 1 correctly. The student's mistake was not being able to identify examples of SPLDV. Indeed, students still do not understand the SPLDV concept well. The results of the interview stated that students were still confused about understanding material the. Furthermore, in question number 2, students still experienced errors in solving the question. Figure 10 is an example of a student's error answer to question number 2.

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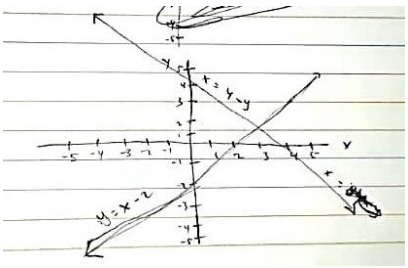

Figure 10. Error answer number 2

Based on the picture shown above, it can be seen that students can draw graphs correctly, but do not explain the steps to solve them. The results of interviews with students also showed that students did not understand how to determine the intersection point of the x-axis, y-axis, and the intersection point of the two lines. Apart from that, students are also not able to explain verbally what they have described. Thus, it can be concluded that *the learning obstacle* faced by students is their inability to determine the steps needed to find the SPLDV solution set using the graphic method. Furthermore, on questions number 3, 4 and 5, students were still unable to solve the questions.

Question 4

The sum of two whole numbers is 27 and the difference between the two numbers is 3. The product of the two numbers is

The indicator for question number 4 is developing necessary or sufficient conditions for a concept of using utilizing and choosing certain procedures or operations. Based on Figure 11, students still cannot solve the problem, students only write down the final result, not the solution, because students still don't understand how to solve it.

Question 5

A parking attendant gets a parking fee of Rp. 25,000 from 3 cars and 5 motorbikes, while from 4 cars and 2 motorbikes, he got Rp. 24,000. If there are 20 cars and 30 motorbikes, the amount of parking money earned is

The indicator for question number 5 is Applying concepts or algorithms in problem-solving. Figure 11 is an example of student answers to questions number 3, 4 and 5.

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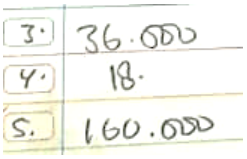

Figure 11. Errors in answers to numbers 3, 4 and 5

From Figure 11, the answer written by the student is correct, but the student did not write down the steps to solve it. The results of interviews with students showed that students still did not understand how to solve the questions because the questions given were different from the examples and the answers that they wrote were the results of their friends' answers. Therefore, it can be concluded that the learning obstacles encountered by students are not clearly understanding the steps for solving problems and being unable to solve problems that are different from the example questions. Based on the previous explanation, a summary of learning obstacles encountered by students in SPLDV material is presented in Table 1.

Table 1. Recapitulation of Learning Obstacles Experienced by Students in SPLDV Material

Concept Understanding Indicator	***Learning Obstacles***
Restates a SPLDV concept	Students have not been able to define SPLDV correctly and have not been able to determine examples of SPLDV
Presents the SPLDV concept in various forms of mathematical representation	Students make mistakes in determining the exact intersection point of the x-axis and y-axis when drawing graphs.
Developing necessary or sufficient conditions for an SPLDV concept to use and utilize and select certain procedures or operations	Students make mistakes in arithmetic operations and have difficulty in arranging steps in solving problems
Apply concepts or algorithms in problem-solving	Students have not identified mathematical models, students have not drawn conclusions as needed, and students have not completed problems other than the example questions given by the teacher.

The difficulty in reformulating the concept of SPLDV is caused by students' inability to precisely define SPLDV and not being able to identify examples of SPLDV. This is in line with research which shows that students who have auditory and kinesthetic learning styles still have difficulty distinguishing between examples and non-examples of the SPLDV concept. (Khoirunnisa & Soro, 2021) . Obstacles in

expressing the SPLDV concept in various forms of mathematical representation occur because students make mistakes in determining the intersection point $x-axis$ and $y-axis$ correctly when making graphs. Previous research findings also indicated similar errors, namely students had difficulty determining the intersection point x and y so they were unable to graph it. This shows that students still have weaknesses in understanding the concept of algebraic calculations (Risnanto et al., 2019). This is in line with research by Durotul et al (2019) which states that some students have difficulty drawing completion graphs.

The obstacle in developing necessary or sufficient conditions for the SPLDV concept by using, utilizing, and selecting certain procedures or operations is that students often make mistakes in carrying out calculation operations and face difficulties in designing steps to solve problems. This is by Hidayah (2016) which states that a common mistake made by students when solving SPLDV problems is an error in building a problem-solving sequence, resulting in the wrong solution. The difficulty in applying concepts or algorithms to solve problems is that students cannot yet identify the mathematical model. Like research conducted by Fahrilianti (2020), *The learning obstacle* faced by students in solving linear programming problems is the students' inability to determine variable separation. This is caused by students' difficulties in developing mathematical models due to a lack of conceptual understanding and a lack of training in solving problems presented in story form (Lestari & Afrilianto, 2021). In line with Adjizah's (2019) research, Students face difficulties in understanding story problems and identifying variables in the context of two-variable linear equation systems material.

Students do not draw the necessary conclusions. Based on previous research, one of the limitations of students in solving SPLDV questions is not being able to write the answers at the end of the lesson, especially the closing answers (Indahsari & Fitrianna, 2019). Students have difficulty solving questions other than the example questions given by the teacher because they lack understanding of the concepts being taught, so they can only follow the example questions that have been given. (Khodijah et al., 2021) . Based on research by Nurussafa'at et al (2016), several factors that cause students to make mistakes in

solving questions include being hasty, not being thorough, not understanding the questions well, not being complete in documenting understanding, not asking enough questions, not understanding the material. , forgetting the formula used, and limited time to work on the questions.

CONCLUSION

Based on the results of research on junior high school students' *learning obstacles* in understanding the SPLDV concept, it can be concluded that students face several difficulties, such as (1) difficulty in reformulating the SPLDV concept and a lack of ability to provide examples of SPLDV. (2) Difficulty in determining the intersection point when creating SPLDV graphs. (3) Errors in carrying out calculation operations and developing mathematical models. (4) Difficulty in designing the steps needed to solve SPLDV problems. (5) Difficulty in solving questions that are different from the example questions taught by the teacher. This shows that several obstacles need to be overcome in learning SPLDV concepts at the junior high school level.

Based on the results of the research above, the researcher provides several recommendations, namely that specifically teachers should ask questions at medium and difficult levels so that students get used to doing questions occasionally because asking lots of practice questions, can improve students' conceptual understanding abilities. Apart from that, it is hoped that didactic teaching materials will be created that can minimize the learning obstacles faced by students when understanding the SPLDV concept, because this material can be used to implement space and implement teaching materials for SPLDV material.

THANK-YOU NOTE

The author would like to thank the Master of Mathematics Education Study Program at Swadaya Gunung Jati University and SMP Negeri 1 Ciwaringin for helping the author complete this research.

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