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MISCONCEPTIONS OF PROSPECTIVE MATHEMATICS TEACHER IN LINEAR EQUATIONS SYSTEM

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Abstract

Misconceptions are still a problem in learning mathematics. The causes are very diverse, ranging from the cognitive abilities of students who are not good at mathematics to the teacher who is the trigger for this misconception. The misconception diagnostic test provides benefits to readers as a reference and pressure point in conveying certain concepts that are prone to misconceptions. This study aims to diagnose the occurrence of misconceptions and to analyze the types of misconceptions that exist in 29 prospective mathematics teachers on the two-variable (SPLDV) and three-variable (SPLTV) linear purchasing system materials. A test to detect conceptual errors was given to these prospective teacher students to diagnose conceptual errors that occurred when they studied SPLDV in junior high school and SPLTV in high school before being given linear sales system material in Elementary Linear Algebra courses. The results show that there are still classificational, correlational and theoretical misconceptions. Theoretical misconceptions that occur in students are related to the definition of misconceptions and related to the definition and types of SPL solutions. Classificational misconceptions occur when students classify examples and non-examples of a given linear sales system. Correlational misconceptions occur in students, namely students cannot connect a statement related to SPLDV with its graphical representation of the statement given, also students are not precise in compiling mathematical models of everyday problems given so that the solutions obtained are not correct.

Keywords: prospective mathematics teacher, misconception, linear system

Abstrak

Miskonsepsi hingga saat ini masih menjadi masalah dalam pembelajaran matematika. Penyebabnya sangat beragam dari mulai kemampuan kognitif peserta didik yang kurang baik dalam mata pelajaran matematika hingga pengajar yang menjadi trigger terjadinya miskonsepsi tersebut. Tes diagnostik miskonsepsi memberikan manfaat pada pengajar sebagai acuan dan titik tekan dalam menyampaikan konsep tertentu yang rawan terjadi miskonsepsi. Penelitian ini bertujuan untuk mendiagnosis terjadinya miskonsepsi dan menganalisis jenis miskonsepsi yang ada pada 29 calon guru matematika pada materi sistem persamaan linier dua variable (SPLDV) dan tiga variable (SPLTV). Sebuah tes untuk mendeteksi miskonsepsi diberikan pada mahasiswa calon guru tersebut untuk mendiagnosis miskonsepsi yang terjadi ketika mereka mempelajari SPLDV di SMP dan SPLTV di SMA sebelum diberikan materi sistem persamaan linear pada mata kuliah Aljabar Linear Elementer. Hasil menunjukkan bahwa masih terjadi miskonsepsi klasifikasional, korelasional dan teoritikal. Miskonsepsi teoritikal terjadi pada mahasiswa yakni terkait definisi miskonsepsi serta terkait definisi dan jenis solusi SPL. Miskonsepsi klasifikasional terjadi pada mahasiswa ketika mengkalsifikasikan contoh dan non-contoh dari sistem persamaan linear yang diberikan. Miskonsepsi Korelasional terjadi pada mahasiswa yakni mahasiswa tidak dapat menghubungkan sebuah pernyataan terkait SPLDV dengan representasinya dalam bentuk grafik dari pernyataan yang diberikan, juga mahasiswa tidak tepat dalam menyusun model matematika dari sebuah masalah sehari-hari yang diberikan sehingga solusi yang diperoleh tidak tepat.

Kata kunci: mahasiswa calon guru, miskonsepsi, Sistem persaman linear

INTRODUCTION

Teacher candidate education is a level that must be taken to prepare someone to become a teacher. In this education, prospective teachers are given both educational material and material related to fields, such as branches of mathematics for prospective teachers of

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mathematics, branches of biology for prospective teachers of biology, and branches of economics for prospective teachers of economics. One of the compulsory courses given to prospective math teachers is Elementary Linear Algebra. This course is a basic Algebra course given in the first year. In the Mathematics Education Study Program, Surabaya State University (2021), this course is given with learning outcomes including students being able to explain and apply concepts and techniques for solving systems of linear equations (SPL) with Elementary Line Operations (OBE), matrices and their operations, space vectors and subspaces, bases and dimensions, row/column spaces, inner product spaces, linear transformations, eigenvalues, eigenvectors, and diagonalization as well as being able to solve problems related to these topics.

Algebra is nothing new for student teachers. Since taking elementary and secondary education, algebraic content has been given. At the elementary level, material related to algebra includes solving problems on numbers or geometry. At the junior high school level, material related to algebra includes linear equations, linear inequalities, straight line equations, SPLDV. At the senior high school level, material related to algebra includes SPLTV, inequalities, quadratic equations, polynomials and many others. In Elementary Linear Algebra courses in tertiary institutions, the initial material given is Systems of Linear Equations (SPL). This material is the main material whose application appears from the beginning to the end of the lecture, so this material is very important to be given carefully. In order to be able to provide algebra material with the right concept to their students in the future, prospective teacher students must understand the concept so that later there will be no misconceptions occur.

During the COVID-19 pandemic, both students and teachers experienced various obstacles (Diana et al, 2021). The implementation of learning that was forced to change from offline to online made teachers less optimal in preparation, delivery of material, and evaluation. Less optimal implementation of learning, can lead to misconceptions. Wafiyah (2012) states that misconceptions are students' conceptions that do not match the conceptions of scientists, can only be accepted in certain cases and do not apply to other cases and cannot be generalized. In algebra, some of the most widely studied and misconceptions occur include those related to equality/inequality, negatives, variables, fractions, order of operations, and functions (Booth et al., 2017). SPL material is closely

related to variables, so this material is prone to misunderstandings. This is reinforced by the opinion of AL-Rababaha et al. (2020) who classifies algebraic misconceptions into four main classifications, namely algebraic expressions, linear equations, polynomials, and exponential and radical expressions.

In fact, when studying at the previous level, students often only studied SPL completion procedures without understanding the concept properly. This triggers a misconception. The specific causes are very diverse. From the perspective of students, according to Kurniati (2007), there are several causes of misconceptions, namely: (1) lack of developing knowledge by doing exercises independently; (2) the lack of cognitive abilities possessed by students to learn and understand a concept; (3) students do not have good conceptual knowledge so they experience difficulties in completing the practice questions; (4) students' mistakes in understanding or interpreting a concept in practice questions and; (5) students have good concepts in solving practice questions but are not applied in completing practice questions. Apart from the student's point of view, misconceptions are also very likely to occur because the delivery from the teacher triggers a wrong concept or because the approach used in learning is not suitable.

According to Moh. Amien (Salirawati, 2011), there are three types of student misconceptions, namely: (1) Classificational misconceptions, which are forms of misconceptions based on misclassification of facts into organized charts. For example, grouping examples and non-examples of linear equations. (2) Correlational misconception, which is a form of misconception based on errors regarding specific incidents that are interconnected, or observations consisting of allegations mainly in the form of formulations of general principles. For example, representing a mathematical problem in a mathematical model incorrectly. (3) Theoretical misconceptions, which are forms of misconceptions based on errors in studying facts or events in an organized system. For example, defining SPLDV incorrectly.

Based on teaching experience, prospective mathematics teacher students carry misconceptions from the previous level, as well as in Elementary Linear Algebra courses. This misconception, if not recognized or diagnosed, will interfere with further acceptance of the concept. Research related to misconceptions in algebra material has been carried out a lot. Among them is research conducted by Al-Rababaha et al. (2017) who analyzed

misconceptions that occur in school algebra, research by Booth et al. (2017) which focuses on algebra at the elementary level, and research conducted by Diana et al. (2021) which focuses on student errors in SPLDV materials. This research focuses on analyzing the misconceptions of prospective teacher students on Linear Systems material as a diagnostic step before students take Elementary Linear Algebra courses.

RESEARCH METHOD

This research is a descriptive research with a qualitative approach. As many as 29 students were given questions on understanding the concept of linear system material online using a Google form before they took Elementary Linear Algebra courses. The number of questions given is 7 questions with indicators of understanding the concept according to Heruman (2007) and corresponding question indicators as shown in Table 1.

Table 1. Indicators of concept understanding, indicator of questions, and the corresponding item

No.	Indicators of concept understanding	indicator of questions	The corresponding item
1.	Develop necessary and sufficient conditions of a concept.	Evaluate the general form of a given System of Linear Equations	Diberikan bentuk umum dari Persamaan Linear Dua Variabel berikut. Menurut Anda, adakah informasi yang kurang dari definisi tersebut? Berikan penjelasan. $ax + by = c$
2.	Classify objects according to certain properties according to the concept.	Classify the given equations into groups of examples and non-examples of linear equations	Pisahkan dari beberapa bentuk di bawah ini menjadi kelompok contoh dan non contoh persamaan linear, berikan penjelasan yang mencukupi. a. $-x + y = 5$ b. $2x + \frac{1}{y} + z = 0$ c. $\sqrt{x} + y = 2$ d. $\sin x + y = 0$ e. $xy - 2y = 1$ f. $\frac{1}{x} + \frac{2}{y} - \frac{1}{z} = 7$ g. $x_1 + x_2 = 4$
3.	Classify objects according to certain properties according to the concept.	Justifying a system is a System of Three Variable Linear Equations.	Apakah $\begin{cases} x - 2y + 2z = 5 \\ 2x + y - z = 2 \end{cases}$ merupakan suatu contoh SPLTV? Berikan alasan.
4.	Restating a concept.	Justify the truth of a statement regarding the SPL solution	Benarkah bahwa SPLDV dan SPLTV selalu punya solusi? Berikan alasan.
5.	Classify objects according to certain properties according to the concept.	Checks whether the given point is a solution or not a solution of an SPL	Apakah (3,1,1) dan (13,5,5) merupakan solusi dari SPLTV berikut? Berikan alasan. $2x_1 - 4x_2 - x_3 = 1$ $x_1 - 3x_2 + x_3 = 1$ $3x_1 - 5x_2 - 3x_3 = 1$

6.	1. Presenting concepts in various forms of mathematical representation. 2. Apply a problem-solving concept or algorithm.	Evaluate the geometric representation of the SPLDV solution from the given statements	"Jika terdapat tiga garis yang terletak pada bidang xy (koordinat cartesius) yang merupakan sisi-sisi dari sebuah segitiga, maka sistem persamaan yang tersusun dari persamaan-persamaan tersebut memiliki 3 solusi, masing-masing bersesuaian dengan tiap puncak." Benar atau salah pernyataan tersebut? Berikan penjelasan.
7.	Using and utilizing and selecting certain procedures or operations.	Solving math problems involving SPLDV with certain methods	Suatu Hari, 68 orang remaja hendak menyaksikan sebuah konser. Mereka berangkat ke lokasi konser dengan menaiki 11 buah mobil. Beberapa mobil dapat mengangkut 7 orang, sementara sisanya berkapasitas 4 orang saja. Dikarenakan ada beberapa orang yang datang terlambat, separo orang yang naik mobil berkapasitas 7 orang gagal menyaksikan konser karena Gedung sudah ditutup. Asumsikan semua mobil terpenuhi kapasitasnya dan orang yang tidak terlambat bisa mengikuti konser, ada berapa orang yang berhasil mengikuti konser?

The seven questions are questions in the form of true-false statements that demand understanding of concepts from prospective mathematics teachers along with their arguments. The answers of prospective teacher students will be classified as understanding or not understanding the concept based on the definition described by Hasan et al. (1999) which can be seen in table 2.

Table 2. CRI and the criteria

CRI	Criteria
0	Totally Guess Answer
1	Almost Guess
2	Not Sure
3	Sure
4	Almost Certain
5	Certain

Hasan et al (1999) developed a method that can be used to help identify misconceptions and distinguish between those who understand the concept and those who do not. This method is commonly called CRI (Certainty of Response Index). The CRI method is used as a method for measuring students' level of certainty when giving answers to each question, as an effort to differentiate students who have misconceptions or do not understand concepts (Tayubi, 2005). Tayubi then classified the four possibilities as shown in table 3 in order to identify students who understood, did not understand, or had misconceptions.

Table 3. Criteria for students who understand, did not understand, and had misconception

Answer's Criteria	Low CRI (< 2.5)	High CRI (≥ 2.5)

Correct Answer	The answer is correct but has a low CRI score means student understand the concept	The answer is correct and has a high CRI score means student understand the concept well
Incorrect Answer	The answer is incorrect and has a low CRI score means student does not understand the concept	the answer is incorrect but has a high CRI score means students has **misconception**

From the students' answers which indicated misconceptions based on the guidelines in table 3, then a further analysis was carried out on the types of misconceptions that emerged, namely whether the misconceptions were classificational, correlational, or theoretical type according to Moh Amien's definition (Salirawati, 2011). Researchers carry out research procedures starting from data collection, data analysis, data reduction, until conclusions are drawn.

RESULTS AND DISCUSSIONS

The results of this study are divided into two parts, namely 1) results of identification of misconceptions and their discussion and 2) results of classification of types of misconceptions and their discussion.

Results of identification of misconceptions and their discussion

The answers obtained from the diagnostic tests given to 29 prospective mathematics teacher students were analyzed based on whether the answers were correct and the level of confidence stated by the students as stated by Tayubi (2005). The percentage of misconceptions that occur in each item can be seen in table 4. The percentage is calculated based on the following formula:

$$P = \frac{the\ number\ of\ students\ answered\ incorrectly\ with\ CRI \geq 2{,}5}{total\ number\ of\ students}$$

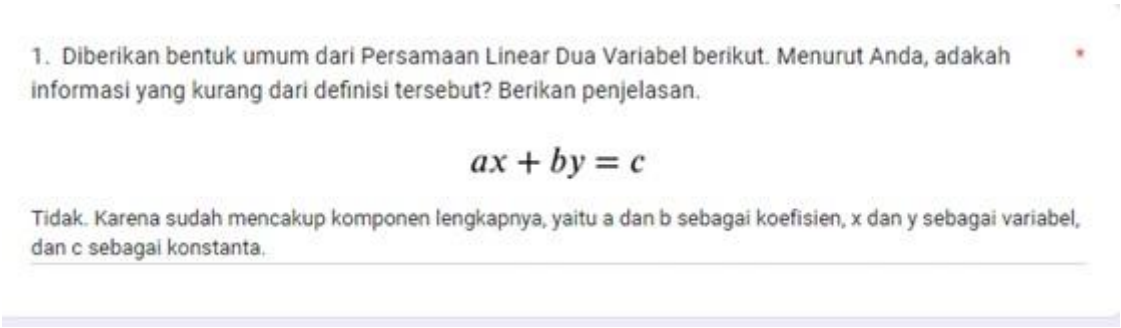
Table 4. Percentage of misconceptions that occur in each item

Question no.	Percentage of misconceptions that occur
1	86.21%
2	27.59%
3	27.59%
4	27.59%
5	20.69%
6	55.17%
7	27.59%

The percentage of misconceptions that occurred in question number 1 was 86.21% indicating that there were 25 out of 29 students who answered wrong question number 1 with a confidence level of ≥2.5 or specifically students chose a confidence level of 3, 4, or 5. If seen from table 4, misconceptions the most was in question number 1, namely the concept of defining a system of linear equations, and the least misconceptions made by students were in question number 5, namely the concept of SPL solutions. This needs to be a teacher's concern because algebraic conceptual errors can be one of the main reasons for students' weaknesses in mathematics (Al-Rahababa et al., 2017). When giving definitions to students in algebraic expressions, for example in defining the general form of a linear equation for 1 variable, the teacher must also emphasize that the given expression has conditions. The teacher not only provides that the general form of a one-variable linear equation is $ax + b = 0$, but also give the conditions that $a \neq 0, a, b \in \mathbb{R}$.

The results of the classification of misconceptions and their discussion

After obtaining the percentage of misconceptions as shown in table 4, then analyzed further for each of these items whether the misconceptions that occur are included in classificational, correlational, or theoretical misconceptions according to Moh's definition. Amien (Salirawati, 2011). In question number 1, the misconception that occurs is a theoretical misconception, namely students do not understand that the SPLDV expression given in the problem requires conditions, namely the values a and b cannot be 0 together, as well as $a, b \in \mathbb{R}$. Twenty-five students stated that there was no problem with this definition and they answered with a CRI of 3, 4, or 5. This in line with the research result of Azis et.al (2020) which showed that student had misconception in definition that relate to algebra. Figure 1 shows an example of the answers and reasons given by students for question number 1.

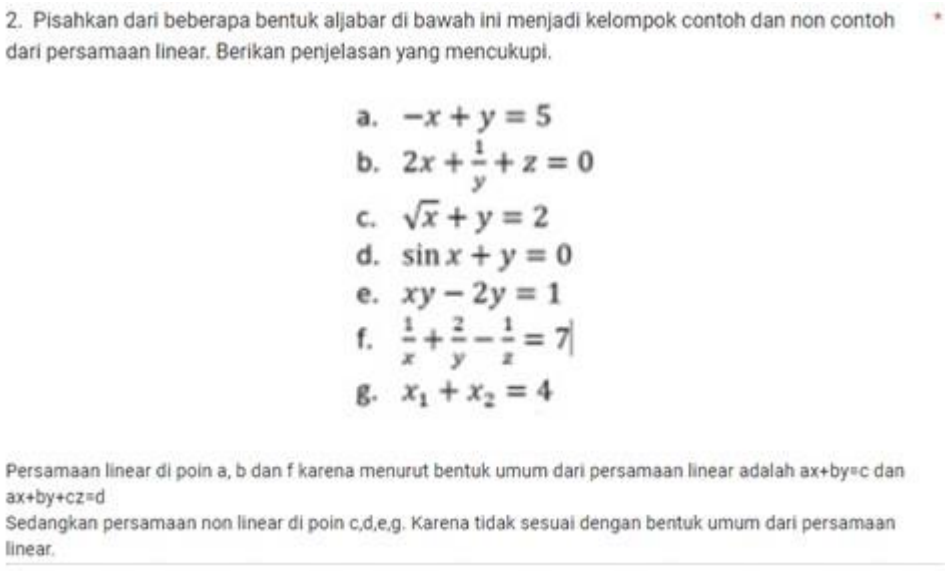

1. Diberikan bentuk umum dari Persamaan Linear Dua Variabel berikut. Menurut Anda, adakah informasi yang kurang dari definisi tersebut? Berikan penjelasan. *

$$ax + by = c$$

Tidak. Karena sudah mencakup komponen lengkapnya, yaitu a dan b sebagai koefisien, x dan y sebagai variabel, dan c sebagai konstanta.

Figure 1. An example of a theoretical misconception in question number 1

In question number 2, the misconception that occurs is a classificational misconception. Because the understanding of the concept of the definition of linear equations is not strong, they are not precise in classifying examples and non-examples of a given SPL. An example of the misconception can be seen in Figure 2.

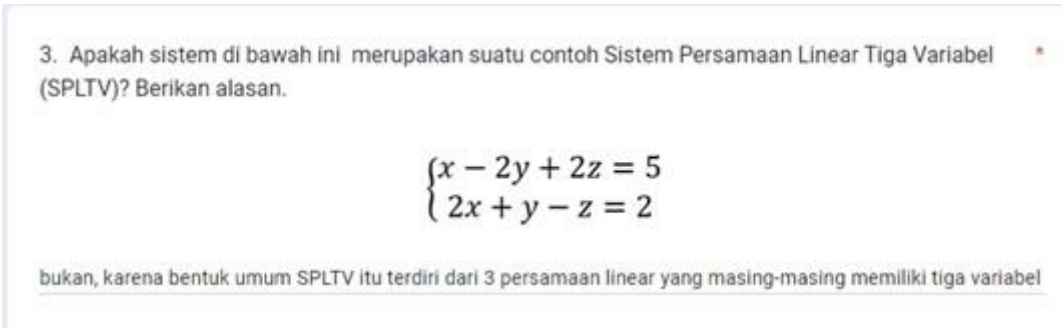

2. Pisahkan dari beberapa bentuk aljabar di bawah ini menjadi kelompok contoh dan non contoh dari persamaan linear. Berikan penjelasan yang mencukupi. *

a. $-x + y = 5$
b. $2x + \frac{1}{y} + z = 0$
c. $\sqrt{x} + y = 2$
d. $\sin x + y = 0$
e. $xy - 2y = 1$
f. $\frac{1}{x} + \frac{2}{y} - \frac{1}{z} = 7$
g. $x_1 + x_2 = 4$

Persamaan linear di poin a, b dan f karena menurut bentuk umum dari persamaan linear adalah ax+by=c dan ax+by+cz=d
Sedangkan persamaan non linear di poin c,d,e,g. Karena tidak sesuai dengan bentuk umum dari persamaan linear.

Figure 2. An example of a classificational misconception in question number 2

In question number 3, students who experience misconceptions think that in an SPL with n variables, there must also be n equations. This may be because the examples given are always like that at the previous level of education, namely 2 variables and 2 equations for SPLDV and 3 variables and 3 equations for SPLTV. The following is an example of a misconception that occurs in question number 3.


3. Apakah sistem di bawah ini merupakan suatu contoh Sistem Persamaan Linear Tiga Variabel (SPLTV)? Berikan alasan. *

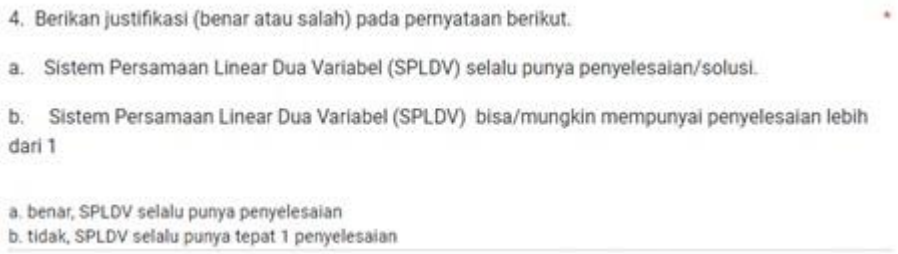
$$\begin{cases} x - 2y + 2z = 5 \\ 2x + y - z = 2 \end{cases}$$

bukan, karena bentuk umum SPLTV itu terdiri dari 3 persamaan linear yang masing-masing memiliki tiga variabel

Figure 3. An example of a theoretical misconception in question number 3

In question number 4, students experienced a misconception that SPLDV and SPLTV always have a solution. This may have the same cause as the misconception that occurred in question number 3, namely because at the previous level the examples were always like that,

and they were never given an understanding at the beginning that there were 3 possible solutions for SPL. Figure 4 below presents an example of a theoretical misconception that appears in question number 4.


4. Berikan justifikasi (benar atau salah) pada pernyataan berikut. *

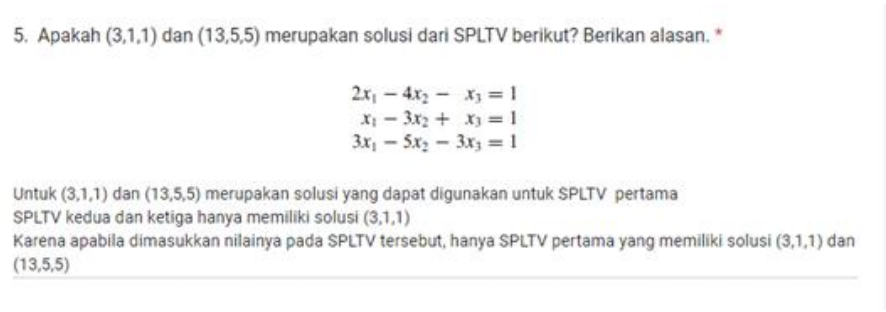
a. Sistem Persamaan Linear Dua Variabel (SPLDV) selalu punya penyelesaian/solusi.

b. Sistem Persamaan Linear Dua Variabel (SPLDV) bisa/mungkin mempunyai penyelesaian lebih dari 1

a. benar, SPLDV selalu punya penyelesaian
b. tidak, SPLDV selalu punya tepat 1 penyelesaian

Figure 4. An example of a theoretical misconception in question number 4

In question number 5, the misconception that occurs is a theoretical misconception. Students who experience this misconception in number 5 do not understand that the solution of an SPL must apply to every linear equation in the system. In the problem, two points are presented to be tested, one point is a solution and the other point only satisfies one of the equations in the given system. Figure 5 below shows the theoretical misconceptions that occur in question number 5.

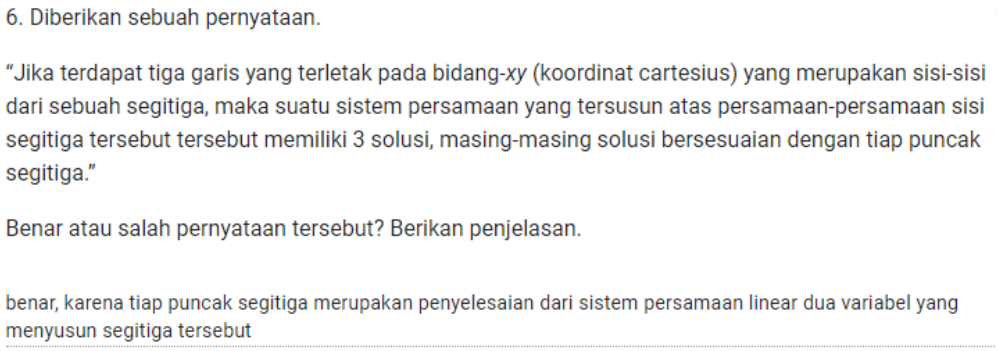

5. Apakah (3,1,1) dan (13,5,5) merupakan solusi dari SPLTV berikut? Berikan alasan. *

$$\begin{aligned} 2x_1 - 4x_2 - x_3 &= 1 \\ x_1 - 3x_2 + x_3 &= 1 \\ 3x_1 - 5x_2 - 3x_3 &= 1 \end{aligned}$$

Untuk (3,1,1) dan (13,5,5) merupakan solusi yang dapat digunakan untuk SPLTV pertama
SPLTV kedua dan ketiga hanya memiliki solusi (3,1,1)
Karena apabila dimasukkan nilainya pada SPLTV tersebut, hanya SPLTV pertama yang memiliki solusi (3,1,1) dan (13,5,5)

Figure 5. An example of a theoretical misconception in question number 5

In question number 6, the misconception that occurs is a correlational misconception. In solving this problem, students are required to be able to translate statements given in visual form, namely in two-dimensional forms. Students who have difficulty correlating statements that are presented verbally into their visual form, for example in Cartesian diagrams, have difficulty understanding this 6th statement. Concept errors made by students in question number 6 can be seen in Figure 6 below.


6. Diberikan sebuah pernyataan.

"Jika terdapat tiga garis yang terletak pada bidang-*xy* (koordinat cartesius) yang merupakan sisi-sisi dari sebuah segitiga, maka suatu sistem persamaan yang tersusun atas persamaan-persamaan sisi segitiga tersebut tersebut memiliki 3 solusi, masing-masing solusi bersesuaian dengan tiap puncak segitiga."

Benar atau salah pernyataan tersebut? Berikan penjelasan.

benar, karena tiap puncak segitiga merupakan penyelesaian dari sistem persamaan linear dua variabel yang menyusun segitiga tersebut

Figure 6. An example of a correlational misconception in question number 6

In question number 7, the misconception that occurs is a correlational misconception. Students who experience misconceptions about number 7 are wrong in compiling a mathematical model of the problems related to the given SPLDV. Students cannot correlate the daily problems given in the form of mathematical models correctly in an effort to solve the problems given. At first, student model the word problem into mathematics model correctly. But, in the second step, students fail to translate the sentence of "half of the people who went by car with a capacity of 7 people failed to see the concert because the building was closed" in to mathematical model so that the last answer is incorrect. This result is in line with the research result of Egodawatte (2011) that showed The main difficulty in word problems was translating them from natural language to algebraic language. The concept error of number 7 can be seen in Figure 7 below.

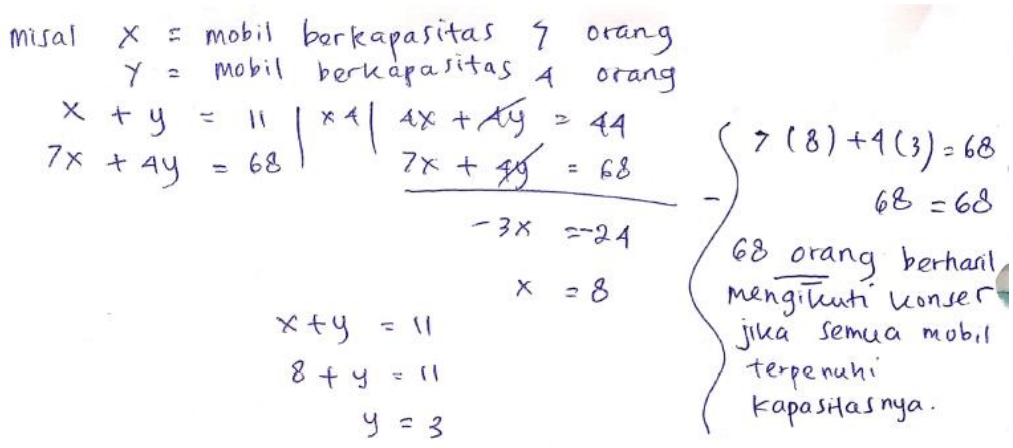


Figure 7. An example of a correlational misconception in question number 7

From the results above, it can be seen that the three types of misconceptions occur in students in SPL material before they take Elementary Linear Algebra courses. Analysis of misconceptions at the beginning before learning as in this study can provide a reference for

teachers to pay more attention to concepts that are prone to these misconceptions. This is very important to do because student teacher candidates must have a mature understanding of concepts so that later they will not cause misconceptions in the students they teach. Booth (2016) suggests using the technique of explaining information to oneself while reading or studying (Self-explanation), replacing some (or even half) of the practice problems with worked-out solutions for students to study can increase learning of the procedures to solve problems (worked examples), presentation of errors for students to consider and study (cognitive dissonance) to strengthen understanding of concepts to prevent misconceptions.

CONCLUSION

Misconceptions among prospective mathematics teacher students regarding SPL material as a prerequisite for taking elementary linear algebra courses brought from their previous level of education still arise. The three types of misconceptions occur in different concepts. Theoretical misconceptions occur in concepts related to the definition of SPL, the definition of SPL solutions and the types of SPL solutions. Classificational misconceptions occur in the concept of examples and non-examples of SPL, while correlational misconceptions arise when prospective teacher students solve problems related to graphics and everyday problems that are solved using SPL. Most misconceptions occur in the initial concept of SPL, namely the definition of SPL. Self-explanation methods, worked examples, and cognitive dissonance can be used as references to prevent this misconception from occurring.

REFERENCES

AL-Rababaha, Y., Yew, W. T., & Meng, C. C. (2020). Misconceptions in School Algebra. International Journal of Academic Research in Business and Social Sciences, 10(5), 803–812

Azis M., Tahmir S., & Minggi, I. (2020). Miskonsepsi pada Materi Aljabar Siswa Kelas VIII SMP. IMED: Issues in Mathematics Education, 4(2), 178-187. https://doi.org/10.35580/imed15329

Booth, J.L., McGinn, K.M., Barbieri, C., Young, L.K. (2017). Misconceptions and Learning Algebra. In: Stewart, S. (eds) And the Rest is Just Algebra. Springer, Cham. https://doi.org/10.1007/978-3-319-45053-7_4

Diana, D., Fitriani, N., & Amelia, R. (2021). Sistem Persamaan Linear Dua Variabel: ditinjau dari Analisis Kesalahan Siswa MTs Kelas VIII pada Pembalajaran Daring. JPMI – Jurnal Pembelajaran Matematika Inovatif, 4 (4), 985-992

Edogawatte, G. (2011). Secondary School Students' Misconceptions In Algebra. A Thesis. Toronto : University of Toronto.

Heruman. (2007). Model Pembelajaran Matematika di Sekolah Dasar. Bandung: PT Remaja Rosdakarya.

Hasan, S., Bagayoko, D. & Kelley, E.L. (1999). Misconceptions And The Certainty Response Index (CRI). Physics Education 34(5):294-299. DOI: 10.1088/0031-9120/34/5/304

Kurniati, D. (2007). Analisis Kesalahan Peserta didik Kelas VII SMP Negeri 2 Puger dalam Menyelesaikan Soal-soal yang Berkaitan dengan Persegi Panjang dan Persegi. Tesis Pendidikan Matematika tidak diterbitkan. Surabaya: PPs Universitas Negeri Surabaya

Salirawati, D. (2011). Pengembangan Instrumen Pendeteksi Miskonsepsi Kimia pada Peserta Didik SMA. Disertasi. PPsUNY.

Tayubi, Y. R. (2005). Identifikasi Miskonsepsi Pada Konsep-konsep Fisika Menggunakan Certainty of Response Index (CRI). Mimbar Pendidikan. No. 3/XXIV.

Tim Pengembang Kurikulum Pendidikan Matematika Unesa. (2021). Dokumen Kurikulum Pendidikan Matematika Unesa. Surabaya: Jurusan Matematika Unesa.

Wafiyah, N. (2012). Identifikasi Miskonsepsi Siswa dan Faktor-faktor Penyebab pada Materi Permutasi dan Kombinasi di SMA Negeri 1 Manyar. Gamatika Vol. II No.2, 128-138