Analysis of Students' Mastery of Mathematical Concepts Material for Linear Equations in Two Variables

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Abstract:
Mathematics learning still experiences several problems. It is still found that students have difficulty defining mathematics subject matter in their own sentences. Students also often do not know the actual applications and examples of the concepts they know. Students' ability to understand/master mathematical concepts is still low. This article aims to describe students' mastery of mathematical concepts regarding Linear Equations in Two Variables as well as efforts to improve students' mastery of mathematical concepts. This research includes qualitative research. Data collection techniques use interviews, observation, test questions, and documentation. The research results showed that students still had not mastered mathematical concepts in the material Linear Equations in Two Variables. This can be seen in students who struggle to memorize formulas and calculation processes involving large numbers. Apart from that, students do not yet understand defining concepts in writing and identify and create examples and non-examples related to the material. The efforts made to improve students' concept mastery abilities include teachers maximizing their role in the learning process and understanding various learning models that stimulate students' ability to learn with careful teaching planning by the teacher.

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Introduction

Mathematics developed along with human civilization. The history of science places mathematics at the top of the scientific hierarchy. However, there are still many negative views towards mathematics. Most of these negative traits arise due to misunderstandings or wrong views of mathematics. Some people think that studying mathematics requires a special talent that not everyone has it (Masykur & Fathani, 2009). This causes them to not be motivated to study mathematics.

There are also those who think that mathematics is the science of counting and only uses the brain (Masykur & Fathani, 2009). Even though counting is a small part of mathematics and studying mathematics also requires creativity and imagination in solving the beauty and structure of mathematical problems. Another opinion also says that mathematics is useless in life. And other opinions consider mathematics to be an abstract and dry science, theoretical in nature and with formulas and problems (Masykur & Fathani, 2009). So they become less and less interested in learning mathematics.

Another problem is that students have difficulty defining mathematics subject matter in their own sentences. Students also often do not know the real applications and examples of the concepts they know (Murizal, Yarman, & Yerizon, 2012). Students often have difficulty understanding mathematical concepts when the learning process is taking place in class (Afriliziana & Kartini, 2021). This was also seen when conducted an interview with a class IX student who still had difficulty expressing a concept he had learned in his own language because he did not understand the concept. And when asked to give an example, the student actually gave an example that was not quite right. The ability to understand mathematical concepts is very important for students. Because mathematical concepts are interrelated with each other, so they need to be studied in a coherent and continuous manner (Nasution, Fitrianti, & Erita, 2021).

Considering the very important role of mathematics, mathematics should be a subject that students are interested in and enjoy. Therefore, mathematics learning at school should run well and be fun so that the desired goals can be achieved. In the Regulation of the Minister of National Education of the Republic of Indonesia Number 22 of 2006, it is explained that mathematics learning in schools aims to ensure that students have the following abilities: (1) Understand mathematical concepts, explain the relationship between concepts and apply concepts or algorithms, flexibly, accurately, efficiently and precisely in solving problems; (2) Using reasoning on patterns and properties, carrying out mathematical manipulations to make generalizations, compiling evidence or explaining mathematical ideas and knowledge; (3) Solving problems which includes the ability to understand problems, design mathematical models, complete models and interpret the solutions obtained; (4) Communicate ideas with symbols, tables, diagrams, or other media to clarify situations or problems; (5) Have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention and interest in studying mathematics, as well as a tenacious and confident attitude in solving problem (Masykur & Fathani, 2009).

Some of the mathematics learning objectives above show that one of the fundamental things to get to the next goal is students' ability to understand mathematical concepts. Students who need to understand a mathematical concept can reason and solve mathematical problems. Mathematics learning in the classroom is often identified with the teacher's process of directing students to the ability to use formulas and memorize formulas. Mathematics is only for working on problems and is rarely taught to analyze and use mathematics in everyday life. So, students can still not express mathematics lesson material in their own language. Students who are given problems different from the examples the teacher gave will make mistakes. Apart from that, students also need help interpreting mathematics in its natural form. This means that students need help with mastering mathematical concepts. In other words, students' mastery of mathematical concepts still needs to improve.

Class VIII students' understanding of mathematical concepts is not very good, which can be seen from the symptoms: Students cannot solve problems that are different from the examples, students only memorize formulas but do not know their meaning, students forget about the material they have studied even though the material is related, and Students have not been able to apply lesson concepts to their lives (Yuliani, Zulfah, & Zulhendri, 2018). Students can understand when the teacher explains example questions. However, students feel they need clarification when the teacher gives questions whose structure differs from the example questions. They cannot even do the questions correctly, so students prefer to be given a question structure like the example questions. Students are more passive and lazy in learning mathematics. In this case, it can be concluded that students' conceptual understanding abilities in understanding mathematics problems tend to be low (Aruan, Panjaitan, Aruan, & Manik, 2022).

The cause of the difficulties experienced by students in the material on Linear Equations with Two Variables is that students have not yet mastered the concept of Linear Equations with Two Variables. The main cause is due to the need for more student interest and the lack of enthusiasm of students to improve their abilities and overcome the difficulties they experience (Novianti & Priatna, 2019). So, it needs to study "Analysis of Students' Mastery of Mathematical Concepts on Linear Equations in Two Variables" in depth. This article aims to describe students' mastery of mathematical concepts regarding Linear Equations in Two Variables as well as efforts to improve students' mastery of mathematical concepts.

Research Methods

This paper includes descriptive qualitative research, with the type of case study. The subjects of this research are Class VII students. The object of this research is students' ability to master mathematical concepts regarding Linear Equations in Two Variables. The sampling technique used is purposive sampling, a sampling technique with specific considerations; in this case, several class VII students have received material on linear equations in two variables.

The data collection techniques in this research used interviews, observations, test questions, and documentation from related literature sources, both from books and journals related to analyzing students' mastery of mathematical concepts

regarding Linear Equations in Two Variables. The data analysis technique in this research uses descriptive analysis techniques, namely describing research results using word descriptions and Miles and Huberman analysis techniques, data reduction, data display, and conclusion/verification.

Finding and Discussion

Students' difficulties with mathematics are primarily related to essential matters regarding students' need for conceptual understanding of mathematical material; one of the leading causes is the implementation of less effective learning. Thus, the expected mathematics learning objectives have yet to be achieved. According to Kesumawati, students are not encouraged to develop thinking skills during the learning process. Especially in classroom learning, students are directed at the ability to use formulas, memorize formulas, and use mathematics only to solve problems; they are rarely taught to analyze and use mathematics in everyday life. As a result, when students are given application questions or questions different from their practice questions, they will make mistakes (Kesumawati, 2008).

It will be easier for students to progress to a higher learning process if they understand the concepts. Therefore, the ability to understand mathematical concepts is one of the essential goals in learning mathematics. As facilitators in learning, teachers should understand that the material taught to students is not just memorizing. However, more than that, namely understanding the concepts given. By understanding, students will better understand the concept of the subject matter (Murizal, Yarman, & Yerizon, 2012). The low ability to understand mathematical concepts is proven by most students needing help to reformulate the solution to the problem given (Umam & Zulkarnaen, 2022).

According to Yuliati (2104), in general, the difficulty of mathematics lessons can be caused by several factors, namely 1) because the objects studied in mathematics are abstract, gradual, and sequential and based on previous learning experiences, 2) the learning process carried out by teachers is less varied, especially in application. Teaching methods, as well as 3) limited teaching aids, also make children less interested in studying mathematics; in the end, their grades become lower. Apart from that, other factors are also caused by the teaching methods used by teachers being monotonous or focused on the teacher only (Muthma'innah, 2017). Then, mistakes often occur when students solve everyday life questions (Muthma'innah, Dahlan & Suhendra, 2019).

The factors causing the difficulty of mathematics lessons for students include that mathematics lessons are less connected to real life. However, not all mathematics material can be linked to everyday life. Then, the learning process associated with teachers is also less varied, so variations in the application of mathematics learning methods, strategies, or models are needed. Moreover, the following reason is the limited teaching aids in mathematics learning. So, teachers need to vary learning and see whether it suits students' conditions when carrying out the learning process.

Interview occurred on class IX junior high school student. In this case the names of students and schools are disguised. The interview lasted approximately 15 minutes. The following are the results of the interview:

Question : What is his name?
Answer   : A
Question : What class are you in?
Answer   : Class IX
Question : Where is the school?
Answer   : SMP X
Question : How old are you?
Answer   : 14 years.
Question : What is your address?
Answer   : In Pine.
Question : What subjects do you like at school?
Answer   : IPA
Question : What about subjects you do not like?
Answer   : English
Question : What do you think about Mathematics lessons?
Answer   : Some are difficult, some are easy.
Question : What part is difficult?
Answer   : Many things are difficult.
Question : What material is the easiest?
Answer   : Similarity material.
Question : Why is there so much difficulty in the material?
Answer   : Memorizing the formula is difficult.
Question : What is the formula for similar materials?
Answer   : Not too difficult.
Question : How does the teacher teach in class, is it the learning fun?
Answer   : Sometimes it is fun, sometimes it is not.
Question : In class, mathematics learning has been implemented with group?
Answer   : Never.
Question : When studying, are there any distractions from friends? friends, or talking
              while studying?
Answer   : Sometimes there is talking too.
Question : Have you studied the material for Linear Equations in Two Variables?
Answer   : Yes.
Question : Well, now try to do as many questions as I can

Figure 1 and 2 gives two questions related to understanding student concepts in the material Linear Equations in Two Variables
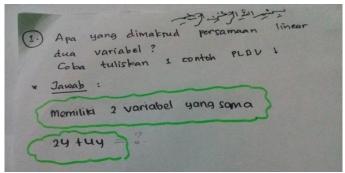Answer   : (Students work on the questions given)

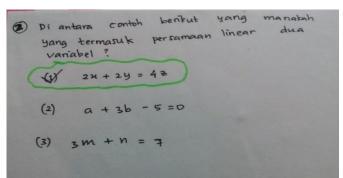**Figure 1. Respondents Work on Question 1**

Figure 2. Respondents Work on Question 2

After working on the questions, continues the interview and this the results.

Question : Do you think learning mathematics is helpful in everyday life?

Answer : Yes, (but still needs clarification about giving examples).

Question : Apart from memorizing formulas, are there any other difficulties in Mathematics learning?

Answer : When calculating, such as when calculating numbers big numbers.

Question : Oh, I see; thank you for your time, and good luck to you ahead in your studies.

Answer : Yes.

Understanding will grow and develop with a systematic and explicit thinking process. Things that influence understanding are the systematization of the presentation of material because the material will enter the brain if the method of entry is orderly. Meanwhile, concepts are based on planned ideas (Hoiriyah, 2019). Understanding concepts is a person's ability to express the knowledge he has acquired, both in spoken and written form, to other people so that other people understand what is being conveyed (Suraji, Maimunah, & Saragih, 2018).

Concept mastery is the level of student learning outcomes so that children can define or explain part of or define the learning material using their sentences (Harja, 2017). Mathematics learning emphasizes concepts. So, in studying mathematics, children must first master mathematical concepts so that they can solve problems and be able to apply this learning in the real world and be able to develop other abilities, which are the goals of learning mathematics (Murizal, Yarman, & Yerizon, 2012).

According to Yuliati, mastery of fundamental concepts must be instilled, and the basis for mastering mathematical concepts must be strong from an early age (Yuliati, 2014).

Conceptual understanding is the competency students demonstrate in carrying out procedures (algorithms) flexibly, accurately, efficiently, and precisely (Zulkarnain & Budiman, 2019). *Understanding concepts* is an aspect that has a role in the learning process. Remember that students can improve their abilities in all the material studied if they understand concepts. Learning mathematics requires instilling concepts in students (Atmaja, 2021). Understanding mathematical concepts is the first ability expected to be achieved in mathematics learning objectives (Aningsih & Asih, 2017) Understanding mathematical concepts is the ability to understand mathematics concepts, operations, and relationships (Klorina & Prabawanto, 2023). Understanding mathematical concepts is the student's ability to understand and master material to apply it in mathematics learning (Putri & Hakim, 2022).

Through interactive activities between teachers and students in mathematics learning, the extent to which students' ability to understand mathematical concepts can be observed (Radiusman, 2020). It is also possible to deepen understanding of concepts by asking each other questions and explaining them to fellow students (Santoso & Supriadi, 2014).

So, mastery of concepts is the basis for interpreting mathematics learning. Student's difficulties in mastering mathematical concepts cannot be ignored because they can cause children to struggle to learn mathematics at the next stage. It is because the concept in mathematics is hierarchical; that is, mathematics lessons are interconnected between initial and subsequent material. Therefore, action is needed to overcome difficulties and improve students' mastery of mathematical concepts.

One of the causes of students' low ability to understand concepts is that the learning strategies implemented by teachers still use conventional methods; students are treated as learning objects, and teachers play a more dominant role in learning, so it is challenging to accept. To be able to realize that students can be active and creative and have a good understanding of mathematical concepts, a learning model is needed that can encourage students to be active and creative based on understanding mathematical concepts (Wijaya, Destiniar, & Mulbasari, 2018).

Teachers' role in improving students' mastery of mathematical concepts is enormous. One is that teachers try to carry out the learning process with variety, especially in applying teaching methods (Yuliati, 2014). Teachers can use various teaching methods, especially those related to mastery of mathematical concepts and students' psychological conditions. According to experts, contextual learning (Contextual Teaching and Learning/CTL) can improve mastery of mathematical concepts (Lukitanto & A, 2010). Contextual learning is a learning concept that helps teachers connect the subject matter they teach with students' real-world situations and encourages students to make connections between the knowledge they have and its application in everyday life. The discovery of meaning is a crucial characteristic of CTL (Johnson, 2011).

According to Sa'ud, there are five important characteristics of using a contextual learning process (Sa'ud, 2009), that is: (1) In CTL, learning is a process of activating existing knowledge, meaning that what will be learned cannot be separated from the

knowledge that has been learned; (2) Contextual learning is learning in order to obtain and add new knowledge, which is obtained deductively, meaning that learning begins by studying the whole, then paying attention to the details; (3) Understanding knowledge, meaning that the knowledge gained is not to be memorized but to be understood; (4) Putting this knowledge and experience into practice, meaning that the knowledge and experience gained must be able to be applied in students' lives; (5) Reflect on knowledge development strategies. It is done as feedback for the strategy improvement and refinement process.

According to Johnson, in contextual learning, at least three main principles are often used: interdependence, differentiation, and self-organization. The principle of interdependence means that the school community and the teaching materials used are interconnected and dependent. Meanwhile, the principle of differentiation means that teachers, carrying out the learning process, should emphasize creativity, uniqueness, variation, and collaboration. The principle of self-organization requires teachers to encourage each student to understand and realize all their potential as optimally as possible (Johnson, 2011).

According to Sa'ud, the principles or components of contextual learning that underlie the implementation of the contextual learning process are the principles of constructivism (the process of building or compiling new knowledge in students' cognitive structures based on experience), inquiry (the process of discovery through a systematic thinking process), asking questions, learning communities, modeling (demonstrating something as an example that every student can imitate), reflection (the process of deposition of experiences that have been learned through re-ordering events or learning events that have been passed through) (Sa'ud, 2009).

The stages of the contextual learning model include four stages: invitation, exploration, explanation and solution, and taking action (Sa'ud, 2009): (1) In the invitation stage, students are encouraged to express their initial knowledge about the concept being discussed. Students are allowed to communicate, including their understanding of the concept; (2) Exploration stage, students are allowed to investigate and discover concepts through collecting, organizing and interpreting data in an activity that the teacher has designed; (3) Explanation and solution stage, when students provide explanations of solutions based on the results of their observations plus teacher reinforcement, then students can convey ideas, create models, make summaries and summaries; (4) Stages of taking action, namely students can make decisions, use knowledge and skills, share information and ideas, ask follow-up questions, submit suggestions both individually and in groups.

According to Ghassani, learning steps based on the principles of CTL, namely 1) Constructivism, 2) Inquiry, 3) Questioning, 4) Learning community, 5) Modeling), 6) Reflection, and 7) Authentic assessment (Ghassani, Kurniasih, & Fitriani, 2019). Then Muchtar said that the steps for implementing CTL in the classroom are as follows: 1) Develop ideas so that students learn more meaningfully by working independently, discovering and building their own new knowledge and skills, 2) Carrying out as many inquiry activities as possible in all subjects, 3) Developing a sense of curiosity know students through questions, 4) form a learning community (learning in groups), 5) present models as examples of learning, 6) reflect at the end of

the meeting, 7) carry out authentic assessments in different ways (Muchtar, et al., 2023).

CTL learning presents a concept that links the subject matter studied by students with the context in which the material is used and is related to how someone learns or the way students learn (Nasirudin, Rahmawati, & Suyitno, 2019) Sari found that students who used CTL learning appeared to be more skilled, critical, able to understand questions better, and able to solve the questions given carefully (Sari, Rahayu, & Widyaningrum, 2018). CTL learning emphasizes student involvement in each stage of learning by connecting it with life situations experienced by students daily. Applying this means understanding or mastery of the material can be applied in real life.

In the world of education, especially mathematics, understanding of concepts is considered not yet optimal. Students' low ability to solve mathematics problems related to understanding concepts is a problem. If students have mastered this concept, it will make working on the following problem easier. Based on the results of the interview with one of the class IX middle school students, the student's difficulties in Mathematics are in terms of memorizing formulas and in the calculation process, which involves quite large numbers. Moreover, one of the materials students understand is 'similarity' because it does not involve many formulas, and the process is also done through pictures.

According to National Council of Teacher of Mathematics (NCTM), to determine students' knowledge and understanding of mathematical concepts, it can be seen from students' abilities in (1) Defining concepts verbally and in writing, (2) Identifying and creating examples and non-examples, (3) Using models, diagrams and symbols to represent a concept; (4) Changing one form of representation to another; (5) Recognize various meanings and interpretations of concepts; (6) Identifying the characteristics of a concept and recognizing the conditions that determine a concept; (7) Compare and contrast concepts (Murizal, Yarman, & Yerizon, 2012).

In this case, students' abilities to define concepts in writing as well as identify and create examples and non-examples. During the interview process, tried to discover the students' conceptual understanding of 'Linear Equations in Two Variables, ' one of the materials studied in the previous week. There are two questions to the students. The first question refers to students' ability to define concepts in writing. Moreover, the second question refers to students' ability to identify and create examples and non-examples, as stated in NCTM.

Table 1. Analysis of Students' Mastery of Mathematical Concepts on Linear Equations in Two Variables

Question	Student's Answer	Conceptual Errors
1. Apa yang dimaksud Persamaan Linier Dua Variabel (PLDV)? Tuliskan 1 contoh PLDV! (What is meant by a Linear Equation in Two Variables (PLDV)?	PLDV adalah memiliki 2 variabel yang sama (PLDV is having the same 2 variables) Contoh PLDV: 2y + 4y (Example PLDV: 2y + 4y)	Occur some definition conceptual errors That has two different variables, not the same variable. Then, students not write the '=' assign

	Write 1 example of PLDV!)		
2.	Di antara contoh berikut, manakah yang termasuk PLDV: (1) $2x + 2y = 4z$ (2) $a + 3b - 5 = 0$ (3) $3m + n = 7$ (Which of the following examples includes PLDV:) (1) $2x + 2y = 4z$ (2) $a + 3b - 5 = 0$ (3) $3m + n = 7$	Contoh PLDV yaitu yang nomor (1) (An example of PLDV is number (1))	Students are still unable to differentiate which ones fall into the category of the concept in question

In the first question, students asked to write the definition of a linear equation in two variables according to the student's language. It turns out the student answered 'which has the same two variables.' Here, some conceptual errors occur. The answer should be an equation with two different variables, different from one another. When the writer asked to write down an example, the student answered an example in the form of two identical variables according to his first conceptual error, and he forgot to write the '=' sign in the equation. So, the example is not included in the equation.

In the second question, the student choose which equations are examples of Linear Equations in Two Variables. Moreover, the student chose the first option. The first choice does not include a linear equation with two variables but a linear equation with three variables. From the students' choices in the second question, it can be seen that when given different variables and positions in an equation, students can still not differentiate which ones fall into the category of the concept in question.

Based on the two ways of looking at students' understanding abilities or mastery of concepts proposed by NCTM, it appears that students still have not mastered mathematical concepts in the material Linear Equations in Two Variables. Based on the interviews, it was also seen that students' difficulties in mathematics lessons were memorizing formulas and calculation processes involving large numbers. As stated by Masykur, the causes of mathematics phobia include excessive emphasis on memorization alone, emphasis on speed or counting, authoritarian teaching, lack of variety in the mathematics teaching and learning process, and excessive emphasis on individual achievement (Masykur & Fathani, 2009). To overcome this, the role of the teacher is crucial.

Teachers should also consider placing more emphasis on concepts when teaching mathematics so that if students understand the concept of a material, then not all formulas have to be memorized by students. Also, this can be achieved by teachers maximizing their role in the learning process. Teachers must try to understand the nature of the subject matter they teach as a lesson that can develop students' thinking abilities and understand various learning models that stimulate students' ability to

learn with careful teaching planning by the teacher. One type of learning that can be used is contextual learning (CTL).

Conclusion

Students' ability to understand or master mathematical concepts in Linear Equations with Two Variables shows that students still have not mastered the mathematical concepts in Linear Equations with Two Variables. It can be seen in students who struggle to memorize formulas and calculation processes involving large numbers. Apart from that, students do not yet understand defining concepts in writing and identify and create examples and non-examples related to the material. The efforts made to improve students' concept mastery abilities include teachers maximizing their role in the learning process and understanding various learning models that stimulate students' ability to learn with careful teaching planning by the teacher. One type of learning that can be used is contextual learning (CTL). As for future researchers, they can study more deeply regarding the analysis of mastery of mathematical concepts in other mathematical materials to see to what extent students have mastered mathematical concepts in various mathematical materials.

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