LEARNING OBSTACLES ANALYSIS OF STUDENTS MATHEMATICAL LITERACY COMPETENCE ON CHANGE AND RELATIONSHIP CONTENT

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ABSTRACT

The purpose of this study was to analyze the types of learning obstacles of students' mathematical literacy skills on the content of change and relationship for 8th grade of junior high school. The research method used is qualitative research with descriptive approach. This research was conducted at SMPN 3 Sungguminasa and the subjects in this study were students of class VIII. i. The data collection technique used a mathematical literacy test on the content of change and relationship with the material of the System of Linear Equations of Two Variables in the form of a written test of 5 numbers in essay form, documentation, and direct interviews with both teachers and students. The results showed that there were several learning barriers experienced by students in understanding mathematical literacy questions on the content of change and relationship in class VIII. i. SMPN 3 Sungguminasa. These barriers include students having difficulty in interpreting the problem, students still make mistakes in changing the statement into a mathematical model, and students cannot change the given problem into mathematical form. Important implications that can be given in designing teaching strategies include using active learning strategies, namely through interaction with classmates and involving themselves in activities.

Keywords: Mathematical literacy; learning obstacles; change and relationship

1. INTRODUCTION

Education plays an important role in preparing quality human resources and being able to compete in the advancement of science and technology, for that education must be organized as effectively as possible to obtain the expected goals. The implementation

of timely and appropriate education greatly supports the success of learning objectives. This is according to (Ridwan Santoso, Berchah Pitoewas, 2018) that the quality of education is an important role holder of a country's progress, which is largely determined by the quality of teaching and learning activities in schools. The utilization of information technology is one of the ways used by the government to improve the quality of Indonesian education. However, inappropriate utilization of information technology is one of the causes of the lack of interest in reading among students today. One of these lessons is mathematics, where mathematics is a subject whose material has abstract characteristics.

Mathematics as a means of scientific thinking is needed to develop the ability to think logically, systematically, and critically in students (Yusuf et al., 2017; Rismawati, 2016; Sulistiani & Masrukan, 2016). Similarly, mastery of mathematical concepts is needed for students to support success in solving problems in daily activities, both directly and indirectly (Hakim & Sari, 2019). In fact, according to (Chisara et al., 2018) if students are given mathematics problems outside the context of everyday problems, students tend to be unable to solve these problems. This is indicated by the majority of students who still believe that mathematics is the most challenging and frightening field of science. Therefore, it is very important to have mathematical abilities that can support students in solving mathematical problems or problems encountered in real life.
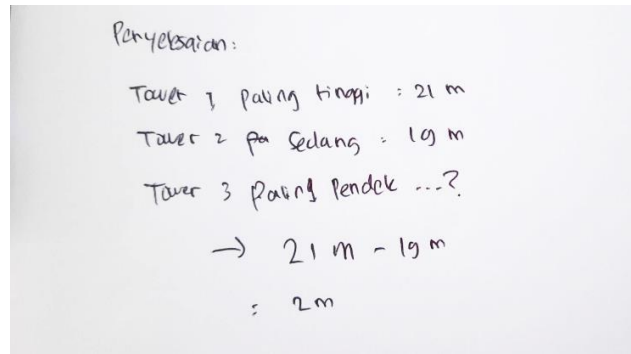
According to the National Council of Teachers of Mathematics (NCTM, 2000), there are five criteria for mathematical ability: mathematical problem solving, mathematical communication, mathematical connection, mathematical reasoning, and mathematical representation. A combination of these five competencies is important for students to be able to use mathematics to solve everyday problems. The ability that summarises the five competencies above is mathematical literacy (Fadillah & Ni'mah, 2019). It is important for students to train concepts and understanding in finding problems related to the application of mathematical literacy.

Mathematical literacy is the ability of students to formulate, use, and interpret mathematics in various contexts, including the ability to reason mathematically (Masjaya & Wardono, 2018; Karawang, 2021; Dinni, 2018). In other words, students are able to use mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena (OECD, 2019). Students can be said to have good mathematical literacy skills when they are able to analyse, reason and communicate their mathematical knowledge and skills effectively, as well as solve and interpret mathematical problems.

Based on some research results, it was found that students' mathematical literacy skills described problems in understanding the three components of mathematical literacy in formulating, applying and interpreting. This is in research (Fadillah & Ni'mah,

2019) there are problems in the first indicator, namely formulating, where students do not first write down the information contained in the problem and the majority of students immediately complete the solution. As for the problem of applying indicators, it is found in the results of research (Maulana & Hasnawati, 2016) which shows that students are less precise in applying the correct mathematical strategies, concepts or facts to solve a problem, it can be seen when working on PISA questions students answer questions by applying the concept of comparison, even though it should be the correct concept to solve PISA questions on the content of change and relationship. In research (Noviana & Murtiyasa, 2020) found mathematical literacy problems in the indicator of interpreting or interpreting which describes the problem of students who are unable to provide interpretation in the form of explanatory conclusions related to the results obtained, so that the resulting answers are confusing.
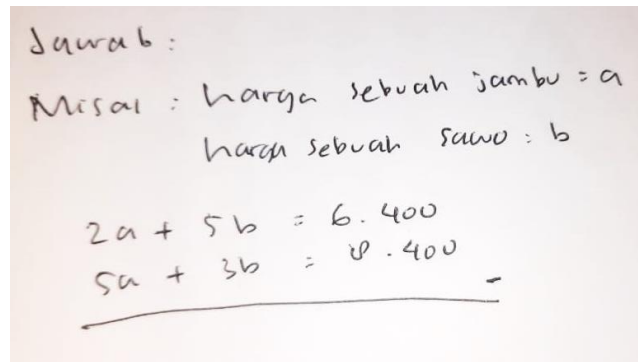
One of the main components of mathematical literacy assessment in PISA is question content. PISA developed several questions based on 4 contents, namely change and relationship content, shape and space content, quantity content, and uncertainty and data content (Ehmke et al., 2020; Dewantara, n.d.). The change and relationship content is one of the most important contents of PISA for students to master as it relates to everyday life in describing, modelling and interpreting growth and phenomena (OECD, 2019). In particular, the surprising results released by PISA 2018 show that the ability of students in Indonesia on the content of change and relationship is far below the average with a score of 379 out of 489 (OECD, 2019). The low PISA results are certainly caused by several factors. One of the causes of the low mathematical literacy skills of students is that Indonesian students are generally less trained in solving questions with types such as questions on PISA (Yena Nurlia Adawiyah, Nur Eva Zakiah, 2022; Salvia et al., 2022). In line with research conducted by (Khoirudin et al., 2017) which shows that the category of low mathematical knowledge ability only reaches level 1 because it is influenced by several factors including: the material chosen, the learning provided by the teacher, the classroom environment, the support of the family environment, the readiness for the test and the ability of each student himself. Meanwhile, based on the results of preliminary observations made by researchers in one junior high school (SMP) by giving two mathematical literacy PISA questions on the System of Linear Equations of Two Variables material showed the following results:

Figure 1. Students' answers to question number 1

Figure 2. Students' answers to question number 2

Based on the answers above, students show that there are still many mistakes in solving mathematical literacy problems and have not been able to solve problems correctly on the material of the system of linear equations of two variables in this case, indicating a link experienced by students to learning obstacles at school. Learning obstacles are obstacles or learning barriers experienced by students in the learning process. (Dani & Badarudin, 2022) said that learning obstacle is a condition experienced by students in learning which is characterised by the emergence of certain obstacles that are influenced by the interaction system to achieve learning goals. Based on this, researchers can say that the role of a teacher really determines the success of students in achieving learning goals in order to be able to understand and not experience learning obstacles. There are three factors that cause students to experience a learning barrier, according to (Lestarai, 2019) including didactic barriers (teaching methods and teacher readiness in learning activities), ontogynous barriers (mental readiness of students to learn), and epistemological barriers (limited context and low understanding of student material). Based on the three types of learning barriers, namely didactic, ontogynous, and epistemological barriers, they have a great influence on students, whether it is one or all three types of barriers that can be experienced directly by students.

Based on initial observations found by researchers, students found difficulties in expressing mathematical ideas on the System of Linear Equations of Two Variables mathematics problems. The System of Linear Equations of Two Variables is a system or unit of several linear equations of the same two variables (Sumbandari & Fuadiah, 2022). Some of the difficulties experienced by students based on the findings of the interviews conducted that students have difficulty in interpreting the problem, students still make mistakes in converting statements into mathematical models, students make mistakes in converting story problems into mathematical sentences. These obstacles experienced by students need to be resolved in relation to learning. Therefore, the researcher will conduct an analysis to find out the learning obstacles of SMP Negeri 3 Sungguminasa students on the System of Linear Equations of Two Variables material so that it can be taken into consideration in improving further learning.

2. METHODS

This research is a descriptive qualitative research, the analysis of which is focused on efforts to reveal a problem and situation as it is so that it is only a revelation of facts with data analysis. The research design used is Didactical Design Research (DDR) which is research on making learning designs based on students' learning obstacles (Aminuddin et al., 2016). This is in line with the purpose of the research to be carried out which aims to describe the difficulties and causes of student difficulties in identifying and solving mathematical literacy problems on the material of the system of linear equations of two variables. Didactical design research according to (Suryadi, 2011) basically consists of three stages, namely: (1) analysis of the didactical situation before learning in the form of Hypothetical Didactical Design including ADP, (2) metapedidactic analysis, and (3) retrospective analysis, which is an analysis that links the results of the analysis of the hypothetical didactical situation with the results of metapedidactic analysis.

In this study, the stages carried out by researchers are only at the prospective analysis stage or didactic situation analysis (learning obstacle) with steps 1) Determine the mathematics learning material that will be used as research material, namely the system of linear equations of two variables; 2) Designing research instruments to be used, namely written test questions. This test question is designed in such a way as to test students' ability to identify and solve mathematical literacy problems regarding the System of Linear Equations of Two Variables; 3) Determine the research subject, namely the group of students who will be the sample in this study, students of class VIII. I SMPN 3 Sungguminasa who have learned the System of Linear Equations of Two Variables material; 4) Conducting recontextualisation activities or the researcher's stage in collecting data in two ways, namely first, conducting a preliminary study test in the form of a written test given to the research sample which is used to find out about how students solve mathematical literacy problems on the System of Linear Equations of Two Variables

material. The written test questions were designed in the form of essays to test students' ability to identify learning difficulties and students' mindset in solving the System of Linear Equations of Two Variables mathematical literacy problems. Second, conducting interviews conducted after the respondents took the test. The interviews used were unstructured interviews with three students who were randomly selected based on the results of the written test. Interviews were used to gain a deeper understanding of students' difficulties in identifying and solving the System of Linear Equations of Two Variables mathematical literacy problems; 5) Analysing data.

Data analysis techniques in this study were carried out with three activities, namely first, reducing data which is the process of selecting and determining data that takes place when starting data collection. Data is selected based on the research objectives that have previously been set, so it is necessary to filter data or information between the relevant and irrelevant. Second, presenting data is an activity of describing the data that has been compiled which will then draw conclusions. Third, drawing conclusions is a final stage activity in qualitative research where this activity is based on data that has been obtained in the field. 6) After all the data has been analysed, the final step is to write a research report. This report will contain a summary of the steps taken in the research, the main findings, data analysis, conclusions, and recommendations for further research.

In the study (Angriani et al., 2020) explained that the mathematical literacy indicators used can be seen in table 1.

Table 1. Change and Relationship Content Indicators

Literacy Process on Content Change and Relationship	Indicator
Formulate the System of Linear Equations of Two Variables situation (Formulate)	1. Identify some variables and aspects of the System of Linear Equations of Two Variables that are important to the contextual problem. 2. Write the structure of the System of Linear Equations of Two Variables on contextual issues. 3. Writing the problem according to the situation what is known, asked, and what should be answered to make it easy to analyse mathematically. 4. Identify constraints and assumptions behind modeling the System of Linear Equations of Two Variables and simplifications derived from the context.

Employ the System of Linear Equations of Two Variables concepts, facts, procedures, and reasoning. (Applying)	1. Design and apply strategies to find the solution of the System of Linear Equations of Two Variables mathematically. 2. Use mathematical definitions, rules, algorithms and mathematical structures during the process of finding answers. 3. Manipulate numbers and algebra.
Interpret, apply, and evaluate the results of the System of Linear Equations of Two Variables. (Formulate)	1. Reinterpret problem solving results in a real context. 2. Evaluate the suitability of the System of Linear Equations of Two Variables solution mathematically in the context of a real-world problem. 3. Explain the reasons for reasonable and unreasonable mathematical solutions based on the context of the problem.

3. RESULTS AND DISCUSSION

This data was obtained from students after completing a written test from the prepared test instrument, in the form of 5 mathematical literacy skills questions that must be completed within 30 minutes, as well as the results of direct interviews with teachers. Furthermore, this data was analysed to find out the difficulties experienced by students by looking at students' mistakes in solving problems and also based on the results of interviews with teachers and documentation.

Based on the findings with a number of questions that have been distributed to students, the results show that students experience many learning difficulties in several indicators in solving mathematical literacy ability questions, in this case also shows that students experience errors in answering questions and there are students who are unable to solve all the problems given. Based on the results obtained, on average students are unable to model linear equations of two variables, this relates to indicators with cognitive levels, namely understanding and application.

The following is a description of the students' ability to answer mathematics literacy test questions on the System of Linear Equations of Two Variables material.

a. Question Number 1

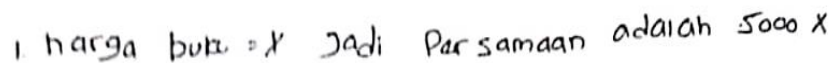*"Dalam sebuah toko, harga total pembelian dipengaruhi oleh jumlah buku yang dibeli. Jika setiap buku memiliki* *harga Rp.50.000. Bagaimanakah bentuk persamaan yang tepat untuk*

menggambarkan hubungan antara variabel-variabel tersebut?"

"In a shop, the total purchase price is affected by the number of books purchased. If each book has a price of Rp.50,000. What is the correct form of equation to describe the relationship between these variables?"

Based on this question, students are expected to be able to identify the right form of equation to describe the relationship between the variables. The answers of students related to question number 1 are in Figure 3.

Figure 3. Students' answers on number 1

Based on Figure 3, it can be seen that students have not been able to write equations correctly. Students have done the variable memorization but there are still some that have not been included in the memorization so that students cannot write the equation correctly. Based on interviews with students that what is understood from the problem given is that there is only one memorization so that the equation written is only one variable.

b. Question Number 2

"Nanda adalah seorang pedagang sendal dan sepatu. Dalam suatu hari ia berhasil menjual sandal dan sepatu sebanyak 12 pasang. Uang yang diperoleh hasil dari penjualan tersebut adalah Rp. 300.000,-. Jika harga sepasang sandal Rp. 20.000,- dan harga sepasang sepatu Rp. 40.000,-. Tuliskan model matematikanya!"

"Nanda was a sandal and shoe trader. One day she sold 12 pairs of sandals and shoes. The money earned from the sale was Rp. 300,000. If the price of a pair of sandals is Rp. 20,000 and the price of a pair of shoes is Rp. 40,000. Write down the mathematical model!"

In question number 2, students are asked to identify the constraints and assumptions behind modelling the System of Linear Equations of Two Variables and simplifications obtained from the context. The students' answers related to question number 2 are in Figure 4.

Figure 4. Students' answers on number 2

Based on Figure 4, it can be seen that students have not been able to write the equation correctly. Students do not carry out a structured solution process where students immediately write x and y only without writing what is known first in the problem. Based on interviews conducted, students said that they did not understand what was meant by capitalizing in variables.

c. *Question Number 3*

"Seorang petani mempunyai beberapa ekor ayam dan kambing di peternakannya. Jumlah kaki hewan tersebut adalah 36 dan jumlah kepala hewan tersebut adalah 14. Tentukanlah berapa banyak ayam dan kambing yang dimiliki oleh petani tersebut!"

"A farmer has some chickens and goats on his farm. The number of legs is 36 and the number of heads is 14. Find how many chickens and goats the farmer has!"

Based on question number 3, students are asked to Design and apply strategies to find solutions to the System of Linear Equations of Two Variables mathematically. The answers of students related to question number 3 are in Figure 5.

Figure 5. Students' answers on number 3

Based on Figure 5, students cannot solve the problem correctly. The first problem, students do not do the planning stage, such as what is known, what is asked, and the information needed in solving the problem. Based on the results of interviews, students feel that the planning stage does not need to be written so students do not write it
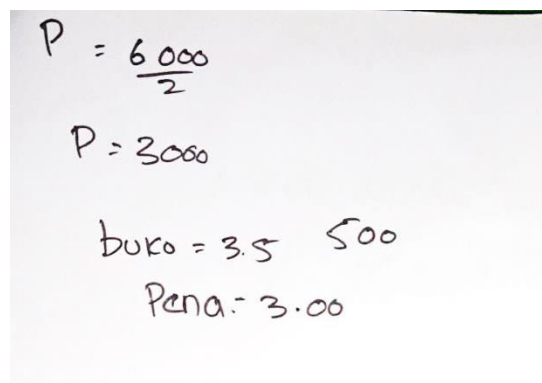
because the most important thing is the end result. The second problem, students do not do variable memorization because students feel confused about what will be used as variable memorization so students do not do variable memorization. The third problem, students form equations but are still inaccurate because students are confused about the variables so students cannot solve the form of the given equation. The fourth problem, students do not do the elimination method and the substitution method because students do not know how to solve the problem correctly, so students only guess the final answer. Then based on the interviews conducted, students said they experienced time constraints seeing that there were still further problems.

d. Question Number 4

"Menjelang awal tahun ajaran baru, Nining, Aswiah, dan Sueti pergi bersama ke toko ATK untuk berbelanja ATK baru. Nining membeli 4 buku tulis dan 2 pulpen seharga Rp 18.000,00 dan Aswiah membeli 3 buku tulis dan 4 pulpen seharga Rp 18.500,00. Jika Sueti membeli 2 buku tulis dan 3 pulpen dan membayar dengan 3 pecahan Rp 5.000, berapakah kembalian yang akan diterima Sueti?"

"Near the beginning of the new school year, Nining, Aswiah, and Sueti went together to the stationery shop to shop for new stationery. Nining bought 4 notebooks and 2 pens for Rp 18,000 and Aswiah bought 3 notebooks and 4 pens for Rp 18,500. If Sueti buys 2 notebooks and 3 pens and pays with 3 denominations of Rp 5,000, how much change will Sueti receive?!!!"

Based on question number 4, students are asked to Design and apply strategies to find solutions to the System of Linear Equations of Two Variables mathematically. The answers of students related to question number 4 are in Figure 6.

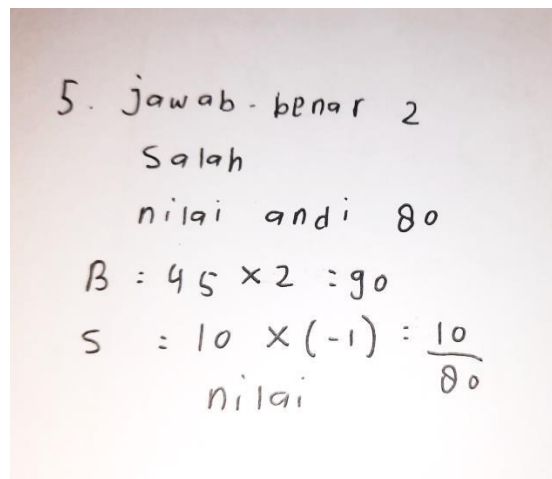Figure 6. Students' answers on number 4

Based on Figure 6, students have not been able to evaluate the problems given. This can be seen from the answers of students who do not formulate in advance what mathematical information is given, namely known, asked and solution. Students do not write the form of the equation given in the problem and only solve with mathematical operations directly. Based on the results of interviews found, students say that the level of the problem given is difficult to solve..

e. Question Number 5

"Andi mengerjakan seluruh ujian masuk perguruan tinggi yang totalnya 70 butir soal. Jika jawaban benar maka diberi skor 2, sedangkan jika jawaban salah diberi skor -1. Saat pengumuman skor, Andi mendapatkan skor 80. Maka banyak soal yang dijawab oleh Andi adalah?"

"Andi took the entire university entrance exam, which totaled 70 items. If the answer is correct, it is given a score of 2, while if the answer is wrong, it is given a score of -1. When the score is announced, Andi gets a score of 80. Then the number of questions answered by Andi is?"

Based on question number 5, students are expected to be able to explain and interpret the results according to the problems given. The answers of students related to question number 5 are in Figure 7.

Figure 7. Students' answers to question 5

Based on Figure 7, it can be seen that there are many steps of completion that students cannot do. Students have not been able to write the problem information correctly, such as known, asked and solution. In addition, students have not been able to make equations from the problem and only solve the problem with mathematical operations. Based on interviews, students feel a lack of time when working on the problems given, so students solve problems using fast methods, and no longer ignore the steps involved in solving problems in the form of a system of linear equations of two variables.

Based on the description of students' ability to answer the mathematics literacy test on the material of the system of linear equations of two variables above, it can be seen that there are several mistakes and errors made by students in solving the problems given. This is supported by the results of interviews with students who revealed that students felt confused about writing equations, unable to understand the problem and did not know how to solve the problems given. To get a full picture of why the above can happen, an analysis of learning obstacles is carried out which includes ontological obstacles and epistemological obstacles.

a. Ontological Obstacles

The results of the research previously presented show that students still make mistakes in the basic concepts of solving problems related to the System of Linear Equations of Two Variables. The autogenic barrier experienced by students in this case is the lack of interest of students in learning mathematics in solving the problems given. This is due to the low literacy of students and understanding of mathematical concepts. In line with research conducted by (Bintara, 2021) which says that ontological obstacles in the material the System of Linear Equations of Two Variables in students are difficult to understand the problem properly. While the ontological obstacle in this study found several difficulties experienced by students, including students not understanding the problem well, difficulty converting information from existing problems to mathematical models, and students are unable to apply the concept of solving algorithmically and choosing the appropriate operation in solving the given problem. The difficulties experienced by students are what cause students to be less motivated to solve the problems given.

b. Epistemological Obstacle

The epistemological obstacle identified from the research is the low concept understanding of students, especially in the material the System of Linear Equations of Two Variables. Students have difficulty transforming problems into simplifying important information to solve existing problems. This is because students do not understand the

questions given and what steps must be taken to solve the problem. This obstacle is related to the low literacy understanding of students, which includes students not being able to understand the purpose and meaning of the story in the problem. Furthermore, epistemological obstacles that occur are students' difficulties in abstracting contextual information into a mathematical model when students write down the information obtained from the problem but cannot make a mathematical model of the problem. (Jupri & Drijvers, 2016) found in their research that students had difficulty understanding the phrase "a number" into something unknown, for example the variable x. Students are often able to present the solution plan externally orally but are unable to do mathematical modeling. The next learning obstacle is that students are unable to solve mathematical models with the concept of the System of Linear Equations of Two Variables, students do not recognize that the problem can be solved using the concept of the System of Linear Equations of Two Variables. This is in line with research (Sundary et al., 2022) which shows that students are able to turn what is known in the problem into a correct mathematical model but students cannot solve the mathematical model with the solution of the System of Linear Equations of Two Variables.

Therefore, based on the research results, several things can be concluded regarding the analysis of learning obstacles of SMP Negeri 3 Sungguminasa students on the material of the system of linear equations of two variables. Some student errors include the first problem, namely students cannot make mathematical models correctly in this case the form of two equations where students only write one equation, there are even students who do not write the form of the equation. The second problem is that students cannot solve problems properly in this case students have not been able to write what is known, what is asked, and sufficient information to solve the problem. Then based on the results of interviews that have been conducted, students say that the time given to answer the questions is not enough, then students feel that the problems given are difficult to solve. The students who stated that they knew what was known, what was asked but did not think to write it down, and the students said that they did not understand what the meaning of specialisation in variables was.

The findings of this study have important implications in threatening more effective teaching strategies in overcoming ontological obstacles and epistemological obstacles in learning mathematics content change and relationship. The following are some of the implications that can be considered:

a. *Understanding Student Challenges*

It is important to understand that each student has a different background knowledge and understanding. Teachers need to identify specific difficulties faced by students in understanding the ontological and epistemological concepts perceived by

students, ranging from difficulties in understanding the concept of variables, formulating equations, understanding the relationship between variables and the solution methods used.

b. Using a concrete to abstract approach

Students often face difficulties in understanding abstract concepts. Therefore, it is important to use a concrete approach first before introducing concepts in the abstract. For example, the use of real objects or mathematical manipulatives can help students build a visual and concrete understanding that can be represented in the context of the System of Linear Equations of Two Variables.

c. Provide an experience of mathematical thinking

Students need to have opportunities to think mathematically and apply the concepts they learn in real contexts. Teachers can provide tasks or problems that require mathematical thinking, modeling and problem solving. This helps students understand the connections between mathematical concepts in a broader context..

d. Using active learning strategies

Active learning strategies, such as group discussion, group work, can help students actively participate in learning. Through interaction with classmates and engaging in the learning. Through interaction with classmates and engaging in activities, students can build a better understanding of the concept of change and relationships.

e. Linking to students' experiences

Linking mathematical concepts to everyday experiences or real situations can help students understand the relevance and application of the concepts. Teachers can provide examples relevant to students' lives or ask students to find connections between mathematical concepts and real situations.

f. Providing constructive feedback

Teachers should provide constructive feedback to students to help them improve their understanding. Feedback should be specific and focus on the difficulties faced by students in understanding ontological and epistemological concepts. In addition, teachers can encourage students to give feedback to each other, so that they can learn collaboratively.

g. *Applying technology in learning*

The use of technology, such as interactive or simultaneous mathematics software, can help students visualize mathematical concepts in the System of Linear Equations of Two Variables. Technology can also provide opportunities for students to practice independently and get instant feedback.

By considering these implications in designing teaching strategies, it is hoped that students can overcome ontological obstacles and epistemological obstacles in learning mathematics content change and relationships more effectively.

Acknowledgment

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