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How Students' Obstacle in Solving Ratio and Proportion Problem? Focusing on Mathematical Literacy Process

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Abstrak
Penting bagi siswa untuk menguasai literasi matematis yang mencakup kemampuan merumuskan, menerapkan, dan menafsirkan dalam menyelesaikan masalah. Namun, siswa masih menghadapi kesulitan dalam proses literasi matematis, khususnya pada materi rasio dan proporsi, yang dapat dikategorikan sebagai hambatan belajar atau learning obstacles. Penelitian ini bertujuan untuk mengidentifikasi hambatan belajar siswa dari tiga aspek, yaitu epistemologis, didaktis, dan ontogenik dalam konteks literasi matematis pada materi rasio dan proporsi. Penelitian ini menggunakan pendekatan kualitatif dengan metode fenomenologi, melibatkan 78 siswa kelas VIII di Palembang, Sumatera Selatan. Teknik pengumpulan data yang digunakan meliputi tes dan wawancara, sementara analisis data dilakukan secara kualitatif melalui teknik triangulasi untuk meningkatkan kredibilitas temuan. Hasil penelitian menunjukkan bahwa siswa mengalami ketiga jenis hambatan belajar dalam proses literasi matematis. Hambatan epistemologis terlihat dari keterbatasan pemahaman konsep dasar rasio, hambatan didaktis muncul akibat metode pengajaran yang tidak optimal, dan hambatan ontogenik terjadi karena kesiapan kognitif siswa yang belum memadai dalam memahami rasio secara proporsional.
Kata Kunci: Hambatan belajar siswa; literasi matematis; rasio dan proporsi.

Abstract
It is essential for students to master mathematical literacy, which includes the ability to formulate, apply, and interpret when solving problems. However, students still encounter difficulties in the mathematical literacy process, especially in the topics of ratio and proportion, which can be categorized as learning obstacles. This study aims to identify students' learning obstacles from three aspects: epistemological, didactic, and ontogenic in the context of mathematical literacy on ratio and proportion material. This research uses a qualitative approach with phenomenological methods, involving 78 eighth-grade students in Palembang, South Sumatra. Data collection techniques include tests and interviews, while data analysis is conducted qualitatively through triangulation techniques to enhance the credibility of the findings. The results indicate that students experience all three types of learning obstacles in the mathematical literacy process. Epistemological obstacles arise from a limited understanding of the basic concept of ratios, didactic obstacles stem from suboptimal teaching methods, and ontogenic obstacles are due to students' cognitive readiness for understanding proportional reasoning.
Keywords: Student’s learning obstacles; mathematical literacy; ratio and proportion.

I. INTRODUCTION

In the context of mathematics, students are not only expected to master calculation skills alone. More than that, it is important for them to have the ability to think logically, critically and creatively in responding to and solving various problems (Stacey & Turner, 2014) . Solving these problems is not only related to routine tasks that require mathematical procedures but also involves real situations that students face in everyday life. Madyaratri et al. (2019) state that this mathematical ability is known as mathematical literacy, which includes understanding mathematical concepts and the ability to apply them to solve problems in the context of everyday life.

OECD (2021) identifies mathematical literacy ability as a person's ability to formulate, employ, and interpret mathematical concepts in solving problems that occur in various life contexts. These three stages include the process of mathematical literacy skills carried out by students in the context of mathematical reasoning (Mumcu, 2016; Wahyuni et al., 2024). At the formulating stage, students can recognize aspects of contextual problems that can be abstracted and presented in mathematical form to be solved. After formulating problems in mathematical form, students apply mathematical concepts, facts, procedures and reasoning to solve problems and obtain mathematical solution (Muhazir et al., 2020). The final stage, namely interpreting, provides an opportunity for students to reflect on mathematical solutions, results, or conclusions and relate them to the context of real-life problems, which is the beginning of the problem-solving process. Therefore, mastering mathematical literacy is important for students in the context of problem-solving.

Ambarwati and Ekawati (2022) and also Puspita et al. (2023) noted that students still need help in carrying out the process of formulating, applying and interpreting problem-solving, especially related to ratio and proportion material. In fact, ratio and proportion are crucial materials for students at the secondary school level to understand. According to Sevinc & Lizano (2024), two basic mathematical concepts that are related to various other concepts at a higher level are ratio and proportion. This material is not only relevant in the context of mathematics but is also important in various other fields of knowledge. Everyday phenomena that are close to students often involve the application of the concepts of ratio and proportion (Ben-Chaim et al., 2012; DOMONDON et al., 2024). For example, the application of ratios and proportions can be found in everyday activities such as measuring ingredients in a cooking recipe or calculating the speed of a vehicle.

A deep understanding of the concepts of ratio and proportion is widely considered to be an important bridge between numerical, concrete mathematics of arithmetic and the abstractions that accompany algebra and higher mathematics (Avcu & Avcu, 2010; Martinovic, 2024). Conceptualization and understanding of the concepts of ratio and proportion, as well as skills and competencies in using them in everyday life problems, are necessary for the development of students' mathematical reasoning (Bas-Ader et al., 2024; S. J. Lamon, 2012). Therefore, the topic of ratio

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and proportion covers critical reasoning skills and is related to many concepts both in mathematics and other fields.

In the latest curriculum in Indonesia, ratios and proportions have been studied since the elementary school level, to be precise, in class VI. At this level, students are expected to be able to reason proportionally in solving problems related to daily life by applying the concept of unit ratios. Then, students are also required to be able to use the arithmetic operations of multiplication and division in solving problems regarding proportions (Setyaningrum & Mampouw, 2020; STANDAR & Kurikulum, 2023). Students at the secondary school level will study further discussion regarding the concepts of ratio and proportion.

Even though ratios and proportions have been studied at previous levels, middle school students still need help dealing with ratios and proportions. Dougherty et al. (2016) found that class VII students still think that the ratio 2: 3 is equivalent to 4: 5 because each number in each ratio has the same difference, namely one. These misconceptions affect his ability to find equivalent ratios and work with ratios and proportions in a variety of contexts, including determining rates of change with function and other contextual situations. Lamon (1994) added that one of the causes of student confusion in ratio material is that learning about the concept of ratio and proportion begins directly with the notation $\frac{a}{b}=\frac{c}{d}$. Students also experience other difficulties, such as difficulty understanding contextual problems related to ratios and proportions, mistakes in carrying out arithmetic operations in the problem-solving process, and mistakes in understanding or differentiating several concepts in ratios and proportions (Fauziah & Cahya, 2021; Wardani et al., 2024).

Several situations regarding the difficulties students encounter in learning the concept of ratio and proportion can be called learning obstacles. Learning obstacle can be interpreted as various forms of obstacles experienced by students in learning situations. These obstacles can make it difficult for students to understand the mathematical concepts being studied (Moru, 2009). According to Brousseau, there are three factors that cause students to experience learning obstacle, namely ontogenic (mental readiness to learn), didactic (as a result of teacher teaching) and epistemological (student knowledge that has limited application context) obstacle (Suryadi, 2016).

Suryadi (2019) stated that ontogenic obstacle are obstacles that focus on students' cognitive readiness and maturity, which can be seen from the gap between learning demands and children's capacities. The second learning obstacle is epistemological, namely an obstacle caused by the limited experience that students have, such as the limited context used when first learning a concept. The final learning obstacle is the didactic obstacle related to the stages and sequence of presenting the material. Based on the description of the previous problem, the researcher will reveal students' learning obstacles from 3 aspects (epistemology, didactic and ontogenic) in students' mathematical literacy abilities in the material on ratios and proportions.

The importance of this research lies in the importance of mastering mathematical literacy, especially in understanding the concept of ratio and proportion, which is a fundamental skill for students at the secondary school level. However, various studies show that students often have difficulty in understanding the concept of ratio and proportion. (Son, 2013)found that many students have misunderstandings in determining equivalent ratios, which impacts their ability to solve various mathematical problems. Epistemological, ontogenic, and didactic barriers in understanding ratio and proportion have also been identified as factors that influence students' understanding (Bintara & Prabawanto, 2024; Wahyuningrum et al., 2023; Wijaya et al., 2019)

As one of the materials taught since elementary school, ratio and proportion play an important role in the development of students' mathematical reasoning. This concept is the basis of many other fields of science, such as physics, chemistry, and economics, which makes mastery of this material a bridge to a broader understanding (Singh, 2000). Thus, this study has a high urgency to reveal the obstacles experienced by students in learning ratio and proportion, as well as provide recommendations to improve the quality of learning in this field.

The originality of this study lies in its approach that focuses on learning obstacles in students' mathematical literacy, especially on the concept of ratio and proportion. Although previous studies have discussed the importance of understanding ratio and proportion, many still focus on teaching methods such as Realistic Mathematics Education (RME) or contextual approaches in mathematics learning, as proposed by Prahmana et al. (2023) and Lestari (2016). They show that this approach can help students understand the concept of ratio and proportion through contexts that are more relevant to everyday life.

However, this study adds novelty by identifying and exploring three types of learning barriers—ontogenic, epistemological, and didactic—that have not been discussed in depth in previous studies. This study also contributes by providing new insights into how these barriers emerge and influence students' mathematical literacy processes, which are rarely explained in previous literature that focuses more on pedagogical solutions without studying students' internal barriers in detail (Prahmana & Nusantara, 2024).

Thus, this study provides a new perspective in understanding the difficulties experienced by students in learning ratios and proportions, and offers further recommendations to overcome these obstacles, which have not been widely found in previous studies.

II. Method

This is qualitative research with a phenomenological approach that aims to describe the meaning for several individuals regarding students' life experiences regarding certain concepts. The focus of this research is to examine students' learning obstacles in mathematical literacy skills in ratio and proportion material. This research involved 78 class VIII students at a school in Palembang, South Sumatra, who had studied ratio and proportion material. Data

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collection techniques used in this research include tests and interviews. The problem-solving process used to analyze students' mathematical literacy abilities, according to OECD (2021), is as follows:

Table 1.
Process of Mathematical Literacy

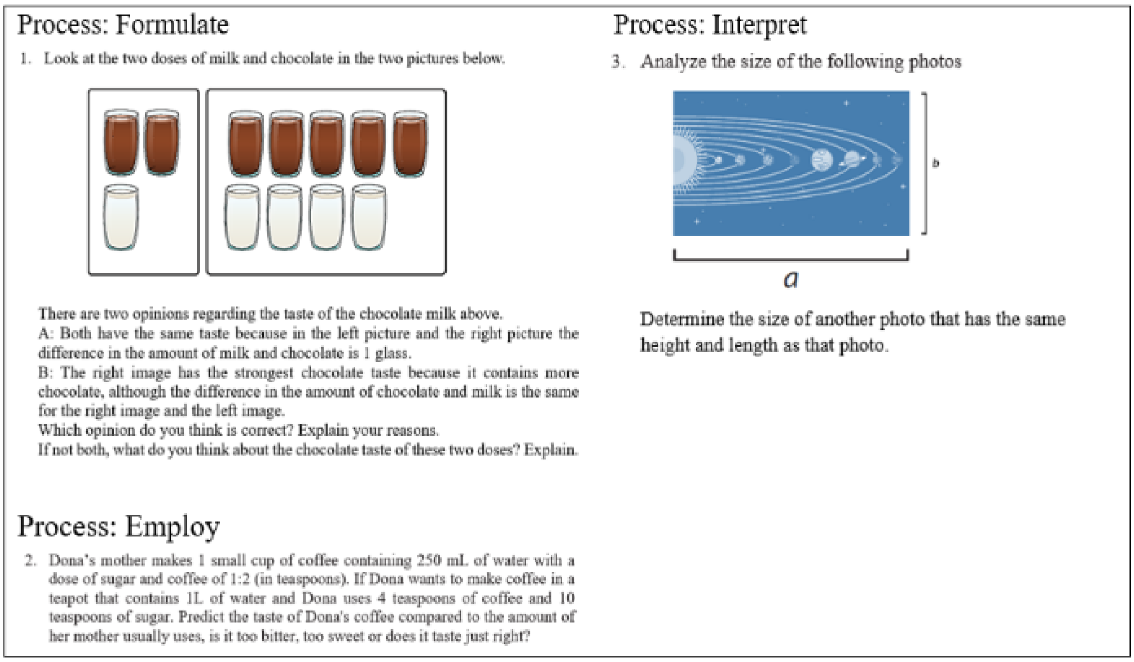
Mathematical Literacy Process	Description
Formulate	• Represent mathematical situations using appropriate variables, symbols, diagrams and models. • Represent problems in different ways, including organizing according to mathematical concepts and making appropriate assumptions.
Employ	• Design and implement strategies to find mathematical solutions. • Apply facts, rules, algorithms, and mathematical structures when searching for solutions.
Interpret	• Translate mathematical solutions or reasoning back into the context of the problem. • Evaluate the reasonableness of mathematical solutions in the context of real-world problems.

The data analysis in this research adhered meticulously to the foundational principles of qualitative research accuracy, encompassing credibility, transferability, dependability, and confirmability (Thomas & Magilvy, 2011). Credibility was maintained through a rigorous approach that included diverse data sources, member checking, and triangulation techniques. These strategies aimed to establish the trustworthiness and authenticity of the data, ensuring that the interpretations accurately reflected the participants' perspectives. Transferability, on the other hand, was enhanced by providing a comprehensive and detailed account of the research context, methods employed, and participant characteristics. The transparency in reporting facilitated readers' assessment of the applicability of the findings to other contexts. Dependability was safeguarded by implementing systematic and well-documented data analysis procedures, coupled with the establishment of an audit trail. This meticulous record-keeping not only ensured the replicability of the study but also contributed to the overall dependability of the research process. Confirmability, emphasizing the objectivity of the research, was achieved by minimizing researcher biases through reflexivity, involving multiple researchers in data analysis, and establishing an audit trail. These measures collectively fortified the research's confirmability, underscoring a commitment to impartiality and the reliability of the study's outcomes. In upholding these four principles, the research exemplifies a robust and comprehensive approach to qualitative data analysis, contributing to the overall quality and credibility of the study.

III. RESULT AND DISCUSSION

A. RESULT

After taking the test given by the researchers (Figure 1) and conducting interviews with several students, they identified three types of learning obstacle experienced by students in the three mathematical literacy processes, namely ontogenic obstacle, didactic obstacle and epistemological obstacle.


Process: Formulate

1. Look at the two doses of milk and chocolate in the two pictures below.

There are two opinions regarding the taste of the chocolate milk above.
A: Both have the same taste because in the left picture and the right picture the difference in the amount of milk and chocolate is 1 glass.
B: The right image has the strongest chocolate taste because it contains more chocolate, although the difference in the amount of chocolate and milk is the same for the right image and the left image.
Which opinion do you think is correct? Explain your reasons.
If not both, what do you think about the chocolate taste of these two doses? Explain.

Process: Employ

2. Dona's mother makes 1 small cup of coffee containing 250 mL of water with a dose of sugar and coffee of 1:2 (in teaspoons). If Dona wants to make coffee in a teapot that contains 1L of water and Dona uses 4 teaspoons of coffee and 10 teaspoons of sugar. Predict the taste of Dona's coffee compared to the amount of her mother usually uses, is it too bitter, too sweet or does it taste just right?

Process: Interpret

3. Analyze the size of the following photos

Determine the size of another photo that has the same height and length as that photo.

Figure 1. Ratio and Proportion Problems

The following describes the learning obstacle for each problem based on the three mathematical literacy processes:

a. **Formulate**

The mathematical literacy process involved in problem 1 is formulated. In this problem, students are expected to be able to represent situations related to milk and chocolate measurements in a mathematical model related to the concept of ratio. This problem also requires students to make appropriate assumptions based on the information in the problem. However, in this question, most students answered option A or B by agreeing with the reasons stated in each option. The researcher interviewed one of the students who answered option B.

Q: "Do you know the mathematical material related to this problem?"

S1: "You know, comparison, right?"

Q: "Why did you choose B?"

S1: "Because in the right picture, there are more chocolate glasses than in the left picture. Even though the difference between chocolate and milk is the same, namely one glass, I just compared the many glasses of chocolate."

Q: "Why only compare the chocolate glasses?"

S1: "Because the question asked about the taste of chocolate, I just compared chocolate. "Because as far as I remember, what was compared was the same thing, like the example questions in the book."

From the interview excerpt above, students are not yet fully able to represent the situations they face in mathematical models related to the concept of ratios. Students only understand that the problem is about ratios. Next, students try to remember what the teacher has taught in class. Students get an explanation of ratios starting with general forms $a : b$. Then, students are immediately asked to determine the ratio of two quantities without providing a deeper explanation of the basic concept of ratio itself $\frac{a}{b}$. This condition is an implication of didactic obstacles. In line with this, Nurjanah & Juliana (2020) state that didactic obstacles can be caused by the teacher's need for more emphasis on the basic concepts of the material being studied.

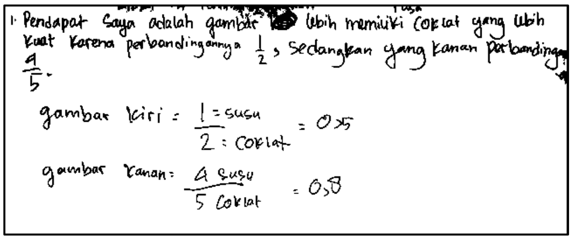


Figure 2. S2 Answers to Problem 1

"My opinion is that the left image has stronger chocolate flavor because the ratio is $\frac{1}{2}$, while the ratio on the right is $\frac{4}{5}$.

Left image: 1 milk 2 chocolate

$= \frac{1\ susu}{2\ coklat} = 0{,}5$

Right image: 4 milk 5 chocolate

$= \frac{4\ susu}{5\ coklat} = 0{,}8$"

On the other hand, S2 was able to represent problems related to the dosage of milk and chocolate in a ratio form correctly (Figure 2). However, the assumption put forward by S2 needs to be corrected because S2 applies the principle of fractions to the concept of ratio. Students need to understand better the definition of ratios and the relationship between fractions and ratios. In the interview, S2 stated that problem 1 was a problem related to fractions, so S2 used the fraction principle in the solution steps. This information is in line with what was expressed by Istiqomah & Prabawanto (2019)that students have difficulty reading and understanding problems related to fractions in contextual questions. This shows that S2 experiences a mismatch between students' way of thinking and mathematical concepts. Therefore, students are indicated to experience ontogenic obstacles.

Based on the answers in Figure 2, it was also identified that S2 did not understand the meaning of the ratio $\frac{1}{2}$. S2 converts the two forms of ratio into decimal numbers and then compares the two decimal numbers. So, this can be categorized as an epistemological obstacle. Because the student's answer indicates that the student has $\frac{4}{5}$ know what concepts should be used, but there are parts of the concepts they already know that they understand incorrectly (A. S. Wahyuningrum et al., 2017).

b. Employ

Problem 2 requires being able to design and implement a strategy to determine the taste of coffee with a new dose. Students are expected to be able to apply facts, rules, and algorithms to the concept of ratios to find solutions. However, 58% of research subjects wrote answers, one of which was S3 (Figure 3).

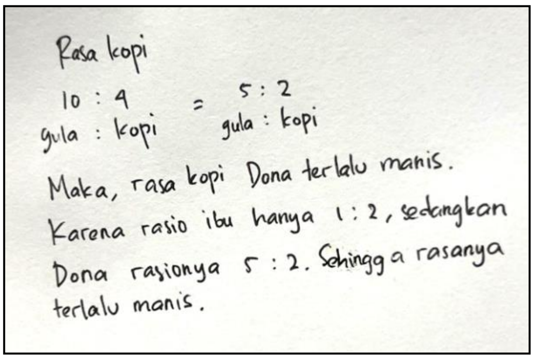


Figure 3. S3's Answer to Problem 2

"Coffee flavor
10:4 = 5:2
sugar coffee sugar coffee
So, Dona's coffee ratio is too sweet.
Because the mother's coffee ratio is only 1:2, while Dona's is 5:2."

To find out more about how S3 designed a strategy to solve problem 3, below are the results of the interview excerpt.

Q: "How did you solve question number 2?"
S3: "By comparing the initial ratio of sugar and coffee, which is 1:2, and the ratio used by Dona, which is 10: 4."
Q: "Don't you consider other elements in making coffee, such as the amount of water or the number of glasses?"
S3: “No.”
Q: “Why?”
S3: "Because the example usually given in class is comparing two ratios that are already in the question."

The results of the interviews showed that students had made mistakes in designing and implementing strategies for solving problems. Students choose to ignore other quantities, such as the amount of water or the number of glasses in the amount of coffee and only focus on the ratio of the amount of sugar and coffee. It suggests that students need help to solve problems that contain more than one ratio. In solving problem 2, students use procedures that are in accordance with what they got from the teacher when learning in class. So, in solving problems, students rely on examples they have studied. For this reason, S3 can be said to experience didactic obstacles.

In addition, ontogenic constraints also appear in S3. As seen in Figure 3, S3 states that in measuring sugar and coffee, the ratio of 5: 2 is considered sweeter than the measurement of 1: 2. This indicates that S3 is able to simplify the form of the ratio, namely 10: 4 = 5: 2, but S3 does not understand and cannot express the meaning of the written ratios.

Researchers also interviewed other students who wrote incorrect answers to problem number 3. Students stated that one of the causes of difficulty in answering this question was because ratio and proportion questions, which use the context of food and drink, usually only determine the ingredients needed if one wants to increase the portion of food or drink. So, when faced with different question formulations, students feel they need clarification in determining steps and strategies for solving problems (Kandaga et al., 2022). For this reason, obstacles like this are epistemological obstacles.

c. Interpret

Problem 3 requires students to reason about a mathematical situation presented in pictorial form and then translate it into a solution. Next, students are expected to be able to evaluate the solutions that have been written. However, in fact, in problem 3, only 18% of students were able to interpret the information contained in the problem into the correct solution strategy. One of them is student 4 (S4), whose answer is shown in Figure 4.

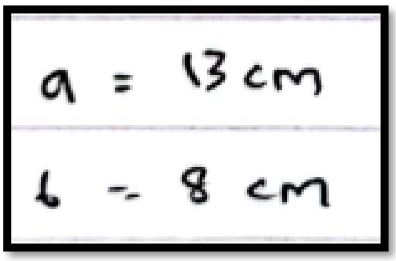


Figure 4. S4’s Answers to Problem 3

The following are the results of the researcher's interview with S4 in order to understand his thought process.

Q: "What do you think is asked in the question?"

S4: "The size of the photo in the question."

Q: "Do you understand the meaning of the sentence 'if the photo is enlarged and reduced'?"

S4: "Do not understand, ma'am."

Q: "Have you ever done a problem like this before?"

S4: "Never."

Based on the interview excerpt above, it can be concluded that students have never worked on problems regarding ratios in a context similar to problem 3. Students stated that the ratio questions that are often worked on at school usually contain information that is clearly known. Conditions like this show that students' knowledge is limited to one particular context. One of the reasons is that teachers only provide one way to solve problems with a concept (Novianda & Turmudi, 2021). It is called an epistemological obstacle. Then, based on the answers given, S4 also showed that he could not interpret and represent questions using the concept of proportion (ontogenic obstacle).

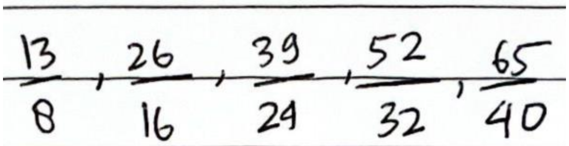


Figure 5. S5's Answers to Problem 3

On the other hand, student 5 (S5) can reason well from the situation presented in problem 3. S5 has written several examples of image sizes that are equivalent to the image in the problem if the image is enlarged. However, the S5 seems unable to infer and generalize the size of the image. It is because the teacher needs to provide various forms of questions at this level in the learning process. Students are used to routine questions or questions with familiar contexts. It is seen as a didactic obstacle.

B. Discussion

The research results highlight three distinct types of learning obstacle encountered by students during mathematical literacy processes: ontogenic obstacle, didactic obstacle, and epistemological obstacle. In the formulation process, illustrated through a problem involving ratio and proportion (Figure 1), students exhibited struggles in representing real-life situations mathematically. Some students, as exemplified by S1, merely associated the problem with the concept of ratios but lacked a deeper understanding of formulating mathematical models (Son et al., 2022). Pinilla (2007) found that the didactic obstacle became evident as students recalled information taught in class without a comprehensive explanation of the basic ratio concept, emphasizing the need for a more foundational approach in teaching.

The ontogenic obstacle surfaced when analyzing the responses of S2, who correctly formulated the problem but struggled with applying the appropriate mathematical concepts. The discrepancy in applying fraction principles to ratios suggests a specific misunderstanding of the distinction between these mathematical concepts. Ni & Zhou (2005) emphasized that it was crucial to address this issue by providing targeted instruction or intervention that clarified the differences between fractions and ratios. This may involve using concrete examples, visual aids, and practical applications to reinforce conceptual understanding (Handelsman et al., 2004; Siahaan & Leli, 2023).

Furthermore, the epistemological obstacle, where S2 converted ratios into decimal numbers, indicates a partial understanding of the underlying concepts. This suggests that S2 might benefit from a deeper exploration of the foundational principles of ratios, including their representation and manipulation. Providing additional exercises, real-world examples, and opportunities for hands-on learning can contribute to a more comprehensive understanding (Schwichow et al., 2016).

Pauji et al., (2023) addressed both ontogenic and epistemological obstacles, it is essential to take a holistic approach that considers the individual's cognitive development, learning style, and prior knowledge. Tailoring instructional strategies to meet the specific needs of S2 can contribute to overcoming these obstacles and fostering a clearer understanding of mathematical concepts. Regular assessment and feedback will also be valuable in tracking progress and adjusting teaching methods accordingly (Crogman et al., 2023).

In the phase of applying mathematical knowledge to solve problems, as explored in the study's examination of a scenario related to determining the taste of coffee with a new dose (Problem 2), the findings revealed intriguing insights into students' problem-solving approaches. Despite 58% of students, including the representative case of S3, submitting answers, deeper investigations through interviews brought to light the existence of didactic obstacles. These obstacles manifested as students exhibited a pronounced tendency to disregard other relevant elements in the problem, concentrating predominantly on the ratio of sugar to coffee. The detailed examination of S3's approach provided a compelling illustration, showcasing their reliance on learned procedures. This reliance suggested a dependence on specific examples taught in the classroom setting, emphasizing the didactic hindrances present in their problem-solving strategies (Pakarinen & Kikas, 2019).

The implications of these findings extend beyond the specific problem scenario, underscoring a broader issue in students' ability to employ mathematical knowledge. The observed didactic obstacles signify that students may be grappling with a constrained application of their acquired knowledge, emphasizing memorized procedures without a deeper understanding of the underlying principles (Hodges, 2023). This points to the critical need for a more comprehensive and conceptually grounded approach to mathematical education, particularly in the context of problem-solving (Gellert et al., 2013). Educators may find value in fostering a deeper understanding of the underlying mathematical concepts, encouraging critical thinking, and promoting a broader perspective when tackling mathematical problems (Rohmawati & Afriansyah, 2022; Efwan et al., 2024). Addressing didactic obstacles in the employment phase of mathematical processes is crucial for nurturing students' ability to consider multiple factors and approach problem-solving with a more holistic and informed perspective.

Furthermore, the study brought to light additional challenges in the form of ontogenic constraints and epistemological obstacles. Specifically, ontogenic constraints became evident as exemplified by S3, who simplified ratios without a deep comprehension of their underlying meanings. This suggests a limitation in S3's developmental stage, indicating that there might be a gap in their ability to grasp the conceptual nuances of mathematical operations. Herscovics (2018) added that an epistemological obstacle emerged when students encountered difficulties with questions that demanded diverse problem-solving strategies. This implies that students might be struggling not only with the procedural aspects of problem-solving but also with a deeper understanding of the varying approaches and strategies applicable to different mathematical scenarios.

The implications of these findings underscore the importance of providing enhanced guidance and a diverse range of problem-solving experiences for students. Addressing ontogenic constraints calls for instructional methods that cater to individual developmental stages, ensuring that students receive the necessary support to understand mathematical concepts comprehensively (Fauzi & Suryadi, 2020). Simultaneously, tackling epistemological obstacles necessitates exposing students to a variety of problem-solving scenarios, fostering their ability to adapt and apply different strategies based on the nature of the mathematical problem at hand. Overall, the research highlights the significance of a nuanced and adaptive teaching approach that recognizes and addresses the diverse challenges students may face in their mathematical learning journey.

In the interpret process, which involves reasoning about mathematical situations presented in pictorial form, the study focused on Problem 3. However, only 18% of students, exemplified by S4, were able to correctly interpret the information. Through interviews with S4, it became evident that epistemological obstacles played a significant role, as students lacked exposure to similar problem contexts. This indicated a reliance on limited knowledge derived from specific contexts provided in the classroom, revealing a gap in their ability to apply mathematical reasoning to unfamiliar situations (Meyer & Land, 2005).

Furthermore, another student, S5, showcased a didactic obstacle during the interpretation process. S5 struggled to infer and generalize information, and this difficulty was attributed to a lack of exposure to diverse question formats. According to Gorghiu et al. (2015) the didactic obstacle in this context suggests that students may face challenges in adapting their learned skills to different problem-solving scenarios, particularly when the format deviates from what they have encountered in class.

These findings emphasize the critical need for providing students with varied problem-solving experiences and diverse contexts in mathematics education. Addressing epistemological obstacles entails exposing students to a range of problem contexts, fostering their ability to apply mathematical reasoning across different situations. Simultaneously, overcoming didactic obstacles involves ensuring that students are exposed to diverse question formats, allowing them to develop the skills to infer and generalize information in various problem-solving scenarios. The study underscores the importance of a comprehensive and versatile approach to mathematics education to effectively address these learning obstacles and promote a more robust understanding of mathematical concepts.

IV. Conclusion

Based on the research findings, it was concluded that students experience learning obstacles in the mathematical literacy process on ratio and proportion material. Students face difficulties in solving ratio and proportion problems due to a mismatch between their cognitive development and mathematical concepts, categorized as ontogenic obstacles. Additionally, students struggle to understand the relationships between concepts they have learned, which is a result of suboptimal didactic practices in the classroom. This condition leads to underdeveloped conceptual understanding and limited experience in applying concepts, ultimately classified as didactic and epistemological obstacles.

Implications for mathematics education suggest that teachers need to understand the types of learning obstacles students face in ratio and proportion topics to design more effective and student-centered instructional strategies. By gaining a deeper understanding of ontogenic, didactic, and epistemological obstacles, teachers can develop approaches that help students overcome these challenges, improve mathematical literacy, and facilitate better conceptual understanding. These findings also provide a foundation for creating adaptive instructional designs, not only for ratio and proportion topics but also for other mathematical concepts, thus enhancing the overall quality of mathematics education.

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