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Problem-Solving Skills of Seventh-Grade Students in Ratio Topic

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Abstract. The proficiency of students in mastering mathematical problem-solving skills stands as a pivotal criterion for the success of mathematics learning. This research aims to assess and portray the level of students' mastery of mathematical problem-solving skills, particularly within the context of the ratio topic. Employing a descriptive qualitative research design, the study involves 10 seventh-grade students from a junior high school in Cimahi, West Java, Indonesia. These students have diverse initial abilities, spanning low, medium, and high levels, as recommended by their mathematics teacher. Data collection is executed through tests encompassing five indicators of mathematical problem-solving skills outlined by the National Council of Teachers of Mathematics (NCTM). The students' answer sheets are meticulously examined to ascertain and evaluate the students' proficiency in mathematical problem-solving skills, specifically pertaining to the ratio topic. The research findings indicate that the seventh-grade students' mathematical problem-solving skills in the ratio topic are deemed quite proficient.

Keywords: Mathematics Learning; Mathematical Skills; Problem-Solving Skills; Ratio Concept

Abstrak. Kemahiran siswa dalam menguasai keterampilan pemecahan masalah matematis merupakan kriteria penting bagi keberhasilan pembelajaran matematika. Penelitian ini bertujuan untuk menilai dan menggambarkan tingkat penguasaan keterampilan pemecahan masalah matematis siswa, khususnya dalam konteks topik rasio. Dengan menggunakan desain penelitian deskriptif kualitatif, penelitian ini melibatkan 10 siswa kelas VII dari sebuah sekolah menengah pertama di Cimahi, Jawa Barat, Indonesia. Siswa-siswa ini memiliki kemampuan awal yang beragam, mulai dari tingkat rendah, sedang, dan tinggi, seperti yang direkomendasikan oleh guru matematika mereka. Pengumpulan data dilakukan melalui tes yang mencakup lima indikator keterampilan pemecahan masalah matematika menurut National Council of Teachers of Mathematics (NCTM). Lembar jawaban siswa diperiksa dengan cermat untuk memastikan dan mengevaluasi kemahiran siswa dalam kemampuan pemecahan masalah matematis, khususnya yang berkaitan dengan topik rasio. Hasil penelitian menunjukkan bahwa kemampuan pemecahan masalah matematis siswa kelas VII pada topik perbandingan dinilai cukup baik.

Kata kunci: Kemampuan Matematis; Kemampuan Pemecahan Masalah; Konsep Perbandingan; Pembelajaran Matematika

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INTRODUCTION

Human beings will never be able to escape from education. From the very beginning of life, humans are always involved in education, whether directly or indirectly, from simple matters to complex ones. Education is a conscious and planned effort to create an active learning process for students to develop their inherent potential (Hakim, 2016; Kholis, 2014). From the given sentence, it can be concluded that education is an individual's effort to make oneself more mature, carried out consciously, meaning there is no coercion involved, but rather stems from one's conscience and desire to obtain education. Additionally, there is a plan for the continuity of this education, indicating that the education doesn't proceed haphazardly but is intentionally structured. In a narrower sense, education refers to a school, in which a system applies to individuals who have the status as students or learners in a school or university. (Pristiwanti et al., 2022). This opinion aligns with our thoughts all along; we often assume that education is confined to the learning we can acquire in school, whether it be at the kindergarten, elementary, middle, high school, or equivalent levels, up to the university.

Indonesian citizens are required to study for 12 years (Hasanah & Jabar, 2017; Kusuma Wardani Welly, 2015; Ulumudin & Martono, 2017). This program is a continuation of the previous program, namely the compulsory 9-year education program. This program aims to provide the citizens with the widest possible platform so that we can achieve maximum learning at school. In school, we receive various types of education, including material education, attitudes, and skills. Education in the form of materials we receive in school encompasses various subject contexts, includes subjects such as Science, Indonesian Language, English, and Mathematics. Mathematics is one of the fundamental sciences that must be learned because it is closely related to daily life. Mathematics is also one of the subjects that we will always encounter and acquire at every level of education. Not only that, also mathematics will always be encountered in national exams at all levels when we are about to move on to higher levels of education. Mathematics provides us with lessons on critical, analytical, and systematic thinking in problem-solving, both in the context of mathematical lessons and in everyday life (A. R. Sari & Aripin, 2018). Recognizing the importance of learning mathematics, the Department of National Education (Yantoro et al., 2021) suggests that in mathematics, there are four goals of mathematical learning: 1) mathematical concepts understanding ability, 2) mathematical property pattern reasoning ability, 3) mathematical problem-solving skill, and 4) communicating mathematical arguments ability.

The ability to solve mathematical problems is one of the goals of mathematical learning. As Singh (Noviani, 2022) suggests, one of the essential functions of teaching and learning mathematics is to develop the ability to solve various mathematical problems. The problem-solving skill is considered a highly important skill (Akuba et al., 2020; Coşkun et al., 2014; Finariyati et al.,

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2020; Jatisunda, 2017; Kharisma & Asman, 2018). Not only for those who will be in the field of mathematics, but this skill is also important for those who will apply it in other fields of study or their daily lives. This ability is also one of the essential abilities that students must have because this skill is one of the benchmarks for the success of learning. The reason is that this ability is an effort or process of transferring and applying a learning concept performed by students to the knowledge they already possess in new situations and conditions. Before being able to solve problems, students are required to comprehend the problem first. Subsequently, students begin to formulate methods or strategies. Afterward, students implement these strategies carefully and responsibly. Finally, students need to review whether the answer aligns with the desired response or not. In a broader sense, the ability to solve mathematical problems is a process that requires logic to find solutions to a problem (Prastiwi & Nurita, 2018).

In reality, despite many students having studied mathematics, their ability to solve mathematical problems remains low. Of course, this occurs due to various factors. For instance, when students are confronted with new obstacles, commonly referred to as non-routine problems, many of them face difficulties in resolving such issues. Additionally, some students feel embarrassed to ask when they are unable to solve it, or they simply wait for the teacher to discuss the solution to the problem. Just mention an example in the ratio material. Another factor contributing to the low problem-solving skill of students is that many perceive mathematics as a complex science due to the multitude of formulas that need to be learned. This is what causes students to distance themselves and not care about mathematics lessons. This can also be seen from the results of PISA, where Indonesia ranks low in mathematics (Hewi & Shaleh, 2020; Pratiwi, 2019; Umrana et al., 2019). In line with PISA results, data from TIMSS in 2011 also prove that Indonesia's situation is still very concerning. (Prastyo, 2020; Rudhito & Prasetyo, 2016; Vendiagrys et al., 2015).

Similarly, the research findings of Mauleto (2019) indicate that 14 students were unable to explain the results according to the given problem. In this case, it demonstrates the non-fulfillment of the fourth indicator out of the five problem-solving indicators according to NCTM. The research results by Rosita & Yuliawati (2017) also show a similar trend, where students with moderate and low dispositions are unable to explain the solution results and verify the accuracy of those solution results.

To enhance students' mathematical problem-solving abilities, especially in ratio material, the first step to be taken is to assess the extent to which students can solve ratio problems and identify the specific indicators where students may face difficulties in answering problems related to ratio concepts. Therefore, this research aims to describe the mathematical problem-solving abilities of 7th-grade junior high school students in the topic of ratios using indicators according to NCTM

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(National Council of Teachers of Mathematics). And this study is limited to the discussion regarding students' problem-solving abilities in the topic of ratios.

METHOD

This research used a qualitative descriptive method. In this qualitative research, the focus is on answering the four basic questions, namely What, Who, Where, and How the event happened, prompting an in-depth study to understand it further. To explain this explanation, this research is conducted with the following steps: The first step is to identify the problem in this study, which is measuring the mathematical problem-solving ability of 7th-grade junior high school students on the topic of ratios. After that, the research was conducted at one of the junior high schools in Cimahi by administering a problem-solving ability test to 10 students who had studied the topic of ratios with low, moderate, and high abilities selected randomly. Student selection is based on the recommendations of the junior high school mathematics teacher as research subjects. After collecting the data, it is analyzed to determine the level of students' mathematical problem-solving abilities. From the processed and analyzed data, conclusions will then be drawn.

In this research, the instrument test was developed based on five indicators of mathematical problem-solving skill by NCTM: first indicator, Students can identify the elements that are known, those that are asked about, and the adequacy of the information required. In this indicator, students are expected to be able to understand and then analyze the problems carefully to determine the adequacy of these elements. Second indicator, Students can formulate mathematical problems or construct mathematical models. In other words, students should be able to transform problems with existing elements into a suitable mathematical form or model. Third indicator, Students can apply strategies to solve various problems (similar and new problems) in or outside of mathematics. In the application of strategies, students need precision to ensure that the obtained answers align with the expected solutions. Fourth indicator, Students can explain the results according to the initial problem, meaning that students are expected to describe the outcomes obtained by the initial problem presented in the problem, and Fifth indicator, Students can use mathematics meaningfully (Gusmania & Marlita, 2016; Mauleto, 2019). All of these indicators are included in 5 questions that are utilized as instruments

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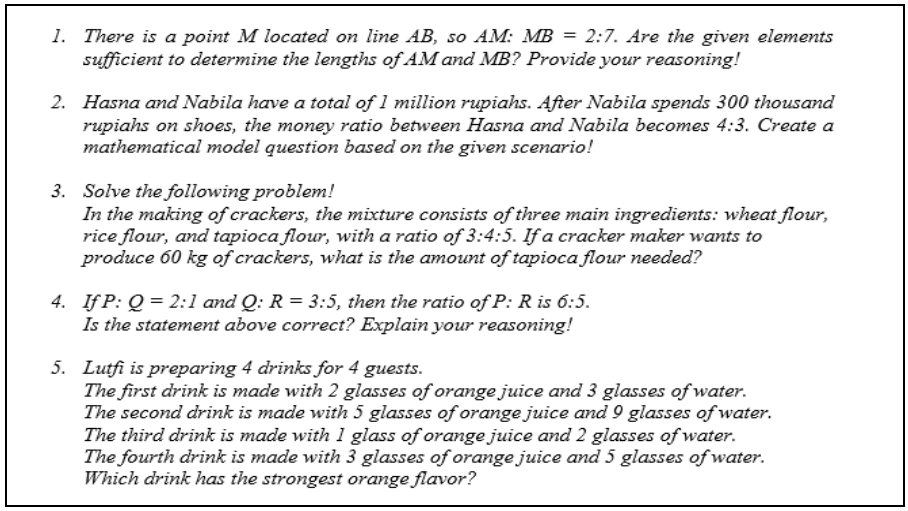

1. *There is a point M located on line AB, so AM: MB = 2:7. Are the given elements sufficient to determine the lengths of AM and MB? Provide your reasoning!*
2. *Hasna and Nabila have a total of 1 million rupiahs. After Nabila spends 300 thousand rupiahs on shoes, the money ratio between Hasna and Nabila becomes 4:3. Create a mathematical model question based on the given scenario!*
3. *Solve the following problem!*
   In the making of crackers, the mixture consists of three main ingredients: wheat flour, rice flour, and tapioca flour, with a ratio of 3:4:5. If a cracker maker wants to produce 60 kg of crackers, what is the amount of tapioca flour needed?
4. *If P: Q = 2:1 and Q: R = 3:5, then the ratio of P: R is 6:5.*
   Is the statement above correct? Explain your reasoning!
5. *Lutfi is preparing 4 drinks for 4 guests.*
   The first drink is made with 2 glasses of orange juice and 3 glasses of water.
   The second drink is made with 5 glasses of orange juice and 9 glasses of water.
   The third drink is made with 1 glass of orange juice and 2 glasses of water.
   The fourth drink is made with 3 glasses of orange juice and 5 glasses of water.
   Which drink has the strongest orange flavor?

Figure 1. Instrument Test

The indicator for Problem 1 is that students are expected to be able to identify the sufficiency of the required elements in the problem. However, before students can answer the adequacy of the information in the problem, they must first analyze what information is known and what elements are being asked in the problem. Afterward, students can then determine the adequacy of the elements. The information in the problem may be sufficient, or there may still be some that are lacking. In this indicator, students are also required to be meticulous in understanding the problem.

The indicator for Problem two is that students are asked to change a story problem into a mathematical form. In this problem, precision is required to change the story problem into a suitable mathematical form. In other words, students are expected to be able to transform the problem into a mathematical format.

After students learn the topic of ratios and the solution methods, they are expected to formulate appropriate strategies and then apply them accurately and carefully to various similar or new problems, both within the context of mathematics and outside of mathematics. For example, in this problem, students are asked to determine how much tapioca flour is needed to make 60 kg of crackers. Therefore, students need to find the common denominator for the ratio of the three ingredients by summing up their ratios.

In the fourth problem, students are asked to explain the results they obtain according to the given problem. The answers to the problem are already provided, but when students want to determine whether the given answers are correct or not, they also need to calculate the problem in the question. If the student's answer matches the statement in the problem, then the student will respond with "correct," and vice versa. Moreover, students are also required to be able to explain why their answer is correct or incorrect.

The indicator in fifth problem expects students to apply mathematics meaningfully. In this context, students are required to solve contextual problems related to daily life. Students must be

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able to solve the problem in order to determine which glass has the strongest orange flavor by first finding its Least Common Multiple (LCM) and then using it as the multiplier for the ratio of each drink. After students determine the Least Common Multiple (LCM) and apply it to the ratios, the next step is as simple as identifying which drink is made with the highest quantity of orange juice glasses.

The measurement technique used to describe students' mathematical problem-solving abilities consists of three stages: checking the results of students' test answers, presenting the data from the students' test results, and finally making conclusions from the data. The scoring used in assessing students' answer is 1 for a correct answer and 0 for an incorrect answer. As for calculating the final percentage of students' mathematical problem-solving abilities, it is measured using a formula:

$$P = \frac{f}{n} \times 100\%$$

Formula description:

P = Percentage of student ability

f = Total score for the aspect indicators obtained by students (Correct answers)

n = the indicators' maximum score

After obtaining the assessment percentage from the results of the students' instrument test, these scores are converted into qualitative values according to Widyoko's (Wijayanti et al., 2017) scoring conversion, as shown in the following table:

Table 1. Qualitative Assessment Score Conversion

Percentage	**Classification**
80 < x	Excellent
60 < x ≤ 80	Good
40 < x ≤ 60	Quite good
20 < x ≤ 40	Not good enough
x < 20	Poor

RESULTS AND DISCUSSION

Here are the results obtained from the students' responses to the given instruments. The question instrument used refers to the 5 indicators of problem-solving according to NCTM, and it has been completed by 10 students, resulting in a total of 50 answers. From the total of 50 answers, the number of questions answered correctly was 23, and the remaining 27 questions were answered incorrectly by the students. Here is the recapitulation of the student instrument test results for each number.

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Table 2. Recapitulation of Student Test Results

Indicators	students who answered correctly	Percentage	Classification
Identifying the known elements, the inquired elements, and the sufficiency of the required elements	3	30%	not good enough
Formulating a mathematical problem or constructing a mathematical model	6	60%	Quite good
Applying strategies to solve various problems (similar and new problems) within or outside the real of mathematics	3	30%	not good enough
Explain the results according to the initial problem	6	60%	Quite good
Applying mathematics meaningfully	5	50%	Quite good
Total	23	46%	Quite good

From the calculation results, it is evident that 46% of students answered correctly for all indicators, indicating that 54% of students are still making mistakes in answering problems, particularly in the topic of ratios. Although it falls into the "quite good" category, the percentage is considered low as the correct responses are still below 50% of the total students. Improvement is needed to achieve better results. Here is the presentation of the student test results for each problem indicator.

Overall, the students' answers received a classification of quite good. That means that students already have quite good ability in mathematical problem-solving, especially in the topic of ratios. However, it is necessary to practice more in solving other problems so that students' mathematical problem-solving skills can improve to become good and excellent. The discussion of the analysis of students' errors in working on each problem is as follows.

First Indicator

The first step to solving a problem is to identify the sufficiency of the elements in the problem. When solving problems related to indicators like Problem 1, ideally, students should be more careful in analyzing the information of the problem, identifying what elements are known and what information is being asked for. Because to determine the sufficiency of elements in the problem, students need to analyze all the elements provided in the problem first. Of the seven students who answered incorrectly and the three students who answered correctly, this is an example of a student's incorrect answer to Problem 1.

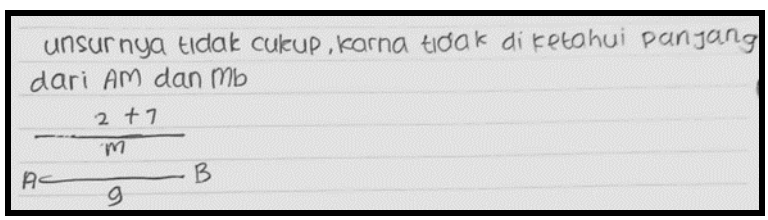

Figure 2. Example of a wrong answer to Problem 1

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In that answer, the student mentioned that "*the known elements are not sufficient because the length of AM and MB is unknown"*. Yet, what is needed is the length of line AB, as the lengths of AM and MB are the ones being questioned in this problem. Because the length of line AB is unknown, we cannot determine the lengths of lines AM and MB. In Zulfitri et al.'s (2019) research, it was also found that students are lacking in identifying the known and unknown information in the problems.

Second Indicator

Next, for Problem 2, students need to transform or convert the problem into mathematical form. The first step of the transformation in this problem is to determine variables as representations of the elements to make it easier to convert the word problem into mathematical form. After determining variables as representations, the next step is to analyze what elements are known from the problem that need to be transformed into mathematical form. Of the four students who answered incorrectly and the six students who answered correctly, this is an example of a student's incorrect answer to Problem 2.

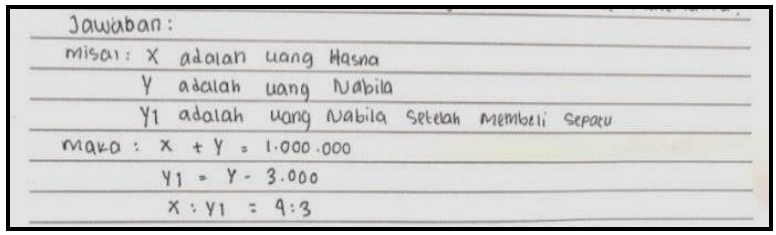

Figure 3. Example of a wrong answer to Problem 2

In that incorrect answer, the student was not careful enough in reading the problem. In figure 3, student wrote "*the answer: example: X is Hasna's money, Y is Nabila's money, Y1 is Nabila's money after buy shoes"* The correct amount of money that Nabila spent on buying shoes should have been 300,000, but the student instead wrote it as 3,000 in that incorrect answer. So, in this indicator, students need to be careful in reading the problem and translating the problem into mathematical form. This is compatible with the research by Putra et al., (2018); Sari et al., (2018), who also found that students make errors in transforming problems into mathematical form. Whereas, students are already able to identify the known and unknown elements, they still make mistakes when transforming the problem into mathematical form.

Third Indicator

Next, the discussion for Problem 3. Of the 7 students who answered incorrectly and the 3 students who answered correctly, this is an example of a student's incorrect answer to Problem 3.

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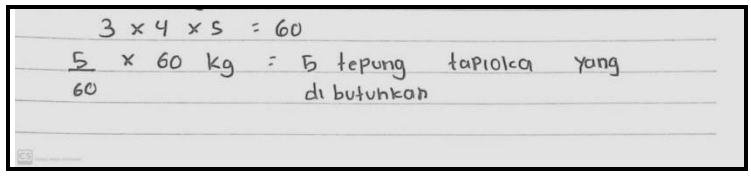

Figure 3. Example of a wrong answer to Problem 3

After students can identify the sufficiency of elements in the problem and successfully transform the problem correctly, the next indicator is an operation of the problem, commonly known as the execution of strategies. P In this problem, we need a denominator to determine how much tapioca flour is needed. However, to determine the denominator, students should find it by adding the three given ratios, not by multiplying them. Then it is multiplied by the quantity of crackers to be made. The mistake made by the student here occurred in the calculation process. The same thing also occurred in Bernard's et al. (2018) research, where students were not accurate in doing the calculation operation. And out of 15 observed students, 27% of them have difficulty or encounter obstacles when solving problems, one of which is related to the calculation operation factor.

Fourth Indicator

The next indicator is that students can explain the results according to the initial problem. That indicator is found in Problem 4. Here, students need to solve the problem and double-check whether the statements in the problem are true or false. In this problem, there are two different values of Q, so students are asked to multiply both values of Q by a number to make them equal. After both values of Q are equal, we can then determine the ratio of the values of P to R. Of the four students who answered incorrectly and the six students who answered correctly, this is an example of a student's incorrect answer to Problem 4.

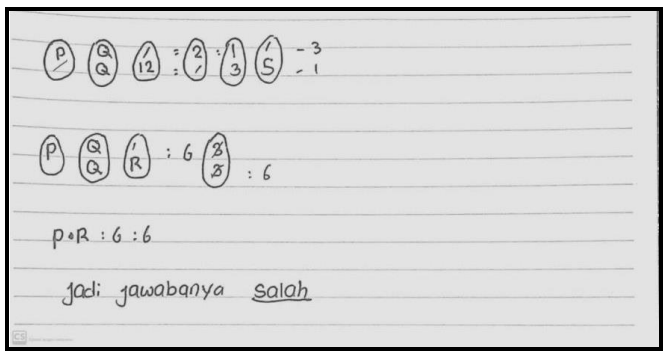

Figure 4. Example of a wrong answer to Problem 4

From the answer in figure 4, it can be seen that the student made a mistake in solving the multiplication in the ratio of R. In addition, the student just wrote "*So, the answer is wrong"* as the conclucien, the student did not explain the reason for their answer. Consistent with this, the research by R. W. Utami & Wutsqa (2017) indicates that the percentage of students' abilities in this

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stage is the smallest compared to other stages. Many students feel satisfied with the initial results they obtain. However, to determine whether the problem in the problem is correct or not, the solution must also be correct. In addition to requiring precision, students also need to double-check the solution results to ensure that the obtained results truly correspond to the desired answers.

Fifth Indicator

Next, for Problem 5, five students answered incorrectly, and five other students answered correctly. Below is an example of a student's incorrect answer to Problem 5.

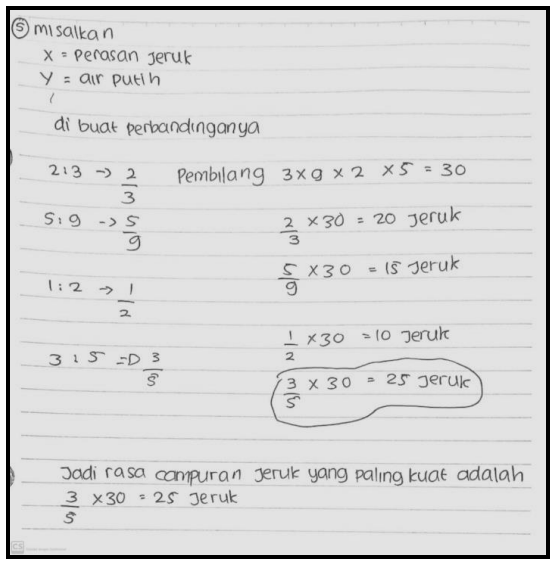

Figure 5. Example of a wrong answer to Problem 5

In figure 5, student wrote "*example: X is Orange Juice, Y is water. And then ratio is made. So, the strongest orange flavot who had 25 oranges".* In line with the opinion that states students have not yet been able to solve word problems (Rahmania & Rahmawati, 2016; H. S. Utami & Puspitasari, 2022). One of the main causes of students' inability to solve word problems is that students are not used to applying the material to problems, or in other words, students are not used to solving non-routine problems. In this problem, to determine which glass has the strongest orange flavor, the first step is to find the Least Common Multiple (LCM) of the four denominators to be used as a multiplier. After obtaining the LCM, we simply operate the four given ratios and then find which drink has the highest amount of orange juice. However, in that answer, the student made a mistake while solving the mathematical operations in the problem. As a result, the multiplier obtained by the student is an incorrect value, leading to the student's answer being considered a false answer.

CONCLUSION

From the research conducted on ten seventh-grade students at a junior high school in Cimahi, it can be observed that the student's ability to solve mathematical problems, particularly on the topic of

ratios, indicates a satisfactory level. Many students made mistakes in answering problems with the first indicator, which is stating the sufficiency of elements in the problem. Some students were less careful in reading the problems and rushed to work on them. In addition to the first indicator, seven students made mistakes on the third indicator. This is because students made mistakes in applying arithmetic operations. There were many mistakes in answering the problems caused by a lack of careful reading and rushing while solving the problems. However, from these results, we can evaluate that the teaching methods and approaches used by the teacher in delivering lessons are already accessible and understandable for the students. However, students need to practice more in solving new problems, both in mathematical contexts and those closely related to real-life situations. Therefore, an improvement in the learning process is needed, and one of them is the use of worksheets that can support students' problem-solving skills training. There is a need for research to develop more varied student worksheets (LKPD) with modified problems to further enhance students' mathematical problem-solving abilities, especially on the topic of ratios. Also, to meet the demands of the era and facilitate students, it would be better if the worksheets were presented in the form of e-worksheets (e-LKPD). By creating e-worksheets that contain various types of problems, it is expected that students' problem-solving abilities on the topic of ratios will improve even further.

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