Analysis of Students' Mathematical Representation Ability Based on Mathematics Ability

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Abstract

The aim of this research is to explore and describe students' mathematical representation abilities based on their level of mathematical ability. This type of research is descriptive with a qualitative approach. The research subjects were 25 students, 13 male students and 12 female students. Then 3 students with high, medium and low abilities were selected. The research results show that highly skilled subjects can re-present information or data from certain representations in the form of visual representations, can express mathematical equations and write down steps to solve mathematical problems in words. Subjects with moderate abilities only present information or data from certain representations in the form of visual representations and express mathematical equations. while low ability subjects can only solve problems involving mathematical expressions or equations. Basically, mathematical representation skills are very important and needed by students to understand the material provided and solve problems. If mathematical representation skills are lacking, it causes a lack of student understanding of the material provided so that students find it difficult to understand and work on the questions provided.

Keywords: *Mathematical representation ability, Solving problems, Pythagorean Theorem*

INTRODUCTION

Education is a very important need for human survival, as well as for the development and progress of a nation (Rafid, 2018; Asdar, Arwadi, & Rismayanti, 2021). So that educational goals can be achieved as optimally as possible, teachers as educators need to be able to develop the learning process according to current conditions and times (Zein, 2016; Afriansyah, et al., 2020). Improving the quality of education also means increasing human resources, therefore a learning process is needed, including learning in the field of mathematics because learning mathematics can really hone students' thinking abilities. Because of the important role it plays, learning mathematics is the main learning material that must be taught at all levels of education, from PAUD to university. So introducing mathematics from an early age can train children in critical thinking. In accordance with this, Triono (2017) believes that children must master the knowledge of mathematics from the start of their education. Furthermore, (Andriani Dewi and Samiyem, 2022) said that in mathematics learning there is a learning experience that is carried out with a series of activities that have been designed in such a way that students will gain skills regarding the mathematical material being studied. In line with this, Triono (2017) said that successful mathematics learning will produce students who have the ability to think systematically, logically, innovatively, analytically, creatively, and so on. This became the starting point for carrying out various updates for the development of science and technology (Science and Technology).

One of the mathematical abilities is the ability to represent mathematically. Therefore, mathematical representation is one of the basic abilities in solving mathematical problems that trains students' way of thinking in problem solving, reasoning and proof, communication, connection, and representation. representation) (NCTM, 2000). The idea of representation has been included in Ministerial Regulation No. 23 of 2006 (Firdaus & Oktaviana, 2020). Mathematical representation skills are the basis or foundation for a student to understand and use mathematical ideas in solving mathematical problems (Sari & Sari, 2019). These ideas or notions are interpreted in the form of graphs, pictures, symbols or mathematical writing as stated by Pasehah and Firmansyah, (2019). This is in line with the opinion of Kurniawan and Kartono (2018) who state that mathematical representation ability is a form of interpretation of students' abilities to a problem they face, where to find solutions to

problems faced by students using their interpretation as a tool.

According to Sabirin (2014), representation is a form of interpretation of students' thinking about a problem which is used as a tool in finding a solution to the problem. The form of representation that emerges from each student is certainly different. Representations can be in the form of words, writing, pictures, tables, graphs, mathematical symbols, and so on according to the student's abilities. (Handayani, 2015) Mathematical representation ability is one of the abilities related to mathematical understanding ability. Representation is the main focus in constructing students' knowledge and understanding in understanding a mathematical concept. Conforming to mathematical representation is very important because it can help students organize their thinking when solving problems or questions. The importance of mathematical representation is also in accordance with the National Council of Teachers of Mathematics (NCTM, 2005: 280) which states that representation is central to learning mathematics.

Students can develop and deepen their understanding of mathematical concepts and the relationships they make, compare, and use varied representations. Mathematical representation is also one of the cognitive abilities that influences students' mathematics learning outcomes. This is in accordance with the research results of Kanisius, et al (2013) which show that mathematical representation abilities contribute significantly by 9.42% to mathematics learning achievement both directly and indirectly. In other words, achievement or learning outcomes in mathematics are determined by mathematical representation abilities. Apart from that, mathematical representation abilities are also closely related to students' ability to solve problems. With high representation skills, students will more easily find solutions to problems to solve exam questions.

According to (Jarnawi & Juandi, 2011) Representation does not actually show the results or products that are realized in new and different configurations or constructs, but the thinking process carried out to reveal and understand the concepts, operations and mathematical relationships of a configuration. This means that the mathematical representation process takes place in two stages, namely internally and externally. Based on this description, the general aim of the research is to describe the ability of mathematical representation. So it can be concluded that representation is

the way students configure or interpret mathematical ideas that are arranged in their minds regarding a problem which they express in physical form (visible) such as writing, pictures, mathematical equations, and so on which are used as auxiliary instruments in finding answers to the problems they face. Forms of mathematical representation according to Villegas, et al (2009), include:

1. Verbal representations are like story questions that are expressed, either orally or in writing.
2. Image representation such as diagrams, pictures, graphs, and so on.
3. Symbolic representations such as operations, relation signs, algebraic symbols, numbers, and the like. The relationship of the three indicators above is shown in the chart below:

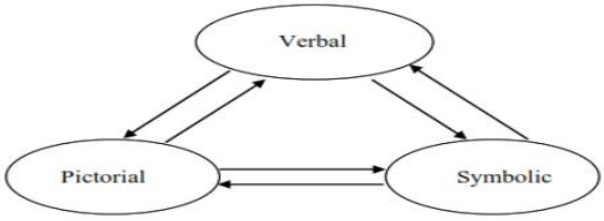

Figure 1. Relationship Chart of Mathematical Representation Indicators according to Villegas

NO	Representation Indicators	Operational Form
1.	Visuals (Images, graphs, diagrams, tables, etc.)	Representation of information or data from certain representations into the form of visual representations such as tables, diagrams, pictures, or graphs, etc.
2.	Mathematical expression or equation	Problem solving involves mathematical expressions or equations.
3.	Written words or text	Write down the steps for solving mathematical problems in words.

Table 1 Indicators of mathematical representation

Based on the results of observations with teachers at SMP 5 Soromandi, the learning outcomes of class VIII students in the even semester of the 2024/2025 academic year are still low, because there are still many students who experience difficulties in drawing triangle shapes based on the problems given, as well as difficulties in the solving process, students are still confused. must use which model of the Pythagorean Theorem equation is appropriate to solve the problem they are working on. This was obtained from daily test results data for class VIII students where only 33.5% of students reached the KKM, with the KKM score for mathematics subjects being 67.5. As can be seen in Table 2 below:

No	Mark	Amount	%	Criteria
1	$68 \leq x \leq 100$	10	33,5%	Complete
2	$0 \leq x < 68$	18	67,5%	Not finished

Table 2. Data on Daily Test Results for Class VIII Students

Based on several things mentioned above, it is known that mathematical representation skills have an important contribution to mathematics learning, especially in improving mathematical literacy skills, which is the government's current priority in education. Because of this, an understanding of mathematical representation must still be present in every mathematics lesson at school. However, in reality the use of mathematical representations in learning at school is still considered insufficient. The use of representations in learning is only used as a complement in delivering lesson material. This is in line with (Fitrianingrum & Basir, 2020) who conducted interviews with teachers who said that teachers did not pay too much attention to mathematical representation; In particular, the form of representation that is usually used is visual representation and is given as a complement to the delivery of material. This is in line with students' daily test data where only33,5%which falls within the criteria for completion. In line with these data, the results of interviews with atheatics teachers stated thatthat when working on problems, students are more likely to solve them by following the teacher's solution steps. Students do not try to solve it with their own understanding based on the concepts of the material that has been taught. As a result, when given a problem that is different from the previous problem, students are confused and find it difficult to solve it. Students still don't seem to understand how to solve the problem, don't understand how to start solving the problem. in interpreting the instructions in the problems given so that they are unable to solve the problems correctly. Based on this explanation, thenThis research isThe aim is to export and describe capabilitiesmathematical representation of students based on level of mathematical ability.

1. Research method

2.1.Types and Research Approaches

The type of research used is descriptive research. Meanwhile, the approach used in this research is a qualitative approach.

2.2.Place and time of research

The research was conducted at SMPN 5 Soromandi in May 2024

2.3.Research subject

The research subjects were class VIII students at SMPN 5 Soromandi, totaling 25 students, 13 male students and 12 female students for the 2023/2024 academic year.

2.4.Data Collection Techniques

The data collection technique in this research is tests. then analyzed in depth to explain students' mathematical representation abilities. Research subject. Meanwhile, the object studied is mathematical representation ability. The data in this research is data collected directly by researchers, namely in the form of students' work on mathematical representation ability test sheets. Meanwhile, the data source in this research is studentsclass VIII SMPN 5 Soromandi.

2. Research Results and Discussion

The first step taken by the researcher was selecting subjects by conducting an initial written test on all class VIII students so that the researcher could find out the students' level of ability and choose 3 categories of high, medium and low mathematical ability using Pyhagoras material. abilities in this initial test are based on grouping criteria according to (Purnama, Kurmaryono, & Basir, 2019). Second step: After categorizing or grouping students based on their level of mathematical ability, then in the third step, 2 students are selected to represent each group. The selection of these 2 students was based on students who had the highest, medium and low scores in their ability categories. Then the researcher submitted the 2 selected students to the mathematics teacher to select again 1 student each representing each category of high, medium and low. These three students were used as the final subjects of the research and were given a mathematical representation ability test on Pythagorean material. Based on the results of this final test, students' abilities can be seen in each indicator of mathematical representation.

The research results are presented by coding to simplify the data analysis process. The coding of subjects in this research is based on the level of students' mathematical abilities, namely subjects with high mathematical abilities are coded KMT, subjects with moderate mathematical abilities are coded KMS and subjects with low mathematical abilities are coded KMR.

3.1.Analysis of Mathematical Representation Ability of KMT Subjects On Question Number One

Judging from the results of the high ability subjects' answers to question number one, the KMT subjects were able to draw a right-angled triangle as a form of restating information by drawing a triangle and writing the base and hypotenuse on the drawing correctly. Next, KMT subjects can write the formula to find the area of a triangle correctly. Because the height of the triangle is not yet known, the KMT subject first finds the height of the triangle using the Pythagorean formula. The final step of the KMT subject is to find the area of the triangle and find the right answer. It was concluded that the KMT subject met the visual indicators because he could re-present information or data from certain representations in the form of a visual representation in the form of a triangle image and could write down the solution steps in finding the area of the triangle correctly. $l\,\frac{a\times t}{2}$

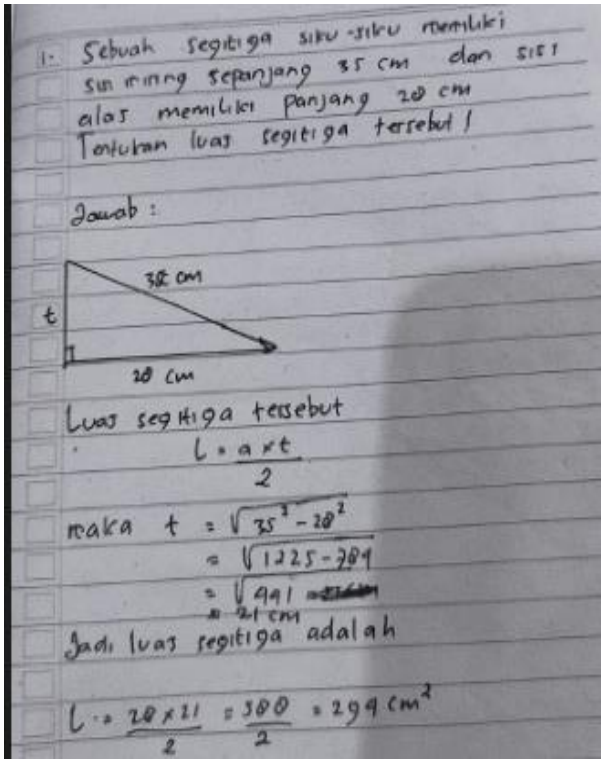

Figure 2 is the result of students' answers in the high category

3.2.Analysis of Mathematical Representation Ability of KMT SubjectsOn Question Number Two

Judging from the results of the high ability subjects' answers to question number two, the KMT subjects were able to arrange the solution steps systematically. Where the KMT subject wrote down the initial steps for solving by finding the length using the Pythagorean formula, then after being able to determine the length. KMT subjects can find the length where the length is the hypotenuse of the triangle. It was concluded that the KMT subject met the indicators of mathematical expressions or equations because it could solve problems.$ACAC^2 = AB^2 + BC^2ACADADACD$

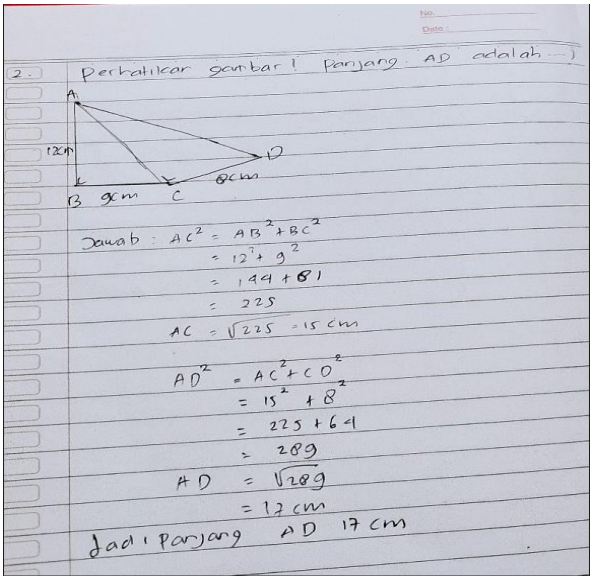

Figure 3 is the result of students' answers in the high category

3.3.Analysis of Mathematical Representation Ability of KMT SubjectsOn Question Number Three

Judging from the results of the high ability subjects' answers to question number three, the KMT subjects were able to make the solution steps correctly and systematically and could explain on the answer sheet that the solution steps used the Pythagorean theorem.$\sqrt{100^2 + 75^2} = \sqrt{10.000 + 5.625} = \sqrt{15.625} = 125km.$ Furthermore, after determining the shortest distance, the KMT subject can explain the shortest distance of the ship using words and completely write down the picture of the question. It was concluded that the KMT subject met the third indicatorwrite down the steps for solving mathematical problems in words.

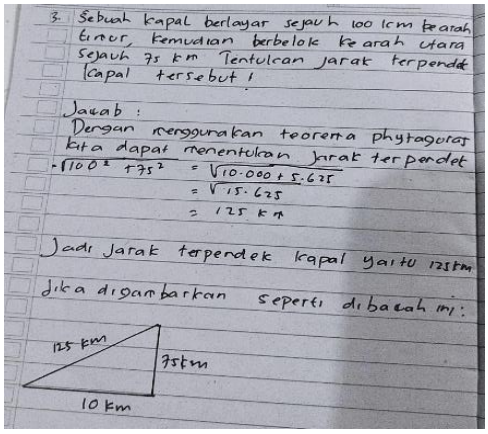

Figure 4 is the result of students' answers in the high category

It was concluded from the three KMT subject answers that the subject could fulfill the three indicators of mathematical representation, namely, restating information or data from certain representations in the form of visual representations. Mathematical expressions or equations and writing down steps to solve mathematical problems in words. This is in line with research (Rosnani, 2023) that students with high mathematical abilities can solve problems by fulfilling all (three) mathematical representation indicators, namely visual representation indicators, representation indicators. *Expressionor* mathematical equations, and indicators of the representation of words or written text. Even though in the representation of mathematical expressions or equations during interviews, it was discovered that high ability students still did not really understand the use of roots and square roots.

3.4. Analysis of the Mathematical Representation Ability of KMS Subjects on Question Number One

Judging from the results of the moderately capable subjects' answers to question number one, the KMS subjects were able to write the base and slanted sides of the picture correctly. Next, the KMS subject can write the formula in *look for* exact area of the triangle. KMS subjects also find the height of the triangle first using the Pythagorean formula in order to determine the area of the triangle. The final step for the KMS subject is to find the area of the triangle after knowing the height of the triangle and finding the right answer. It was concluded that the KMS subject meets the visual indicators because it can re-present information or data from certain representations in the form of visual representations in the form of triangle images and can write down the solution steps in finding the area of a triangle correctly. $l\frac{a\times t}{2}$

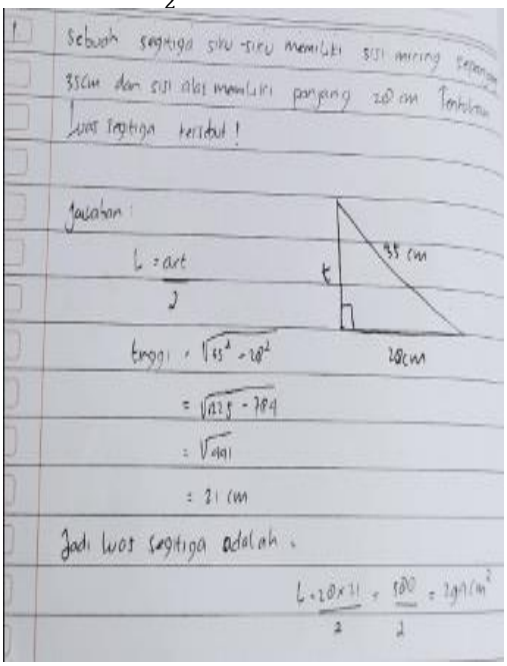

Figure 5 is the result of students' answers in the medium category

3.5. Analysis of the Mathematical Representation Ability of KMS Subjects in Question Number Two

Judging from the results of the answers of moderately capable subjects in question number two of the KMS subject *can* arrange solution steps systematically. The KMS subject wrote down the initial steps for solving by finding the length using the Pythagorean formula in order to determine the length. Next, after being able to determine the length. KMT subjects can find the length where the length is the hypotenuse of the triangle. It is concluded that the KMT subject meets the indicators of mathematical expressions or equations because it can solve problems involving

mathematical expressions or equations.$ACAC^2 = AB^2 + BC^2ADACADADACD$

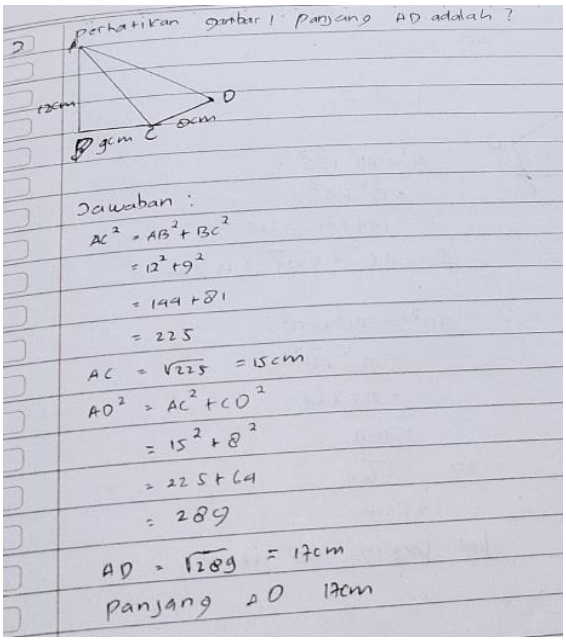

Figure 6 is the result of students' answers in the medium category

3.6. Analysis of the Mathematical Representation Ability of KMS Subjects in Question Number Three

Judging from the results of the answers of the moderately capable subjects in question number three, the KMS subjects were able to solve the questions correctly*However*KMS subjects cannot write down the solution steps and make conclusions from the answers using words. It was concluded that the KMS subject did not meet the third indicator, namely writing the steps to solve mathematical problems in words.

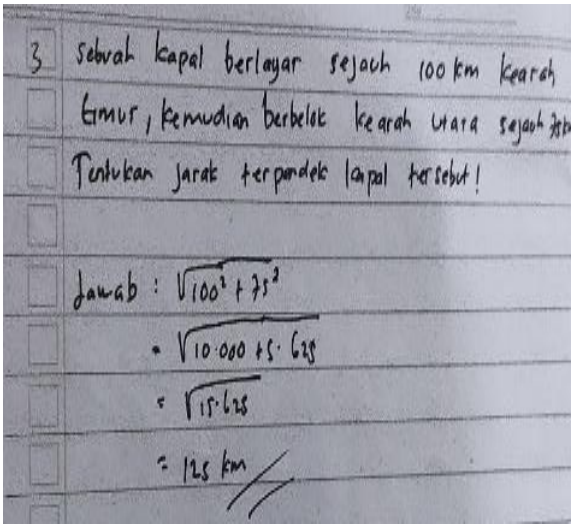

Figure 7 is the result of students' answers in the medium category

It was concluded from the three KMS subject answers that the subject could only fulfill the two indicators of mathematical representation, namely, restatement of information or data from certain representations in the form of visual representations and mathematical expressions or equations. Meanwhile, in the indicator of writing steps to solve mathematical problems in words, students cannot write them in words even though*the answer*Correct.This is in line with the research resultsStudents with moderate category representation abilities can solve indicator questions on visual representation, symbolic representation and verbal representation, but there are several errors (Hardianti, 2021).

3.7. Analysis of the Mathematical Representation Ability of KMR Subjects on Question Number One

Judging from the results of the low ability subjects' answers to question number two, the KMR subjects were unable to formulate solution steps*with*appropriate. Where the KMR subject cannot present questions in the form of pictures. Furthermore, the KMR subject could not write the formula to find the area of a right triangle. The KMR subject only multiplies the hypotenuse by the base to determine the area of a right triangle 28×35It was concluded that the KMR subject could not fulfill the first

indicator. Representation of information or data from certain representations into the form of image representations.

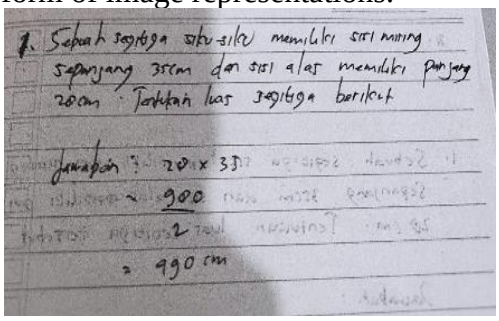

Figure 8 is the result of students' answers in the low category

3.8. Analysis of the Mathematical Representation Ability of KMR Subjects in Question Number Two

Judging from the results of the low ability subjects' answers to question number two, the KMR subjects were able to arrange the solution steps systematically. Where the KMT subject wrote down the initial steps for solving by finding the length using the Pythagorean formula, then after being able to determine the length. KMT subjects can find the length where the length is the hypotenuse of the triangle. It was concluded that the KMT subject met the indicators for mathematical expressions or equations because it could solve problems involving mathematical expressions or equations.$ACAC^2 = AB^2 + BC^2ACADADACD$

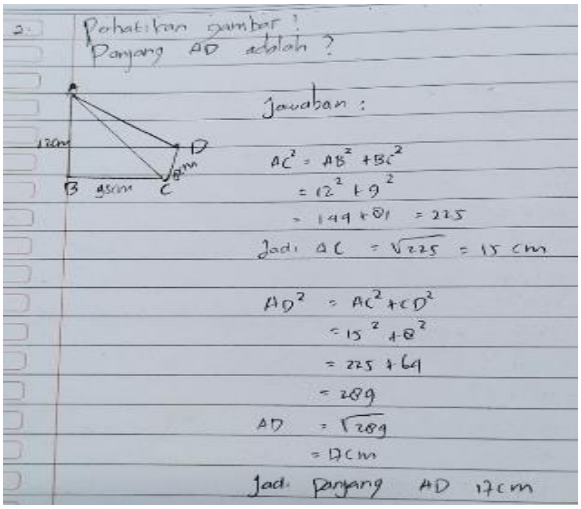

Figure 9 is the result of students' answers in the low category

3.9. Analysis of the Mathematical Representation Ability of KMR Subjects in Question Number Three

Judging from the results of the low ability subjects' answers to question number three, the KMR subjects did not organize their answers correctly and could not write down the solution steps in words. The KMR subject simply adds up the questions like this$\sqrt{100^2 + 75^2} = 10.0000 + 5.625 = 15.625$.It was concluded that*subject*KMR does not meet the third indicator, namely writing down the steps to solve mathematical problems in words.

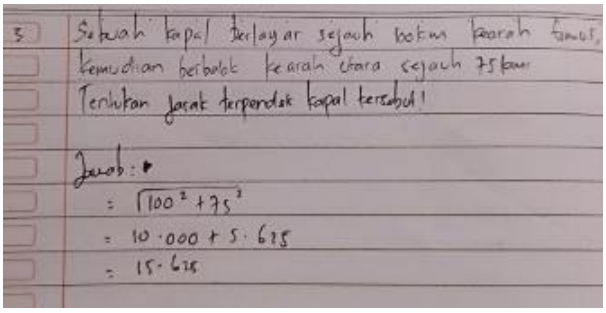

Figure 9 is the result of students' answers in the low category

It was concluded that the KMR subject could only fulfill one indicator. KMR subjects can only*fulfil*one indicator. In the first indicator, the subject cannot present information or data from certain representations back into it*form*visual representation. Meanwhile, in the second indicator, the KMR subject can fulfill the indicators for solving problems involving mathematical expressions or equations. In the third indicator, KMR is also unable to complete and write down the steps for solving mathematical problems in words. This is in line with research results (Wijaya, 2018) that mathematical representation skills are very important and needed by students in understanding the material given and solving problems. If mathematical representation skills are lacking, it causes a lack of student understanding of the material provided so that students have difficulty understanding and working. questions provided.

CONCLUSION

The analysis results show thatthat high-ability subjects can fulfill the three indicators of mathematical representation, namely, restating information or data from certain representations in the form of visual representations. Mathematical expressions or equations and writing down the steps to solve mathematical problems in words. Subjects with moderate abilities can only fulfill the two indicators of mathematical representation, namely, restatement of information or data from certain representations in the form of visual representations and mathematical expressions or equations. Meanwhile, in the indicator of writing steps to solve mathematical problems in words, students cannot write them in words even though the answer is correct. Low ability subjects can only meet one indicator. In the first indicator, the subject cannot re-present information or data from certain representations in the form of visual representations. Meanwhile, in the second indicator, subjects with low abilities can fulfill the indicators for solving problems involving mathematical expressions or equations. In the third indicator, subjects with low ability are also unable to complete and write down the steps for solving mathematical problems in words. Thus, mathematical representation skills are very important and needed by students in understanding the material provided and solving problems. If mathematical representation skills are lacking, it causes a lack of student understanding in the material provided so that students feel difficulty in understanding and working on the questions provided.

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