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ANALYSIS OF STUDENTS' MATHEMATICAL CONCEPT REPRESENTATION ABILITY IN SOLVING SPACE BUILDING QUESTIONS

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Abstract. This study aims to describe the ability to represent the mathematical concept of students in solving spatial building problems. The type of research used is qualitative descriptive. Data is collected using tests, interviews, and documentation. Tests and interviews are conducted to learn more about the ability to represent the mathematical concept of students in solving the problem of building a room. The subjects in this study were two people, obtained from 30 students through a test of subject networking. The results of the data analysis showed that the ability to represent mathematical concepts of students arises when presented mathematical problems, namely visual ability, symbolic ability, and verbal ability. Visual capabilities in the form of images are to create geometric building images to explain problems and facilitate their resolution; symbolic ability in the form of mathematical equations or expressions by creating mathematical equations or models of the given representation and problem solving by involving mathematical expressions; verbal ability in the form of written words or text that is to write the interpretation of a representation appropriately and write down the steps of solving mathematical problems.

Keywords: Representation Ability, Mathematical Concept, Space Building Problem

Abstrak. Tujuan dari penelitian ini untuk mendeskripsikan kemampuan representasi konsep matematis siswa dalam menyelesaikan soal-soal bangun ruang. Jenis penelitian yang digunakan adalah deskriptif kualitatif. Data dikumulkan menggunakan tes, wawancara, dan dokumentasi. Tes dan wawancara dilakukan untuk mengetahui lebih dalam tentang kemampuan representasi konsep matematis siswa dalam menyelesaikan soal bangun ruang. Subjek dalam penelitian ini adalah dua orang, diperoleh dari 30 orang siswa melalui tes penjaringan subjek. Hasil analisis data menunjukkan bahwa kemampuan representasi konsep matematis siswa muncul ketika disajikan masalah matematis yaitu kemampuan visual, kemampuan simbolik dan kemampuan verbal. Kemampuan visual berupa gambar yaitu dengan membuat gambar bangun geometri untuk menjelaskan masalah dan memfasilitasi penyelesaianya; kemampuan simbolik berupa persamaan atau ekspresi matematika yaitu dengan membuat persamaan atau model matematis dari representasi yang diberikan dan penyelesaian masalah dengan melibatkan ekspresi matematis; kemampuan verbal berupa kata-kata atau teks tertulis yaitu dengan menuliskan interpretasi dari suatu representasi secara tepat dan menuliskan langkah-langkah penyelesaian masalah matematika.

Kata Kunci: Kemampuan Representasi, Konsep Matematis, Soal Bangun Ruang

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INTRODUCTION

The reality in the field of mathematics learning still tends to focus on textbooks and use conventional learning methods such as presenting learning materials, giving examples of questions, and having students work on the practice questions contained in the textbooks they use in teaching and then discussing them with students. Effendi's findings (2012) show that most students seem to follow every explanation or information from the teacher well. Students very rarely ask questions to the teacher, so the teacher is engrossed in explaining what he has prepared.

The National Council of Teachers of Mathematics (NCTM) states that mathematics learning in schools from primary education to grade XII requires a standard of learning that produces students who have thinking skills (Kamsurya, 2019), mathematical reasoning skills, have useful basic knowledge and skills. These learning standards include content standards and process standards. Content standard is a standard of mathematics learning that contains material concepts that students must study: numbers and their operations, algebra, geometry, measurement, data analysis, and opportunities. While process standards are the skills students must have to achieve content standards (Effendi, 2012), one of the process standards is representation.

Representation, in general, is a form of student thinking interpretation of a problem, which is used as a tool to find solutions to the problem, especially in mathematics learning. The best step of learning mathematics by making representations, because the initial step of learning the concept, understanding will be more inherent when activities that show the representation (model) of the concept is done by the students themselves (Bruner in Simanjuntak, 2012)

Concept representation is a very important competency for students. The representation of concepts is closely related to the understanding of concepts and mathematical thinking. The ability to represent concepts demonstrates students' capacity to understand concepts and solve mathematical problems. In the process of problem solving, representation is a means of thinking (tools of thinking). Solso states that thinking is the process of generating new mental representations through the transformation of information involving complex interactions between mental attributes such as judgment, abstraction, reasoning, imagination and understanding of problems (Mustangin, 2015). Each student has a different way of building his or her knowledge. In this case, it is possible for students to try various representations in understanding a concept. With representation, students can provide information about their opinions on a context or mathematical idea. Therefore, representation skills are needed by

students to support students' understanding in the learning process and in solving math problems.

The results of the initial observations in grade VIII of SMP Negeri 14 Ambon showed that students' understanding of the concept is still lacking. Shiva has not been able to describe the materials taught. Based on the results of interviews with math teachers, it is known that there are some problems. Namely, students have difficulty solving problems in the form of pictures, which is because students are less able to understand the picture correctly. Hence, the steps in solving it are also not appropriate. The verbal ability of the student is also lacking. The student still tends to follow according to the steps taught by the teacher so that if given the same problem but in a different context, the student is not able to solve it. As a result, if the analysis of the ability to represent the student's mathematical concept, the cause of the problem will not be known.

Aryanti et al., (2013) showed that the mathematical representation of highly capable, moderate, and low-skilled students is symbolic. Furthermore, Apriani (2016) research results found that students' mathematical representations in solving problems are visual representations, arithmetic, algebra, and written text. There are factors students use in determining the mathematical representation used. The difference of research that will be conducted with previous research is that this study does not use grouping the level of ability of students and also this study to know the ability of mathematical representation, namely visual representation in the form of images, symbolic equations or mathematical expressions, and verbal in the form of words or written text.

METHOD

The type of research used is qualitative descriptive, namely data in the form of words, images, and not numbers (Moleong, 2014) to obtain data and describe the ability to represent mathematical concepts in the form of visual, symbolic, and verbal abilities in solving the problem of building space. The subjects in this study were two people, obtained through a test of the networking of subjects from 30 students in grade $VIII_{15}$ of SMP Negeri 14 Ambon. The results of the subject networking test for all students were obtained by four students who met the indicators of mathematical concept representation, then from the results of the mathematical representation ability test and interviews on two students.

The main instruments in this study are the researchers themselves, test questions, and interview guidelines. The test used is a description test conducted with two stages, namely the first stage for the networking of research subjects and the second stage to know the ability to

represent the mathematical concept of students in solving the problem of building space. Interviews in this study were conducted unstructured. The data analysis techniques used in this study are qualitative data analysis, following the concept developed by Miles and Huberman, namely data reduction, data presentation, conclusion drawing, and testing the validity of findings (Sugiyono, 2014).

RESULTS

Solving the math concept representation test and the subject's interview resulted in two different answer patterns. Here are the results of the analysis of S-1 and S-2 in solving the problem of building space.

Analysis of S-1 Mathematical Representation Capability in Solving Space Building Problems

Visual Capabilities

The results of the written test S-1 meet the initiator of visual representation in figure 1 below.

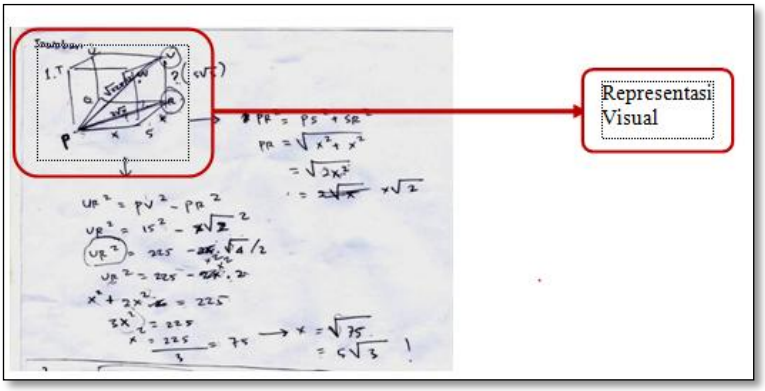
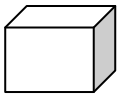
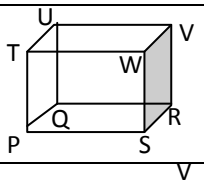
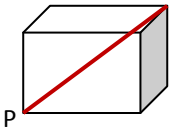
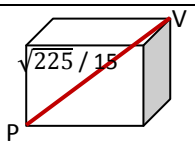
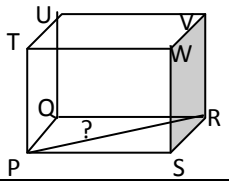


Figure 1. S-1 written test results using a visual representation

Based on thinking aloud, S-1 can meet the image build geometry indicators to explain the problem. Here are the results of the S-1 think-aloud on the subject's work.

Table 1. S-1 think-aloud results that meet visual representation indicators

Think Alouds	Writing
It's a cube.	
$PQRS, TUVW$ base	

Known diagonal space, meaning this is P, P to V	
The root of 225 or 15 cm	
Asked the length of the cube ribs means PR. This is a question mark.	

The results of S-1 think clouds are corroborated by the S-1 statement during the interview, as contained in the following excerpt.

R : What comes to mind when you read a question?
S-1 : What comes to mind when reading the question is that inside the cube, there must be a triangle, and because it is known diagonal space or side tilt, must find the base first to get the height
R : When it comes to not being told to draw cubes, why is it that you're finishing using drawings?
S-1 : To make it easier to work on the problem, use the image later difficult. Because in the case of the diagonal known space and diagonal space, it forms a triangle in the cube, so if not draw the cube first, it won't be easy to find the base and height of the triangle.

Symbolic Capabilities

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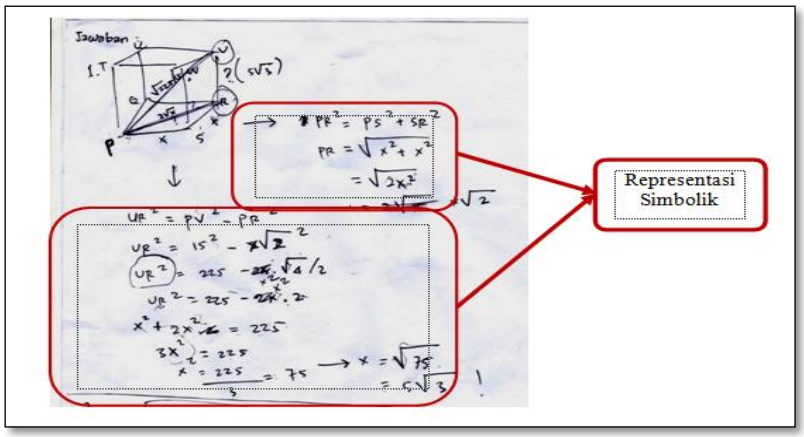


Figure 2. S-1 written results using symbolic representations

Based on the results of the S-1, I think clouds can meet the indicators make equations or mathematical models of the representation given to the question appropriately. Here are the results of think-aloud S-1 in solving the problem.

Table 2. S-1 think-aloud results that meet symbolic representation indicators

Think Alouds	Writing
PR rank 2 equals PS rank two or PR equals the root of x rank two patch x rank two, or root of two x rank two or two root x	$\rightarrow PR2 = PS2 + SR2$ $PR = \sqrt{x^2 + x^2}$ $= \sqrt{2x^2}$ $= 2\sqrt{x}$
Since these are two roots x, meaning that is asked this	Write $2\sqrt{x}$ on a triangular base on a cube and write a mark ? on RV ribs
UR rank two equals PV rank two in less PR rank two. UR rank two, PV 15 rank two less two root x rank 2	$UR2 = PV2 - PR2$ $UR2 = 152 - 2\sqrt{x^2}$
UR rank two equals two hundred and twenty-five in less two ranks of two	$UR2 = 225 -$
This means these two x multiplied root 4 or 2	$2x.\sqrt{4} / 2$
Means two hundred and twenty-five less two x multiplied by two	$UR2 = 225 - 2x.2$
Means x is less than 2 x.2 less equal to two hundred and twenty-five	$x^2 - 2x^2 = 225$
Three...	$3x^2 = 225$ $x^2 = \frac{225}{3} = 75 \rightarrow$ $x = \sqrt{75} = 5\sqrt{3}$

The results of the S-1 think the S-1 statement reinforces clouds above during the interview contained in the following excerpt.

R : Why not explain the solution?

S-1 : The question is already known as diagonal space $\sqrt{225}$. It's 15 cm, meaning the oblique side of this PV is 15. So, $PR^2 = PS^2 + SR^2$

Verbal Ability

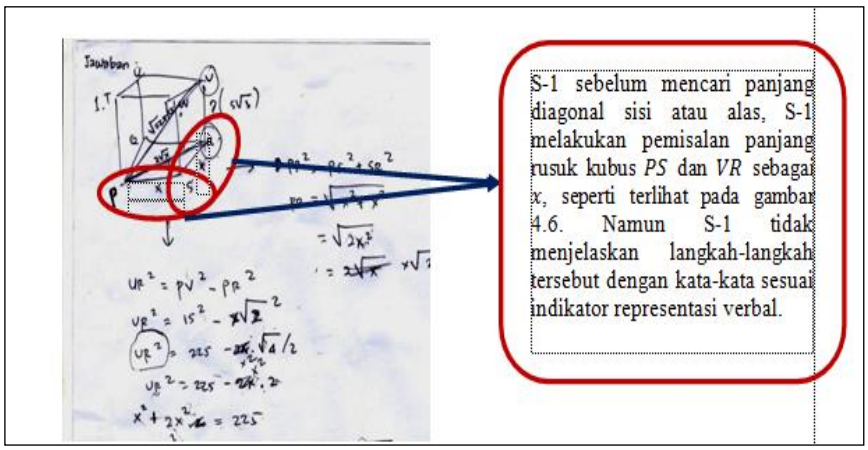
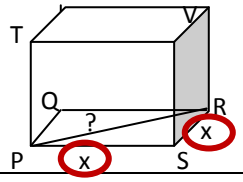


Figure 3. S-1 written test results do not use verbal representation

Based on the results of the S-1 think clouds have not been able to meet the indicators, write down the interpretation of a representation on the question. Here are the results of the S-1 think-aloud in solving the problem of building space.

Table 3. S-1 think-aloud results on the question have not met the indicators of verbal representation

Think Alouds	Writing
But if this ribs PS we suppose with x dan SR also we suppose with x.	

The S-1 statements reinforce the results of the S-1's recent verbal representations in the interviews listed in the following excerpts.

R : Try explaining the solution to the problem you're doing?
S-1 : Must find PR to get a base and be high if this PR and SR regretted x and PS are also regretted x.
R : Why not explain in the words that before searching the base's diagonal side, we make the example ribs PS, SR, and UR as x so that the solution is clearer.
S-1 : If explained in words too complicated, the question of not telling us that the important thing can be the result.

Analysis of S-2 Mathematical Representation Capabilities in Solving Problems

Visual Capabilities

Written test results containing visual representation indicators on the question, S-2 found no interpretation that met. The test results are written S-2 in Figure 4 below.

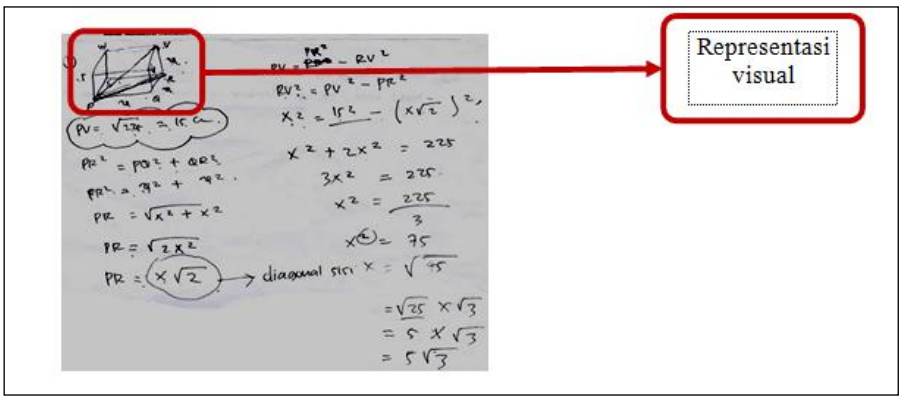
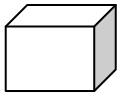
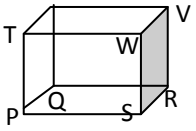
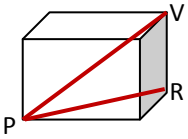
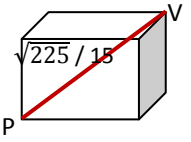


Figure 4. S-2 written results on the question using a visual representation

Based on the think-aloud S-2, it can meet the indicators to make geometric build images explain the problem and facilitate its resolution. Here are the results of think-aloud S-2 in solving the problem of building space.

Table 4. S-2 think-aloud results on the question meet visual representation indicators

Think Alouds	Writing
We draw the cube first.	
The one here is T, here U, here V, and this is W. Here P,Q,R,S.	
Where PV is the diagonal of the space and the PR is the diagonal of the side.	
We have got $PV, PV = \sqrt{225}$, $\sqrt{225}$ is equal to 15 cm if 15 multiplied by 2 times produces 225	

The results of the S-2 think the S-2 statement reinforces clouds above in the interview contained in the following excerpt.

R : What comes to mind when you read a question?

S-2 : What came to my mind anyway? The first one was the cube, I imagined the cube first, and then I imagined a right triangle.

Symbolic Capabilities

S-2 written test results that meet the indicators of symbolic representation in the following questions.

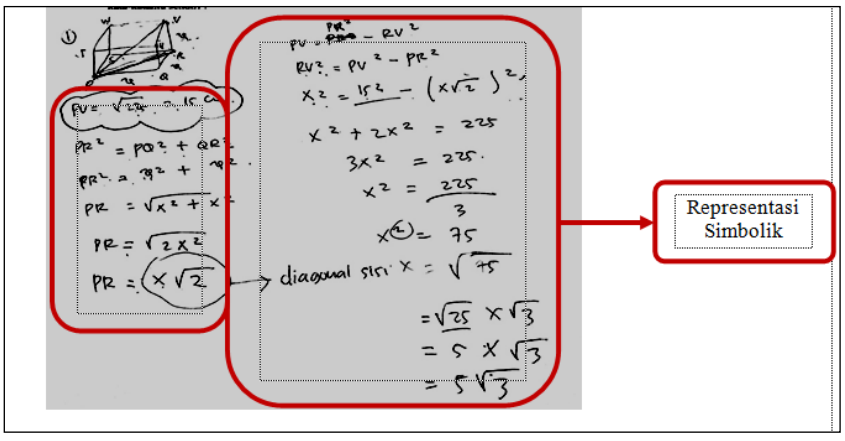


Figure 5. S-2 written test results on the question using symbolic representations

Based on the results of the S-2, I think clouds can meet the indicators make equations or mathematical models of the representation given to the question appropriately. Here are the results of the S-2 think-aloud in solving the problem of building space.

Table 5. S-2 think-aloud results on the question meet symbolic representation indicators

Think Alouds	Writing
PR^2 because we want to find the base when we have got the hypotenuse. So $PR^2 = PQ^2 + QR^2$	PR^2 $PR^2 = PQ^2 + QR^2$
$PR^2 = x^2$ because the PQ we already regret with x. And QR also think it has been rumored with x then x^2	$PR^2 = x^2 + x^2$
PR, PR itself means root $x^2 + x^2$	$PR = \sqrt{x^2 + x^2}$
PR equals root $2x^2$	$PR = \sqrt{2x^2}$
PR his we can $x\sqrt{2}$	$PR = x\sqrt{2}$
It's the diagonal of the sides	→ Diagonal side

The results of the S-2 think the S-2 statement reinforces aloud for the above during the interview contained in the following excerpt.

R : Try explaining how you use the Pythagoras theorem to find the diagonal length of the sides or bases?

S-2 : We want to find the base when we have the hypotenuse and $PR^2 = PQ^2 + QR^2$, $PR^2 = x^2$ because PQ we already regret with x and QR also think it has been regretted with x then $PR = \sqrt{2}$.

Verbal Ability

Written test results contained verbal representation indicators on the question, S-2 of the settlement results, and no interpretations met the verbal representation indicators. The results of the S-2 written test are in the following figure.

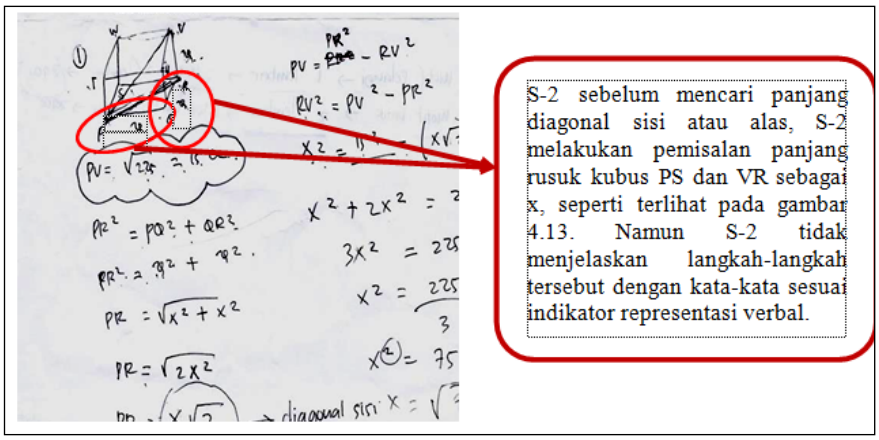
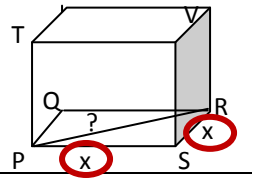


Figure 6. S-2 written test results on the question of not using verbal representation

Based on the results of the S-2, think-aloud has not been able to meet the indicators writing down the interpretation of a representation on the question. Here are the results of the S-2 think-aloud in solving the problem of building space.

Table 6. S-2 think-aloud results on the question have not met the indicators of verbal representation

Think Alouds	Writing
When the PV is already able, we will regret this PQ or PQ ribs as x, this QR is also x, and this VR is also x	

The results of the S-2's unfulfilled verbal representation indicators are reinforced by the S-2 statement during the interview, as contained in the following excerpt.

R *: When you're assuming $PQ, QR,$ and VR ribs as x, why don't you write them down with words, but you only give symbols to the cube image?*

S-2 *: That's my easy way. If written in words must take a lot of time. If there is easier, why should it be difficult.*

Researchers observed that S-2 has been very good at solving problems based on the test results and interviews above. Like S-1, there is one indicator that has not been achieved by S-2, which is the indicator of making geometric wake-up images to clarify the problem and facilitate its resolution. Thus, the S-2 has met the indicators of mathematical concept representation capability.

DISCUSSION

Mathematical representation capability is an essential ability to solve mathematical problems (Saputri & Kamsurya, 2020). Mathematical concept representation is a form of student thought interpretation of a problem, which is used as a tool to find a solution to the problem. The student's form of interpretation can be words or verbal, writings, drawings, concrete objects, mathematical symbols, etc. One of the math skills that students must master is the ability to represent mathematical concepts. The representations presented by students are expressions of mathematical ideas or ideas displayed by students to find solutions to the problems they are facing (Mustangin, 2015)**.** The best step of learning mathematics is by making representations. Because of the initial step of learning concepts, understanding will be more inherent when activities that show representation (model) of concepts are carried out by students themselves (Simanjuntak, 2012).

Based on the results of test analysis, think aloud, and S-1 and S-2 interviews, all indicators of mathematical representation are met, i.e., visual representations, equations or mathematical expressions, and verbal. Representation is everything that students make to modernize and

show their work (Kartini, 2009). Test results, think aloud, and interview results from S-1 and S-2 show that subjects in solving problems know the ability of mathematical representation to produce answers with diverse representations. To maintain the ability to explore models in a real-world context, one must use mathematically diverse representations or multiple representations (Kholiqowati et al., 2016). These diverse representations manifest the subject's solving strategy in solving the test of mathematical representation ability given.

The visual capabilities for the S-1 already meet the visual representation indicators of the problem. The S-1 has no difficulty drawing, even though there are no instructions for drawing. The S-1 feels the need to draw to facilitate easier problem-solving. One needs representations in images, graphs, diagrams, and other forms of representation to communicate something (Sabirin, 2014). Just like the S-1, the S-2 also meets the indicators of visual representation of the problem precisely. The commands on the question do the process of working on the problem. The verbal ability of the S-1 is the same as the S-2 seen from the workmanship of the problem. The subject can express the results of his thoughts in the form of words. However, do not write down the steps to resolve the question because it considers the deadline for working on the question.

CONCLUSION

Based on the research and discussion results, it was concluded that the ability to represent the mathematical concept of grade VIII students of SMP Negeri 14 Ambon includes visual ability, symbolic ability, and verbal ability. Visual capabilities in the form of images are to create geometric building images to explain problems and facilitate their resolution; symbolic ability in the form of mathematical equations or expressions by creating mathematical equations or models of the given representation and problem solving by involving mathematical expressions; verbal ability in the form of written words or texts by writing the interpretation of a representation appropriately and writing down the steps of solving mathematical problems with words.

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