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Analysis of Students' Mathematical Representation Ability on Cube and Cuboid Topics: A Case Study in A Junior High School

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ABSTRACT

This study aims to analyze the ability of mathematical representation on cube and cuboid topic in one of the junior high schools in Bandung. The research design used to achieve the objectives of this study is a case study design that is carried out to investigate students' mathematical representation skills. Data was collected from ten grade IX junior high school students through written tests in the form of descriptions and interviews. Based on the results of the data analysis described above, it can be concluded that the mathematical representation ability of grade IX students at one of the State Junior High Schools in Bandung still has many errors. This is because almost all students have not been able to solve the problems given. Two indicators used in this study, namely visual representation and representation of equations or mathematical expressions, there are still many students who solve mathematical problems that are not completed perfectly and some students are still not thorough and impetuous to find solutions to problems so that students are wrong in providing the final result.

Keywords: cube; cuboid; math; representation

INTRODUCTION

One branch of science that has a very important role in daily life and the development of science is mathematics. In this increasingly developing era, especially in education, mathematics is a tool used to solve a problem and not only that, logical and critical thinking skills can be developed through mathematics (Syafruddin & Pujiastuti, 2020). Mathematics is a very abstract science and difficult school material. One of the most important subjects to study from the elementary education level to the higher education level (Islamiati & Zulkarnaen, 2022). Therefore, mathematical concepts must be mastered at the primary and secondary education levels to prepare students for higher levels of education.

One of the mathematics materials that is often taught in the current independent curriculum is the concept of building space, especially on the topic of this research material, namely cubes and cuboids. Cube and cuboid material is a basic material, but the concept of cubes and cuboids is very important for students to learn and understand. In cube and cuboid material, many students have difficulty in representing the concept of cubes and cuboids. The difficulty experienced by students is that students are not able to understand the concept and describe cubes and cuboids through various forms of representation, namely images, mathematical models or symbols, and text (Rahmadian, 2019). In mathematics learning, it is very important to visualize problems so that they can help students find solutions through representation skills.

Mathematical representation skills are the ability where students can turn one idea into the form of another idea and can change terms – terms, concrete objects or symbols, images, and writing to find a solution to a problem. The ability of mathematical representation can be categorized into three aspects, namely visual representation, representation of equations or mathematical expressions, and verbal representation. Visual representations can be in the form of graphs, diagrams, or tables, while representations of equations or mathematical expressions can be in the form of formulas and mathematical elements, and verbal representations can be objects that can be held such as models of cubes and cuboids and can be words or written texts (Rohana et al., 2021).

Research that has been widely researched and published is research on analysing representation skills with other abilities and other topics, while representation skills with cube and cuboid topic are still rarely found, as evidenced by the results obtained from the VOSviewer application, researchers represent that there has been no specific research related to mathematical representation skills associated with cube and cuboid topic.

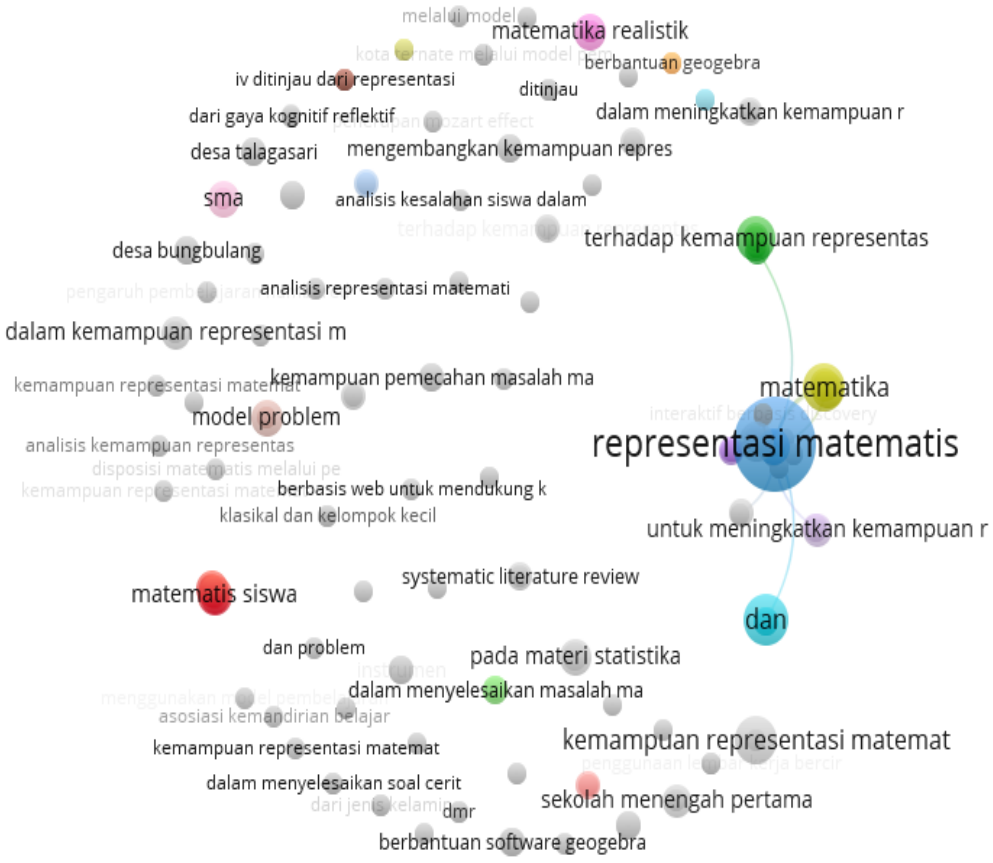

Figure 1. Visualization of Representation Skills

Representation skills are very important for every student to have because they are closely related to mathematics subjects such as cubes and cuboids. However, often students have difficulty in converting problems in cube and cuboid materials into other forms of ideas such as visual representations to representations of equations or mathematical expressions, so students are hampered in understanding the concepts in cube and cuboid materials (Athallah & Roesdiana, 2021). If students have difficulty changing one idea into

another, what will happen in the future is that students will not be able to solve more complex problems (Hwang et al., 2007).

This study aims to analyze in depth the ability of mathematical representation of cube and cuboid materials. By analyzing and identifying the way students can represent problems in cube and cuboid materials, they will get what factors affect their understanding and analyze and identify the difficulties they face in solving these problems. The results of this analysis can be useful to add insight for educators to design learning strategies that are more effective and meet student needs.

RESEARCH METHODS

The research method used in this study is qualitative with a research design using case studies. Research that presents data using a case study design, the results of the study have the potential to be of high quality. According to Mertler, qualitative research using case study design includes: collecting data, exploring, analyzing, and reviewing data so that the research that has been researched can provide accurate results and conclusions from the focus of the research. In this study, the subjects that became the focus were 34 grade IX students at one of the State Junior High Schools in Bandung in the 2024/2025 Academic Year. The research subject is selected through the purposive sampling technique, which is a sampling technique where the researcher deliberately selects participants based on certain criteria that are relevant to the research objectives. Class IX, which is the subject of this study, is the result of recommendations given by teachers who teach at the school because this class IX includes students with mathematical abilities that are evenly distributed from low to high. The instrument used in this research is in the form of three descriptive questions, each of which refers to an indicator of mathematical representation ability.

Data collection in this study uses a triangulation technique which aims to increase the depth of analysis results, validity, and accuracy in research results. The data triangulation technique according to Cresswell is a written test containing 3 descriptive questions related to cube and cuboid materials as well as interviews to confirm students' answers and analyze students' difficulties. In this study, written tests in the form of description questions and interviews were conducted based on mathematical representation indicators, namely according to Hwang:

1. Verbal representation – The ability to translate traits – properties and relationships observed in mathematical problems into verbal or vocal representations.
2. Visual representation – The ability to translate a mathematical problem into a representation of an image or graph.
3. Representation of equations or mathematical expressions – Ability to translate mathematical problems into representations of arithmetic formulas.

However, in this study, only 2 indicators were used, namely visual representation indicators and representation of equations or mathematical expressions.

RESULTS AND DISCUSSION

Analysis of Students' Visual Representation Ability

Students' visual representation skills can be known from question items 1 and 2 where students are required to think about visualizing if the size of cubes and cuboids increases so that they can draw visualizations of cubes and cuboids that have increased in size. Based on the results of the students' answers that have been given to the researcher, there are some students who are not able to visualize cubes and cuboids. Therefore, the researcher analyzed several answers from students who completed the visual representation indicator test questions in question number 1, namely:

Question number 1:
A cube has an unknown side length. If it is known that the volume of the cube is 125 cm^3, how long is the side of the cube? If the length of the side of the cube doubles, what is the surface area? Draw the difference in the size of the cube!

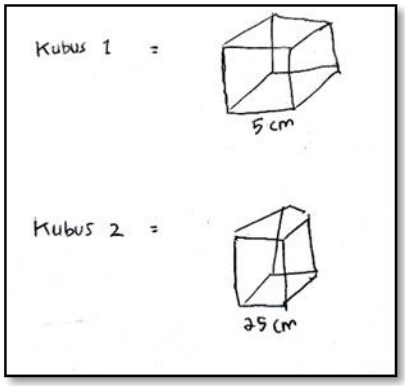

Figure 2. S–3 Answer Results

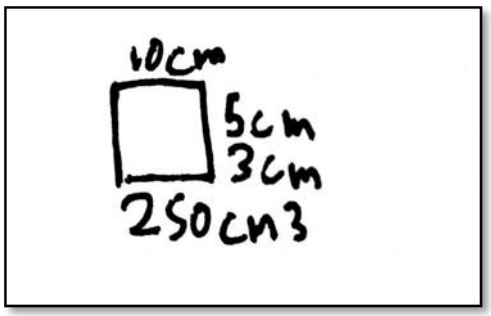

Figure 3. S–5 Answer Results

From Figure 2, it can be seen that students are able to draw a cube but are still wrong in interpreting the problem so that students draw a second cube with a side size of 25 cm while the one that should be 10 cm. The results of the researcher's interview with S – 3 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : What I understand from the problem is that there is a side of the cube that needs to be looked for from the volume of the cube and then the side is made twice to find the surface area
Researcher : Good understanding of the problem, it's good, but I want to ask you if you don't understand the side that is made double, right?
Student : Yes, ma'am, I think it's double the side at times with another 5 cm.

Meanwhile, from Figure 3, it can be seen that S-5 has not been able to draw the cube well. The results of the researcher's interview with S – 5 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I don't understand the question, ma'am.

Researcher : Why don't you understand? Has this material not been taught by the teacher before?
Student : I have been taught by teacher, but indeed I don't understand the lesson

In working on math problems in question numbers 1 and 2, at least students must have the ability of visual representation so that students can solve the problems requested from the problem. However, when the question was given, it turned out that the results of the students' answers showed that the students had difficulty working on the questions. In Bruner's learning theory, it is known that learners build their understanding of the world through images or visual representations so that the concepts conveyed become meaningful understanding and also this is in line with the opinion of (Amaliyah & Mahmud, 2018) who argues that students are unable to solve problems contained in problems due to a lack of understanding of the concepts of shapes and images.

Question number 2:
A cuboid is 10 cm long, 5 cm wide, and of unknown height. If the volume of the cuboid is 250 cm^3, how tall is the cuboid? If the width of the cuboid increases by 3 cm, what is the surface area? Draw the difference in the size of the cuboids!

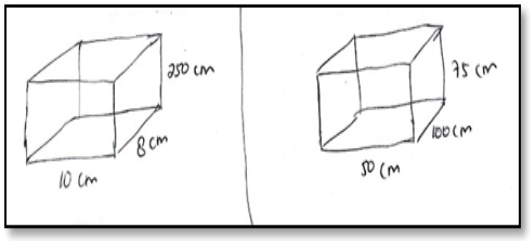

Figure 4. Answer Result S – 4

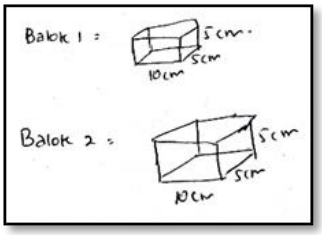

Figure 5. Answer Result S – 10

From Figure 4, it can be seen that S – 4 is able to draw cuboid but is still wrong in interpreting the problem so that students draw cuboid with the elements of length, width, and height that are wrong than they should be. The results of the researcher's interview with S – 10 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I understand that I have to find the height first, ma'am, but I don't know how to find the height and the one I think is 250 cm tall
Researcher : Well, so you don't understand the length, width, and height of a cuboid, right?
Student : Yes, ma'am.

Meanwhile, from Figure 5 it can be seen that S – 10 is able to draw the cuboid well but for the width of the second cuboid is not added to the width so that S – 10 draws the cuboid with the same size. The results of the researcher's interview with S – 10 regarding the results of the answers are:

Researcher : What do you understand from this question?

Student : I understand that what will be asked at the end when the height is obtained will be to look for the surface area

Researcher : That's right but why don't you increase the width as requested in the question?

Student : I didn't know that the width was asked to be added by 3 so I drew a cuboid size equal to cuboid 1 ma'am

In working on math problems in question items 1 and 2, at least students must have the ability to visually represent so that students can solve the problems requested from the questions. However, when the question was given, it turned out that the results of the students' answers showed that the students had difficulty working on the questions. In Bruner's learning theory, it is known that learners build their understanding of the world through images or visual representations so that the concepts conveyed become meaningful understanding and also this is in line with the opinion of (Amaliyah & Mahmud, 2018) who said that students are unable to solve the problems contained in the questions due to a lack of understanding of the concepts of shapes and images.

Analysis of Students' Ability to Represent Equations or Expressions

The ability to represent equations or expressions of students can be known in question items 1, 2, and 3 where students must be able to work on the problem by stating the formula for the volume and area of the cube and cuboid correctly and completely and then calculating the volume and surface area of the cube and cuboid requested in the problem. However, when the students had given the answer sheets to the researcher, the researcher analyzed that some students were not able to come up with the formula for the volume and surface area of the cubes and cuboid, so the calculation of the problems in questions 1, 2, and 3 was wrong. Therefore, the researcher analyzed several answers of students who completed the test of the representation indicator of the equation or expression of students in question items number 1, 2, and 3, namely:

Question number 1:
A cube has an unknown side length. If it is known that the volume of the cube is 125cm^3, how long is the side of the cube? If the length of the side of the cube doubles, what is the surface area? Draw the difference in the size of the cube!

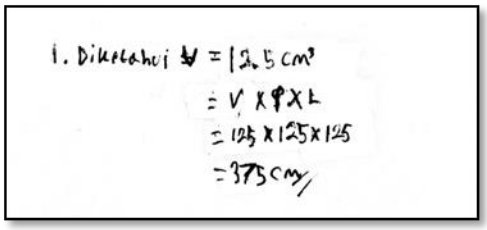

Figure 6. Answer Result S – 4

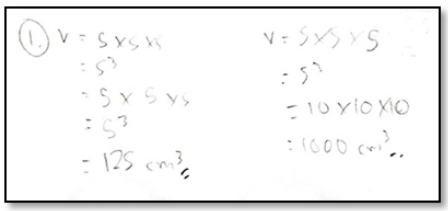

Figure 7. Answer Result S– 1

From Figure 6, S – 4 answers question number 1 using the wrong formula. Students have not been able to find the right mathematical equations or expressions to work on the problem. The solution to the problem is to find the side of the cube through the mathematical model of the volume of the cube and then after the side of the cube is found,

the second side of the cube is twice as large as the first cube so that the surface area can be found, which is 600 cm^2. Based on the answer S – 4, S – 4 still has not mastered the concept and ability to represent equations or mathematical expressions. The results of the researcher's interview with S – 4 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I understand that at the end the surface area of the cube will be asked
Researcher : The answer you just geve is correct but why is your answer on the paper like looking for the volume of the cube even though the volume of the cube is also wrong?
Student : Miss to be honest I don't know the formula of the cube volume and don't know how to use the formula ma'am.

In Bruner's learning theory, it is known that learners build their understanding of the world through the use of symbols, such as language and mathematical notation so that the concepts conveyed can become meaningfull understanding and also this is in line with the opinion of (Amaliyah AR & Mahmud, 2018) that to solve the problem of volume and surface area of cube and cuboid, you must understand the concept first so that when students are faced with problems that are more complicated than usual, students can use mathematical equations or expressions well.

Meanwhile, from Figure 7, S – 1 answers the problem that does not match the equation or mathematical expression that should be. S – 1 uses the volume formula to work on the problem in question number 1 so that the answer given is wrong which should use the surface area formula, which is $6 \times s^2$ the final answer, which is 600 cm^2. The results of the researcher's interview with S – 1 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I don't understand the formula for the surface area, I only know the formula for the volume of the cube, so I finished using the formula for the volume of the cube.

In Bruner's learning theory, it is known that learners build their understanding of the world through the use of symbols, such as language and mathematical notation so that the concepts conveyed can become meaningfull understanding and also this is in line with the opinion of (Sumalasia et al., 2020) that to solve the problem of volume and surface area of cubes and cuboids, you must understand the concept first so that when students are faced with problems that are more complicated than usual, students can use mathematical equations or expressions well.

Question number 2:
A cuboid is 10 cm long, 5 cm wide, and of unknown height. If the volume of the cuboid is 250 cm^3, how tall is the cuboid? If the width of the cuboid increases by 3 cm, what is the surface area? Draw the difference in the size of the cuboids!

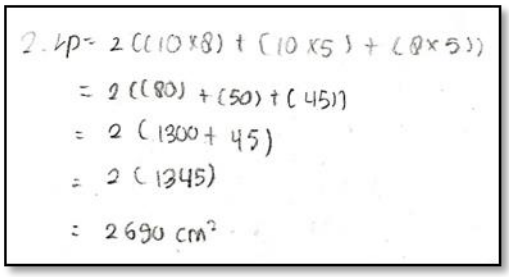

Figure 8. Answer Result S – 6

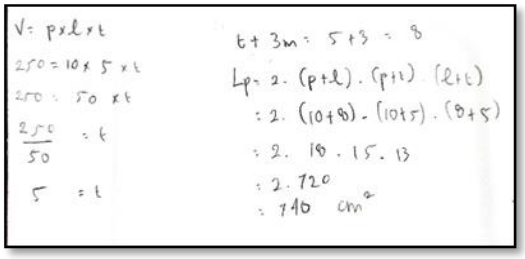

Figure 9. S – 2 Answer Result

From Figure 8, S – 6 has presented the equation or mathematical expression correctly according to the surface area formula but when solving the problem S – 6 is not thorough in working so that the result of the surface area of the cuboid is wrong as it should be 340 cm^2. The results of the researcher's interview with S – 6 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I understand that the problem asks us to find the height of the cuboid from the formula of the cuboid volume first, then after getting the width for the second cuboid plus 3 cm, find the surface area, ma'am.
Researcher : That's right, the understanding of the problem and the formula you have presented is correct and good, but why is the calculation of the surface area you are looking for was wrong?
Student : I wasn't careful to shift the numbers, and to be honest I'm still weak at multiplication, ma'am.

In Bruner's learning theory, it is known that learners build their understanding of the world through the use of symbols, such as language and mathematical notation so that the concepts conveyed can become meaningfull understanding and also this is in line with the opinion (Huda et al., 2019) that students are still often not thorough in solving the problems given so they are wrong in determining the final result of the existing problems. This is also in line with the (Handayani, 2019) argument that students are often in a hurry and wrong in calculating so the final results presented are also wrong.

While in Figure 9, S-2 almost presents the correct mathematical model but there is an error in the formula that has been presented, which is $LP = 2(p + l).(p + t).(l + t)$ what it should be, so that the final result obtained by S-2 is wrong as it should be LP = 2((p.l)+(p.t)+(l.t)) The results of the researcher's interview with S – 2 regarding the results of the answers are :

Researcher : What do you understand from this question?
Student : I understand that the problem asks us to find the height of the cuboid from the formula of the cuboid volume first, then after getting the width for the second cuboid plus 3 cm, then find the surface area, ma'am.

Researcher : That's right, the understanding of the problem is good, but why is the formula you gave wrong? Did you know that the formula is wrong?

Student : I don't know that the surface area formula I made is wrong because what I remember is the surface area formula as I answered

In Bruner's learning theory, it is known that learners build their understanding of the world through the use of symbols, such as language and mathematical notation so that the concepts conveyed can become meaningfull understanding and also this is in line with the opinion of (Amaliyah & Mahmud, 2018) that to solve the problem of volume and surface area of cubes and cuboids, you must understand the concept first so that when students are faced with problems that are more complicated than usual, students can use mathematical equations or expressions well. In line with the opinion (Handayani, 2019) that students are still often not thorough in solving the problems given so they are wrong in determining the final result of the existing problems.

Question number 3:
If both bathtubs are filled with water, which bathtub needs more water? Explain your answer!

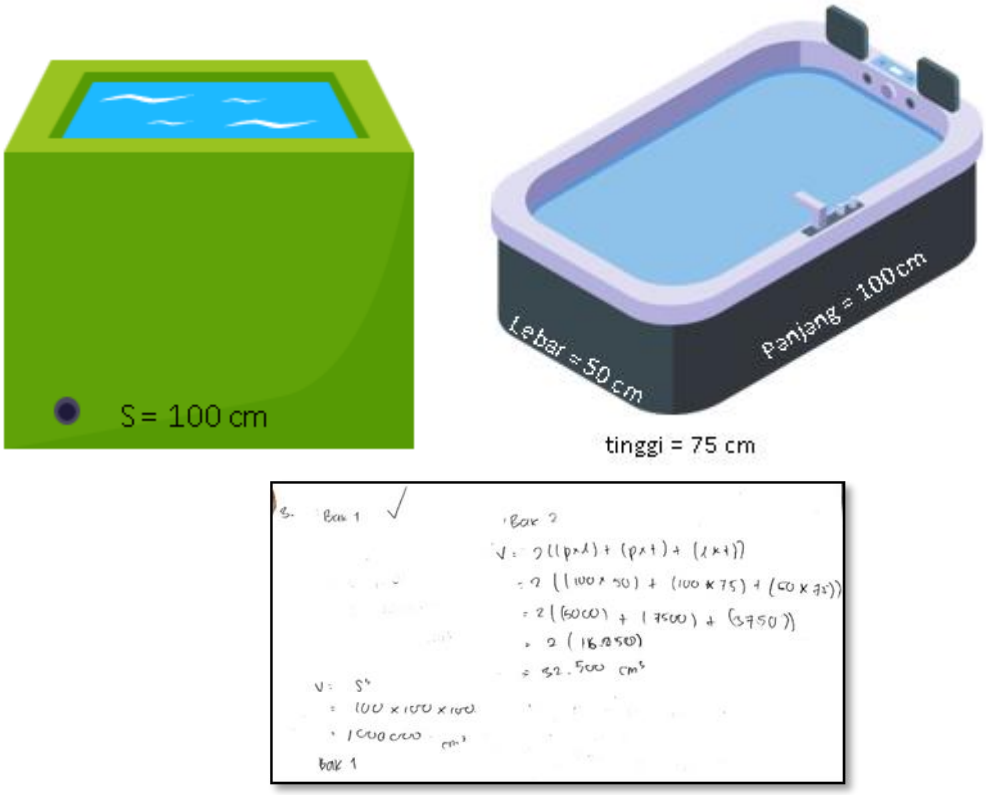

Figure 10. Answer Result S – 8

From Figure 10, S – 8 presents the formula of the wrong cuboid volume that should $V = p \times l \times t$ be presented that should be the formula of the surface area of the cuboid. The results of the researcher's interview with S – 8 regarding the results of the answers are:

Researcher : What do you understand from this question?
Student : I understand that you ask us to find which bathtub needs more water and if it is related to the content of the space, then it is related to the volume, then I use the volume formula to find it.
Researcher : That's right, the understanding of the problem is good, but the formula you presented to find the volume in bathtub 2 in the shape of a cuboid is wrong. Did you know that the formula you presented was wrong?
Student : I don't know because in my memory the formula from the volume of the cuboid is like my answer

In Bruner's learning theory, it is known that learners build their understanding of the world through the use of symbols, such as language and mathematical notation so that the concepts conveyed can become meaningfull understanding and also this is in line with the opinion of (Amaliyah AR & Mahmud, 2018) that to solve the problem of volume and surface area of cubes and cuboids, you must understand the concept first so that when students are faced with problems that are more complicated than usual, students can use mathematical equations or expressions well. Based on the results of the study, the researcher concluded that there was a problem in the mathematical representation ability of students. The students' representation skills still have many errors and have not been used properly. So that when students are given problems that should be solved if they have good mathematical representation skills.

CONCLUSION

Based on the results of the data analysis that has been described above, it can be concluded that the mathematical representation ability of grade IX students at one of the State Junior High Schools in Bandung still has many errors. This is because almost all students are less able to solve the problems given. In the indicator of visual representation ability, some students are still not able to change the mathematical idea into the form of an accurate and correct picture. In the indicator of the ability to represent equations or expressions, some students still do not understand the concept of cube and block materials, so when presenting a mathematical model, there are errors so that the final results presented by students are wrong and some students are also still not careful and in a hurry to find solutions to problems so that students are wrong in providing the final results.

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