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Junior High School Students' Mathematical Modelling Ability in Solving Geometry and Measurements Problems on *Asesmen Kompetensi Minimum*

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Abstract

The connection between mathematics and the application of mathematical concepts affects all aspects of daily life. Because of the connection between mathematics and the real world through mathematical models, mathematical modelling may help students in understanding this relationship. In the context-based *Asesmen Kompetensi Minimum* (AKM) problems, students are asked to solve mathematical problems related to the real world. This study aims to determine the mathematical modelling ability of grade VIII junior high school students in solving AKM problems. The place of research was carried out at SMP Negeri 22 Surabaya. This type of research is descriptive research with a qualitative approach. Data analysis was carried out by drawing conclusions and describing the percentage of students who achieved certain mathematical modeling indicators. The subjects of this study were twenty-six junior high school students in grade VIII. Students were given a test sheet containing AKM problems in the numeracy section that had been adapted to the geometry and measurements content domain. The results showed that in the geometry and measurements content domain, 77% of students are still in the stage of working mathematically. Students are able to make mathematical modelling used to calculate volume using the formula and calculate water volume using debit and time. However, students still have difficulty in interpreting answers and referring the results of answers that have been obtained with mathematical models to the context of everyday life problem situations given in AKM problems in the geometry and measurement content domain. Teachers have an important role in training students to get used to writing answers systematically, so that they are able to provide appropriate solutions when answering the problems given.

Keywords: *Asesmen Kompetensi Minimum;* Geometry and measurements; Mathematical modelling.

Abstrak

Hubungan antara matematika dan penerapan konsep matematika mempengaruhi semua aspek kehidupan sehari-hari. Karena adanya hubungan antara matematika

dan dunia nyata melalui model matematika, pemodelan matematika dapat membantu siswa dalam memahami hubungan ini. Dalam soal Asesmen Kompetensi Minimum (AKM) berbasis konteks, siswa diminta untuk menyelesaikan soal matematika yang berkaitan dengan dunia nyata. Penelitian ini bertujuan untuk mengetahui kemampuan pemodelan matematis siswa kelas VIII SMP dalam menyelesaikan soal AKM. Jenis penelitian ini adalah penelitian deskriptif dengan pendekatan kualitatif. Analisis data dilakukan dengan penarikan kesimpulan dan mendeskripsikan persentase banyaknya peserta didik yang mencapai indikator pemodelan matematika tertentu. Subjek penelitian ini adalah dua puluh enam siswa SMP kelas VIII. Siswa diberikan lembar tes yang berisi soal AKM pada bagian berhitung yang telah disesuaikan dengan domain konten geometri dan pengukuran. Hasil penelitian menunjukkan bahwa pada domain konten geometri dan pengukuran, 77% siswa masih dalam tahap bekerja secara matematis. Siswa mampu membuat pemodelan matematika yang digunakan untuk menghitung volume dengan menggunakan rumus dan menghitung volume air dengan menggunakan debit dan waktu. Namun, siswa masih mengalami kesulitan dalam menginterpretasikan jawaban dan menghubungkan hasil jawaban yang telah diperoleh dengan model matematika dengan konteks situasi masalah kehidupan sehari-hari yang diberikan dalam soal AKM pada domain konten geometri dan pengukuran. Guru memiliki peran penting dalam melatih peserta didik agar terbiasa menuliskan jawaban secara sistematis, sehingga mereka mampu memberikan solusi yang tepat saat menjawab pertanyaan-pertanyaan yang diberikan.

Kata Kunci: Asesmen Kompetensi Minimum; Geometri dan pengukuran; Pemodelan matematika

Introduction

Mathematics and the application of mathematical ideas in all activities are tied to all aspects of daily life. Because of this connection with mathematics through mathematical models, mathematical modelling can help students to understand and use mathematics in real world and see the connection between mathematics and real world (Zulkarnaen, 2018). Students' modelling ability affects the way students solve modelling problems (Mousoulides et al., 2008). Therefore, in solving context-based mathematics problems and related to the real world, students need mathematical modelling skills to be able to solve the problems given.

In compiling a mathematical modelling, skills are needed to transform real world into mathematical problems appropriately so that the mathematical modelling made can represent the problem correctly (Khusna & Ulfah, 2021). Therefore, mathematical modelling always comes from the real world, which is then explained with a mathematical model and solved using the model. This whole process is then called modelling (Greefrath & Vorhölter, 2016). It can be concluded that modelling mathematical problems requires mathematical modelling skills to convert into the form of mathematical symbols, so that a solution can be obtained.

According to the results of research by Khusna & Ulfah, (2021), some students still have difficulty in understanding problems in the form of story problems, while students' abilities in the structure phase are still insufficient. In fact, compiling mathematical models from the real world is the first step in the modelling process that must be done to get a solution. Based on the concept of the relationship between students' mathematical modelling skills and the stages of solving story problems, both have a mutually reinforcing role. Story problems can be solved by students using their ability in mathematical modelling (Pandiangan & Zulkarnaen, 2021). Thus, problem solving in the real world and mathematical modelling are interrelated. The introduction must be clear and written descriptively.

Abassian et al., (2019: 6), state that the process of making mathematical models made from real problems, then modelling in mathematical language or mathematization. Once completed in the mathematical world and conclusions are drawn, it is necessary to "translate back" to the real problem to validate the model. Thus, mathematical models are always linked back to the original situation or problem that was the background for their creation to ensure that the results obtained can be used in everyday life. According to Lestari & Raya (2019), one of the reasons students are unable to work on story problems is that they do not understand what is known and what is asked in the story problem. The difficulty of students in determining a solution is not due to students not mastering the steps in solving a story problem but more likely to the difficulty of students to interpret the problem. Based on the results of their research, it can be concluded that the level of ability of students in translating story problems into mathematical models to be classified as moderate seen from the presentation of students' test results in solving story problems, which reached 65.67%. Therefore, in modelling contextual problems, students need to understand mathematical problems to model in mathematical language, so that they can solve the problems given.

The mathematising process of translating relevant objects, relationships, and assumptions from the model created into mathematics, resulting in a mathematical model that can be used to solve the identified problem (Blum, 2015). Mathematical methods are used to solve mathematical problems within the framework of the created model and to obtain results. The mathematical results obtained must then be interpreted in relation to the context of the original daily life problem (Greefrath & Vorhölter, 2016). This research uses indicators of mathematical modelling ability developed by Greefrath & Vorhölter (2021) which can be seen in Table 1.

Table 1. Indicator of Mathematical Modelling

Indicator	Description
Understanding	construct their own mental model for a given problem situation and thus understand the question
Simplifying	separate important and unimportant information about a real situation
Mathematising	translate suitably simplified real situations into mathematical models (e.g. term, equation, figure, diagram, function)
Working Mathematically	apply heuristic strategies and mathematical knowledge to solve the mathematical problem
Interpreting	refer the results obtained in the model to the real situation and thus achieve real results
Validating	check the real results in the situation model for adequacy
Exposing	refer the answers found in the situation model to the real situation and thus answer the question

One of the components in the *Asesmen Nasional* is the *Asesmen Kompetensi Minimum* (AKM). AKM is an assessment of the minimum abilities that are carried out to students. The minimum competencies are the most basic skills that must be possessed by students at a certain level, which include reading literacy and numeracy. Math and numeracy are closely related concepts in AKM. Numeracy in AKM, covers more than just math lessons. A broad context is very important in AKM numeracy, so that students can recognize the role of mathematics in real world. In AKM, the content domain in numeracy is divided into four, namely (1) Numbers, which assesses the understanding of whole numbers, decimals, and percents, including calculating squares/powers of two and cubic/powers of three of a decimal number with one number behind the comma, (2) Geometry and measurement, assesses students' competence from recognizing flat shapes to using volume and surface area in real world, as well as about measuring length, weight, time, volume and debit, and area units using standard units, (3) Algebra, which will assess the understanding and use of systems of quadratic equations and inequalities as well as systems of linear equations of two to three variables, the ability of students to solve problems with the concept of function, and the understanding of the concepts of ratio and proportion in real world problems including social arithmetic, and (4) Data and uncertainty, which is expected to enable students to use measures of concentration (grade VIII) and dispersion (grade X), such as the mean and variance of data, specifically focusing on understanding how to obtain information and present data and understanding the uncertainty of an event, according to the *Desain*

Pengembangan Soal AKM guidelines by Pusmenjar (2020). Referring to the results of the PISA assessment in 2018, the literacy and numeracy abilities of Indonesian students are relatively low. Based on the results of the Program for International Student Assessment (PISA) survey, Indonesia is ranked 72nd out of 77 countries for literacy skills and 72nd out of 78 countries for numeracy skills (OECD, 2019). This has an impact on learning which requires problem solving abilities including modeling abilities in solving given problems. This study is related to research conducted by Novianti (2021) on AKM and its relationship with problem solving skills. The study showed that students' mathematical problem-solving ability is related to numeracy skills. Students can solve AKM problems related to numeracy in the form of story problems with steps that are in accordance with the Polya stages. Research related to mathematical modelling ability was conducted by Khusna & Ulfah (2021), which showed that the mathematical modelling ability of junior high school students varied, independent of high, medium, or low mathematical ability. Although most students are able to make mathematical modelling, there are still those who have difficulty because they do not understand the problems given. In addition, the form of modelling images of students also varies and most of them are still not appropriate according to the problems given. The relevance of the research to be conducted by researchers is to describe and analyze the mathematical modelling ability of students. However, the instruments used are different, in the study using contextual math problems while the researchers will use context-based numeracy AKM problems.

Based on this description, this research leads to the mathematical modelling ability of grade VIII students in solving *Asesmen Kompetensi Minimum* questions. Therefore, this research aims to describe the mathematical modelling ability of grade VIII students in solving *Asesmen Kompetensi Minimum* problems within the geometry and measurement content domain.

Method

The approach taken in this research is a qualitative approach with descriptive research type. The data described in this study is the mathematical modelling ability of students in solving *Asesmen Kompetensi Minimum* (AKM) questions. The research design that will be carried out, including: (1) Problem identification, in this study the problem identification carried out is to find out the mathematical modelling ability of students in solving AKM problems. (2) Determining the research subject, to determine the research subject in this study, the researcher took the subject of one class of VIII A students totaling 26 students at SMP Negeri 22 Surabaya by purposive sampling to determine the class randomly.

Abdussamad (2021), describes the purposive sampling technique as sampling data sources with certain considerations. In this study, considering the time, place, and condition of the class and students when determining the subject. Since the data collection took place right after the class promotion exam ended and both students and teachers were preoccupied with both academic and extracurricular events at the conclusion of the school year, it was not possible to conduct interviews. (3) Developing research instruments, the instruments needed in this study are test sheets containing adapted AKM numeracy questions. The preparation of this instrument was carried out by the researcher. In compiling the instrument sheet, an instrument consultation was also carried out with the supervisor. (4) Giving the AKM problem test sheet, the adapted numeracy AKM problem test sheet was given to the subjects who had been selected to find out the students' mathematical modelling ability in solving the problem.

In collecting data, a test technique was carried out, namely giving a test sheet of mathematical modelling questions from the adapted AKM. Then, students must complete the test sheet that has been given. Furthermore, from the results of the students' answer sheets, the results of the data can be processed to describe the students' mathematical modelling abilities.

According to Miles, Huberman and Saldaña (2014), there are three types of activities in data analysis, namely data condensation, data presentation, and conclusion drawing and verification. (1) Data condensation, which refers to the process of selecting, focusing, simplifying, abstracting, and transforming data on the main things to provide a clearer picture, as well as making it easier for researchers to conduct further data collection and search for it when needed. In this case, data condensation is carried out based on the indicators of mathematical modelling ability used. The method used, namely reviewing the results of students' answer sheets then making an analysis that is focused on indicators of mathematical modelling ability on each problem, each of which contains the AKM content domain of all data obtained. (2) Data presentation, compiling a set of information that has been obtained in the form of a brief description that refers to each indicator of modelling ability. Data is presented in the form of graphs according to the ability of mathematical modelling that appears, from each student's work and the number of students who reach certain indicators. (3) Drawing and verifying conclusions, drawing conclusions in qualitative research is an answer to the formulation of problems that have been formulated at the beginning which is supported by valid evidence during data collection during the data presentation stage and based on the results of data analysis. Conclusions will be described with a percentage of the

number of students who achieve certain mathematical modelling indicators. The basic percentage formula used is:

$$Percent\ 100\% = \frac{Number\ of\ subjects\ who\ achieved\ a\ certain\ indicator}{Total\ number\ of\ research\ subjects} \times 100\%$$

In this data discussion, it is intended to describe the number of students who achieve each indicator of mathematical modelling ability in solving AKM problems, so that it can be described in detail. Then it will be described qualitatively for each achievement of students' mathematical modelling indicators.

Results

The geometry and measurement content domain, assesses students' competencies from recognizing geometric shapes to using volume and surface area in everyday life, as well as about measuring length, weight, time, volume and debit, and area using standard units. The context used is a personal context with reading information about a bathtub box. Further reading context is not used because the information for solving is already provided in the problem.

The form of the question is an essay or description, so students must express ideas from the answers obtained in the form of a written description. Figure 1 is question of the geometry and measurement content domain.

Apakah kolam akan terisi penuh, tidak penuh atau bahkan meluap dari kolam? Apabila kolam belum terisi penuh, berapakah volume air yang kurang? Apabila air meluap dari kolam, berapakah volume air yang meluap dari kolam tersebut? Jelaskan jawabanmu!

Figure 1. Geometry and Measurements Content Domain Question

An overview of the results of students' mathematical modelling abilities from questions with data and uncertainty content domains can be seen in the graph in Figure 2.

In question of geometry and measurement content domain, seen from Figure 2, of the 26 students who took the mathematical modelling ability test, 8% of students did not answer the question at all and did not meet the mathematical modelling indicators.

Understanding Phase

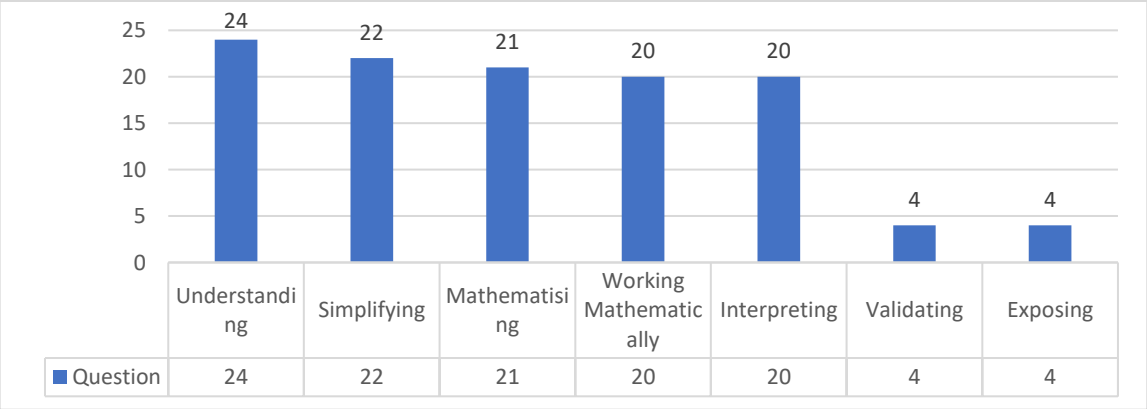

Figure 2. Results of Students' Mathematical Modelling Ability from the Geometry and Measurement Content Domain

Students understand how to solve problems using the concept of combined volume of geometric shapes and finding the volume of water using debit and time. Based on the results of the answers, 92% of students met the understanding indicator.

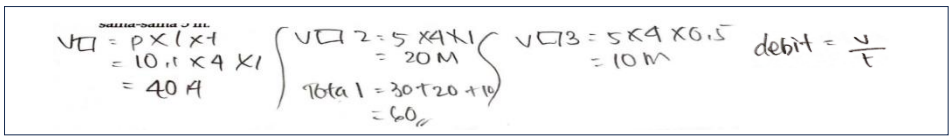

Figure 3 Students' Answer to the Understanding Phase

Students have reached the stage of understanding mathematical modelling, because they are able to understand the space building formula and the formula for calculating the volume of water that will be used. Students can write formulas on the answer sheet.

Simplifying Phase

Students eliminate the necessary information about the given situation. In the simplify indicator, students can write the known information on the answer

sheet. Students divide the combination of geometric shapes, making it easier for students to find the volume of each geometric shape. Based on the answer results, 85% of students fulfill the simplify indicator.

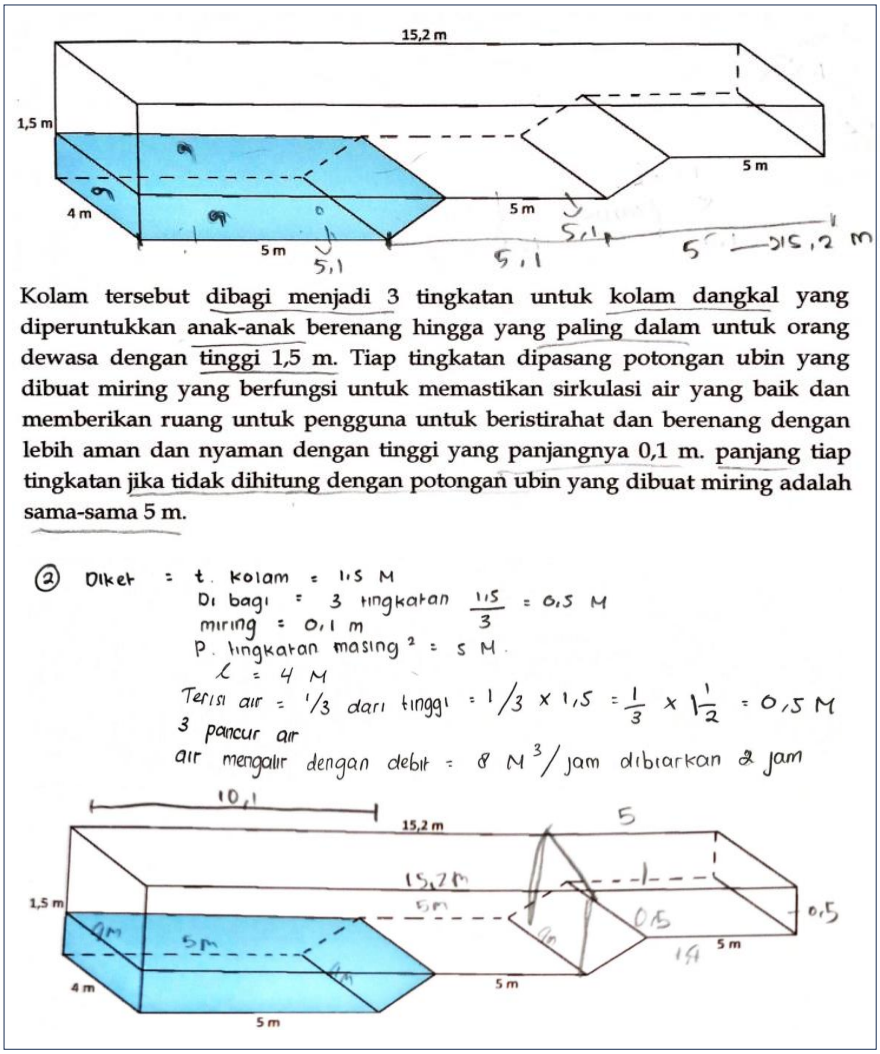

Figure 4 Students'answer to the Simplifying Phase

Students reach the stage of simplifying mathematical modelling, because students are able to separate the information needed in the problem to answer the question. Students can write information by underlining or writing known information on the answer sheet. In addition, students can divide the combined space formed into several parts of the space that can be calculated with a known formula including writing each length, height and width.

Mathematising Phase

Students translate the actual situation that has been simplified into a mathematical model. In the mathematization indicator, students make memorization and mathematical models. Students determine the spatial formula to be used and the formula for finding the volume of water. A total of 81% of students met the mathematization indicator.

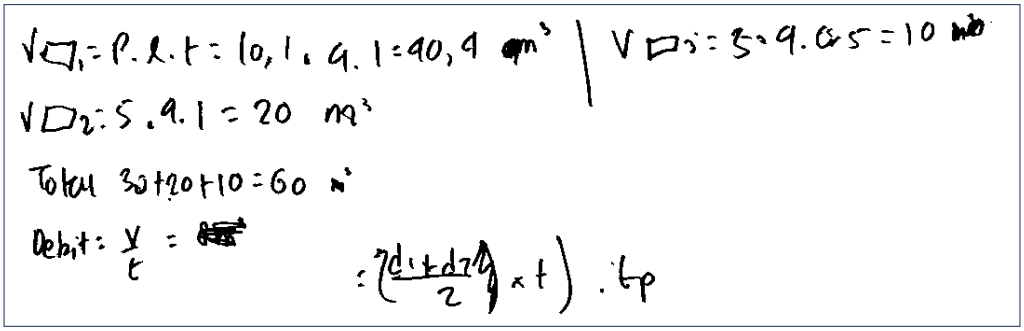

Figure 5 Students' answer to the mathematising phase

Mathematical modelling indicators are met if students make mathematical models, namely writing length, height, width, debit and time in the volume formula of a space and water volume formula.

Working Mathematically

Students apply the formulas that have been learned, namely the formula for the volume of a space and the formula for finding the volume of water to solve the mathematical model that has been made. Based on the answers, 77% of students fulfill the indicators of working mathematically.

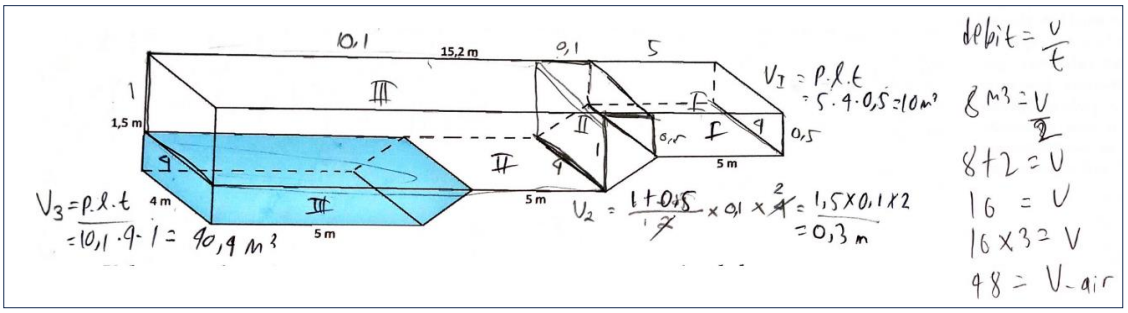

Figure 6 Students'answer to the working mathematically phase

Students reach the stage of working mathematically, because students are able to perform calculations with mathematical operations by substituting the values of length, height, width, debit and time in the mathematical model in the form of a formula that has been written.

Interpreting Phase

Students obtain the answer after performing calculations on the indicator of working mathematically. The results of students' answers are in accordance with mathematical calculations. From the calculation results, the value of the volume of the building space and the volume of water is obtained. As many as 77% of students fulfill the indicator of interpreting.

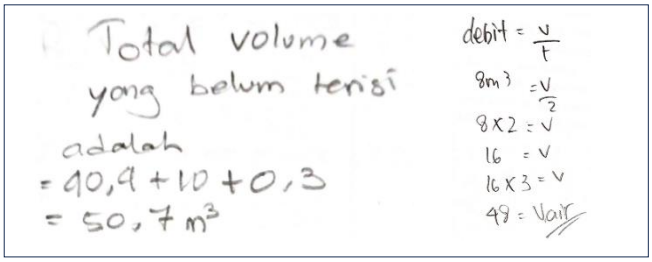

Figure 7 Students' answer to the interpreting phase

Students reach the interpreting stage, because students are able to get answers after doing calculations by working mathematically. The results of the answers obtained from the mathematical model that has been made will refer to the situation of daily life problems contained in the problem given. Students should write the right unit after getting the answer.

Validating Phase

Students refer the answers obtained in the mathematical model to the actual situation in the problem, check and validate the answers that have been obtained. The results of the volume of space and volume of water, students check whether the pool will be filled, not full or overflowing by calculating the difference. A total of 15% of students fulfill the indicator of validating.

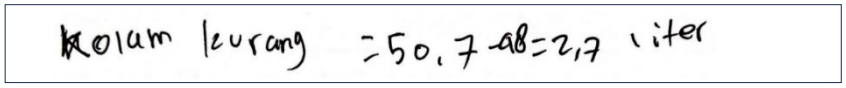

Figure 8 Students' answer to the validating phase

Students reach the validate stage because they are able to check the results that have been obtained from performing calculations in the mathematical model into the problem situation given in the problem. Students calculate the difference between the volume of the building space, namely the pool in the problem and the volume of water that fills the pool, so that students can answer the questions given.

Exposing Phase

After students validate and check the answers obtained from the mathematical model to the actual situation, students answer the questions listed in the problem correctly. In question number 2 with the form of an essay or description question, students answer that the volume of water that fills the pool is still less than 2.7 m3. A total of 15% of students fulfill the indicator of exposing.

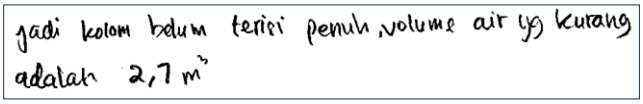

Figure 9 Students' answer to the understanding phase

Students reach the stage of exposing mathematical modelling, because students are able to answer correctly according to the question's instructions by referring to the results of answers that have been calculated with mathematical modelling and returned to the situation of the given daily life problem. The form of question is an essay or description, students should write the correct answer, namely the pool is not yet fully filled and the volume of water that is less is 2.7 m^3, so that if there is this sentence then the student's answer is correct.

Discussion

The results of students' answers from question number 2 with the content domain of geometry and measurement are 77% of students only up to the interpretation indicator. Students do not check the results of the mathematical model that has been made with the actual situation model contained in the problem, so that the answer is not obtained in accordance with the question. However, there are 4 students who have reached the exposing indicator and answered correctly, referred to in Figure 2. Research conducted by Cahyanovianty & Wahidin (2021) shows that grade VIII students do not understand much about AKM, so they have difficulty in the process of working on it and also have difficulty solving problems in the description section due to lack of understanding, so they are unable to answer optimally.

Most students only calculate the volume of the pool and the volume of water. In the understanding indicator, students use the concept of volume of space and water debit to solve the problem. Simplifying indicators, the students' separate information that is only needed to answer questions in the problem, namely the combination of space, water debit and the time needed. Indicators of mathematization in problem number 2, students make a design of the combined wake-up space formed and the formula for finding the volume of water. Indicators of working mathematically, students calculate the volume of the formed building and calculate the volume of water from the information known in the problem. Indicators of interpreting, students get answers to the volume of the building and the volume of water.

To determine mathematical modeling ability, a specific instrument is needed that is able to cover all the indicators used. In this study, there are validation indicators that are difficult to ascertain only through students' written answers. Therefore, the interview method is an effective way to check and validate. By using this method, researchers can conclude the results according to the indicators used. Furthermore, the researcher suggests using appropriate methods and developing instruments that can cover all the indicators used.

Conclusion

Based on the results of the research that has been done, it can be concluded that: The mathematical modelling ability of grade VIII junior high school students in solving AKM questions in geometry and measurement, students only reach the interpretation indicator. Students do not check the results of the mathematical model that has been made with the actual situation model contained in the problem,

so that the answer is not obtained in accordance with the question. However, there are 4 students who have reached the exposing indicator and answered correctly.

In accordance with the conclusions that have been presented, the suggestions that researcher can give is based on the results of the research, the researcher has a recommendation that students be encouraged to organize answers systematically. One way that can be applied by teachers is to teach students to organize answers based on information that is already known, questions asked, and answers given. Thus, students will be accustomed to completing tasks in a clear and structured manner.

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