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Analysis of Student Difficulty Levels in Solving Spatial Structure Problems for Grade IX Students at SMPN 2 Krounjendit Mindiptana

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Abstract:
This study is an analysis of the level of difficulty students encounter in solving mathematical problems related to spatial structures at SMPN 2 Krounjendit Mindiptana. The research aims to identify the types of difficulties experienced by students and to determine their mathematical problem-solving abilities. The method employed in this study is experimentation. Data collection techniques involve the use of test instruments and in-depth interviews with students. Data analysis employs descriptive statistics to provide a clear overview of the difficulties experienced by students and their mathematical problem-solving abilities. The research was conducted with 24 students, while 4 students were interviewed. Based on the analysis, it was found that 67% of the students were unable to comprehend the problems presented in each item, 58% struggled with planning problem-solving approaches, 71% had difficulties with calculations involved in mathematical problem-solving, and 79% of students did not review their answers after solving mathematical problems. Furthermore, findings from the interviews revealed that all interviewed students expressed a lack of understanding in spatial structures learning and a deficiency in memory when applying concepts or formulas in mathematical problem-solving.

Abstrak:
Penelitian ini merupakan analisis tingkat kesulitan siswa dalam memecahkan masalah matematika pada bangun ruang di SMPN 2 Krounjendit Mindiptana. Tujuan penelitian untuk mengetahui jenis-jenis kesulitan yang dialamai siswa dan untuk mengetahui kemampuan pemecahkan masalah matematik. Metode yang digunakan dalam penelitian ini adalah eksperimen. Tehnik pengumpulan data dengan instrument tes dan wawancara mendalam terhadap siswa. Analisis data menggunakan statistic deskriptif yaitu memberikan gambaran yang jelas terhadap kusulitan yang dialami siswa dan kemampuan siswa dalam memecahkan masalah matematika. Penelitian ini dilakukan terhadap 24 siswa sedangkan yang diwawancarai 4 siswa. berdasarkan hasil analisis, ditemukan 67% siswa yang belum mampu memahami masalah pada tiap butir soal, 58% siswa yang belum mampu dalam merencanakan pemecahan masalah, 71% siswa yang belum mampu melakukan perhitungan dalam memecahkan masalah matematika dan 79% siswa yang tidak memeriksa kembali hasil jawannya ketika melakukan pemecahan masalah dalam matematika. Sedangkan dari hasil wawancara menunjukan bahwa semua siswa yang diwawancara menyatakan tidak paham dalam pembelajaran bangun ruang dan kurangnya daya ingat siswa dalam penerapan konsep atau rumus yang digunakan dalam pemecahan masalah matematika.

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INTRODUCTION

School is essentially a place where students gather to channel their thoughts through learning and train themselves to the best of their abilities. However, in the process of learning, students often encounter learning difficulties. Literally, learning difficulties in mathematics are translated from English as Learning Disability, which means the inability of students to learn (Utami, 2020). Furthermore, (Utari et al., 2019) state that students experiencing learning difficulties have several characteristics, including frequently making mistakes in learning. One of these mistakes occurs when students are studying mathematics. Many students assume that mathematics is a difficult and boring subject, leading to a lack of interest in mathematics (Ayu et al., 2021). The difficulties faced by these students are the main factors causing them to be unable to solve mathematical problems (Hardianty & Septian, 2020). Thus, it is undeniable that in learning mathematics, especially in the topic of spatial structures, students will encounter various difficulties. Given these difficulties, teachers fundamentally need to take steps to address each student's learning challenges. According to (Arifin, 2020), the process of understanding students' learning difficulties is known as learning difficulty diagnosis. This is necessary because not all students face constraints or issues that hinder them from achieving the required competencies in mathematics learning. The difficulties students face in learning usually lead to problems in the learning process, particularly in learning mathematics. The difficulties students encounter are often abstract in nature and push them to find solutions. In the process of learning mathematics, students are often presented with problems, known as exercises or questions provided by educators. These exercises typically have varying levels of difficulty. According to (Simbolon, 2020), a good problem is one that is neither too easy nor too difficult. An excessively easy problem fails to stimulate students to exert effort to solve it, while an overly difficult problem can discourage students from attempting to solve it. Generally, students are expected to solve mathematical problems using appropriate methods (Silaban et al., 2022). Solving mathematical problems with correct concepts or methods is a crucial goal in mathematics education. Understanding concepts, for example, is a student's ability to solve mathematical problems (Pratiwi et al., 2021). Fundamentally, students are advised to revisit the concept of mathematical problem-solving. According to (Khofifah et al., 2021), the ability of students to absorb and understand mathematical ideas is known as understanding the concept of mathematical ability. Meanwhile, problem-solving ability is the capacity to use existing knowledge or concepts to answer difficult or unresolved problems (Irwan, 2022). Conceptual understanding is the most fundamental aspect for students; if they lack a solid grasp of concepts, they may simply master procedural solutions without truly understanding the essence of problem-solving. In fact, a lack of conceptual understanding can hinder students from translating a problem into mathematical language, resulting in errors when solving problems (Khoirunnisa et al., 2020). Problem-solving is not only the goal of mathematics education; it is also at the core of mathematical learning. By practicing and becoming accustomed to solving mathematical problems, students not only develop their thinking abilities but also enhance their basic problem-solving skills (Rahadatul ‘Aisy, 2022). This applies not only to mathematical problems but also to everyday life challenges (Mulyanti et al., 2018). These opinions align with (Bernard et al., 2018) and (Sihotang, 2020), who emphasize that problem-solving is crucial in mathematics because it enhances students' higher-order thinking skills, allowing them to explore knowledge and skills to solve infrequent problems. In mathematics, spatial structures are among the topics encountered by students in the teaching and learning process. Spatial structures are portions of space bounded by a set of points found on the entire surface of the structure. This surface is referred to as the side (Awangga, 2019), while according to (Hawa, 2021), a spatial structure is a term used for three-dimensional structures. Spatial structures

are mathematical entities that possess volume or content. From the definitions above, it can be concluded that a spatial structure is a collection of points that form a three-dimensional space with volume. Spatial structures can be grouped into two major categories: flat-sided spatial structures and curved-sided spatial structures. Curved-sided spatial structures include spheres, cylinders, and cones, while flat-sided spatial structures include cubes, rectangular prisms, prisms, and pyramids (Dewi et al., 2021). The topic of spatial structures is included in mathematics education at the junior high school level. Learning about spatial structures requires teachers to identify the difficulties students face in solving problems, particularly in this topic. Based on the explanations above, it is evident that mathematics is a challenging subject for learners, particularly when it comes to solving problems or exercises related to spatial structures. Generally, students struggle to understand how to solve problems involving spatial structures. One primary cause of student difficulties is a lack of conceptual understanding and challenges in comprehending the language used in the given problems. This lack of understanding indicates that students do not grasp the concepts or methods required for mathematical problem-solving. Moreover, the difficulties students face may also stem from their lack of interest in or enthusiasm for mathematics, especially regarding spatial structures. This can impact their overall performance and lead to low assessment scores in this area. Low assessment scores suggest a lower level of understanding among students in this topic, indicating the presence of learning difficulties related to spatial structures. Therefore, this article aims to analyze the level of difficulty students face in solving problems related to spatial structures among ninth-grade students at SMPN 2 Krounjendit Mindiptana.

METHODS

This research is an analysis of students' difficulty levels in solving mathematical problems related to spatial structures at SMPN 2 Krounjendit Mindiptana. The aim of the study is to identify the types of difficulties experienced by students and to assess their mathematical problem-solving abilities. The method employed in this research is an experiment. To fulfill the data requirements, data collection techniques include the use of test instruments and in-depth interviews with students. The study was conducted with 24 students, and 4 of them were interviewed. In-depth interviews were conducted to gain a clear understanding of the issues students face when solving mathematical problems. The indicators in the analysis of learning difficulties include factual errors, conceptual errors, principle errors, and errors in the use of operations. The instruments used were previously tested by researchers and include the difficulty index and item discrimination (Subakti et al., 2022). Data analysis employs descriptive statistics to provide a clear overview of the difficulties experienced by students and their mathematical problem-solving abilities.

RESULTS AND DISCUSSION

This study was conducted on 24 students in the ninth grade at SMPN 2 Krounjendit Mindiptana, and obtained the percentage of student responses for each item presented in the table below:

Table 1. Percentage of student responses for each item

No Question	Indicators in solving math problems			
	Understanding the problem	Plan a settlement	Do the calculations	Check again
1	50%	71%	67%	71%
2	67%	63%	88%	29%

3	75%	54%	71%	75%
4	63%	29%	58%	58%
5	54%	38%	67%	25%

In solving mathematical problems, particularly in the topic of spatial geometry, students make several errors in the problem-solving process, including: factual errors, where students have difficulty understanding the meaning of the problem; conceptual errors, where students struggle to apply concepts related to the topic; principle errors, where students overlook prerequisites for using formulas or theorems relevant to the topic; and operational errors, where students take inappropriate steps or struggle to manipulate the solution steps (Khairani & Kartini, 2021) (Niss & Højgaard, 2019).

Based on the test and interviews conducted with students regarding the five test items, this constitutes an analysis of the potential difficulties experienced by students in problem-solving, leading to errors in solving mathematical problems, particularly in the context of spatial geometry. The results of the students' test responses are further supported by in-depth interviews conducted with 4 students.

a. Analysis of question no. 1

Please take a look at the following image!
A sketch of a building in the shape of a right prism,
with an isosceles triangle as its base.
If AB = 10 m, and DB = 8 m, and the height of the building is 50 m,
what is the volume of the building?

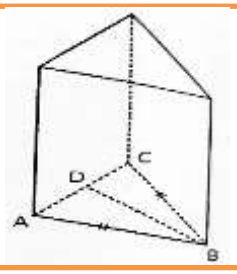


Figure 1. Problem number 1

Student answers;

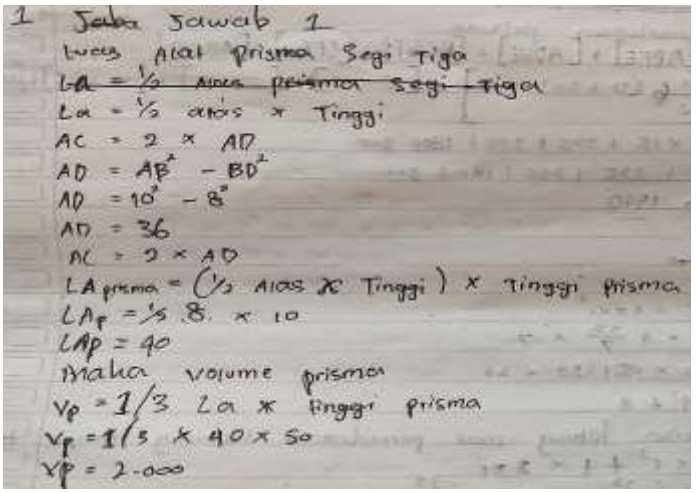


Figure 2. Student Response Errors, Question Number 1

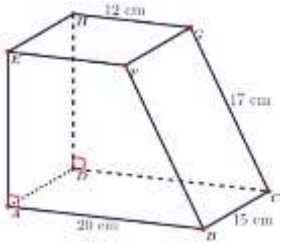
In question number 1, students were asked to identify the given elements, the question itself, and the scope of elements in the problem of the Triangular Prism spatial figure. The spatial figure above represents a right triangular prism with a triangular base.

Based on the analysis and problem-solving results, out of 24 students who answered the question correctly, 9 students obtained a score of 20. However, 14 students made errors while attempting the question. The displayed student answers are examples of

errors made in responding to the question. From the student responses to question 1, it can be observed that the errors include: a lack of understanding of the problem's context, concept comprehension in problem-solving, and mistakes in utilizing formulas.

b. Analysis of Question Number 2

The surface area of the given figure is..



Picture 3. Problem number 2

Student answers;

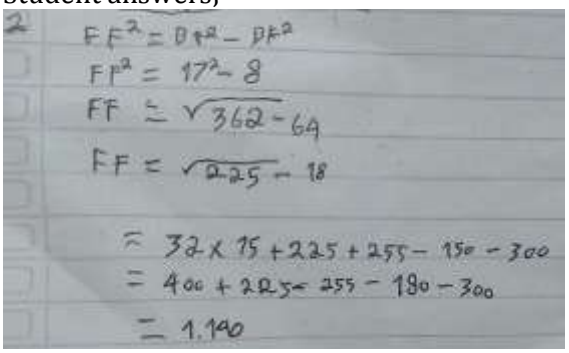


Figure 4. Student Response Errors, Question Number 2

In question number 2, students were asked to identify the given elements as shown in figure number 3 above, and then calculate the surface area of the given spatial figure. The spatial figure depicted above represents a prism with a rectangular base. Based on the analysis and problem-solving results, out of 24 students who answered the question correctly, 11 students obtained a score of 20. However, 13 students made errors while attempting the question. The displayed student answers are examples of errors made in responding to the question. From the student responses to question 2, it can be observed that the errors include a lack of understanding of the problem's context, concept comprehension in problem-solving, and lack of carefulness in calculations during problem-solving.

c. Analysis of Question Number 3

The total surface area of the given figure is…

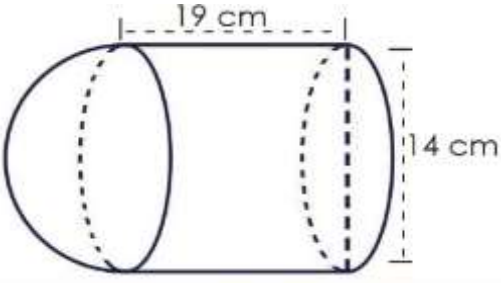


Figure 5. Problem number 3

Student Answers;

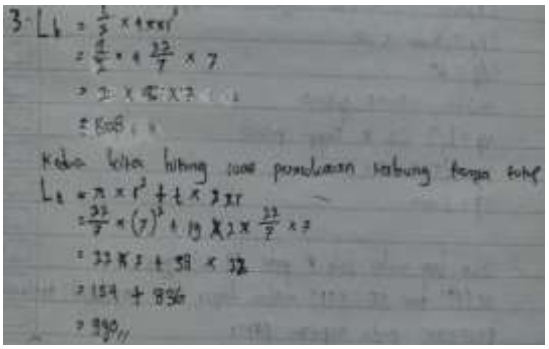


Figure 6. Student Response Errors, Question Number 3

In question number 3, students were asked to identify the given elements as shown in figure number 5 above, and then calculate the total surface area of the given spatial figure. The spatial figure depicted above consists of two types of spatial structures, namely a cylindrical shape and a semi-circle shape. Based on the analysis and problem-solving results, out of 24 students who answered the question correctly, 7 students obtained a score of 20. However, 17 students made errors while attempting the question. The displayed student answers are examples of errors made in responding to the question. It can be observed from the student responses to question 3 that the answers were almost correct, but the error made by the students in this question is lack of accuracy in calculations and written explanations during problem-solving.

d. Analysis of Question Number 4

Observe the combined figure of a cylinder and a cone below!

The surface area of the given spatial figure is...

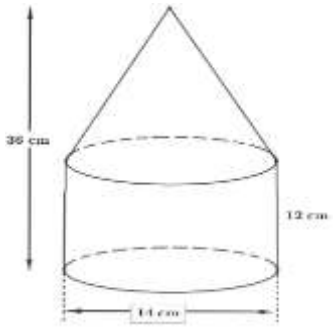


Figure 7. Problem number 4

Student answers;

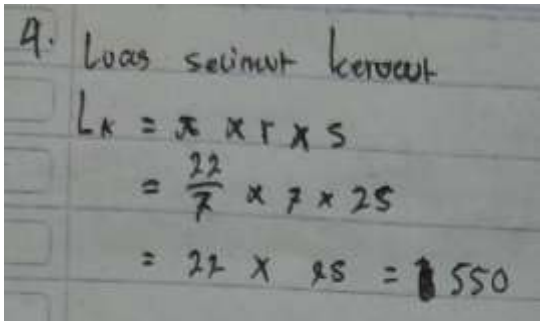


Figure 8. Student Response Errors, Question Number 4

In question number 4, students were asked to identify the given elements as shown in figure number 7 above, and then calculate the total surface area of the given spatial figure. The spatial figure depicted above consists of two types of spatial structures, namely a cylindrical shape and a cone shape. Based on the analysis and problem-solving results, out of 24 students who answered the question correctly, only 4 students obtained a score of 20. However, 20 students made errors while attempting the question. The displayed student answers are examples of errors made in responding to the question. It can be observed from the student responses to question 4 that the errors made by the students in problem-solving include not understanding the question, not grasping the concept, making calculation mistakes, and lack of precision in writing.

e. Analysis of Question Number 5

A pyramid with a square base
with a side length of 15 cm and a height of 7 cm, the volume of the pyramid is...

Figure 9. Problem number 5.

Student answers

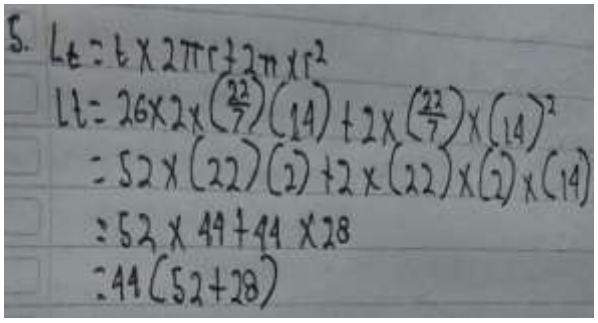


Image 10. Student Answer Mistake for Question Number 5

In question number 5, students were asked to identify known elements and the question posed in the Solid Geometry problem. The given solid geometry figure is a right square pyramid. Based on the analysis and problem-solving results, out of 24 students who answered correctly, 13 students obtained a score of 20, while 11 students made mistakes in solving the problem. The displayed student answers are examples of mistakes made in answering the question. From the answers to question number 5, it can be observed that students' errors in problem-solving include: not understanding the question, not grasping the concept and applying formulas, making calculation errors, and incomplete calculations.

To explore information related to students' difficulties in solving mathematical problems, in-depth interviews were conducted with 4 participants. Here are 2 examples of interviews with students regarding the given problems:

Interview 1:
P: From each question, which part did you find difficult?
S: All of it, sir.
P: Haven't we learned about solid geometry?
S: Yes, we have, sir, but it's difficult to understand.
P: Which part is hard to understand?
S: Memorizing the formulas, sir.
P: And what else?
S: Translating the questions, sir.

Interview 2:
P: From each question you just worked on, which part was difficult?
S: All of them, sir.
P: Can you mention one specific difficulty you faced while solving it?
S: Not understanding and using the formulas, sir.
P: Didn't we write down the formulas?
S: Yes, sir, but I forgot.
P: Okay, thank you.

Discussion

Based on the research conducted by analyzing students' difficulty levels in solving mathematical problems using test questions and in-depth interviews with 4 students, it was found that some students still face difficulties in solving mathematical problems. (Juniawan, 2021) states that student difficulties in solving problems are caused by various factors, such as lack of motivation, interest in the subject matter, lack of understanding of concepts, and inability to apply formulas. Furthermore, according to (Lumbantoruan & Male, 2020), both general and specific factors significantly influence students' success in the learning process, both inside and outside the classroom.

The results obtained from the analysis show that 67% of students are unable to understand the problems in each question, 58% are unable to plan problem-solving, 71% are unable to perform calculations in solving mathematical problems, and 79% do not review their answers when solving mathematical problems. This analysis, along with the previously mentioned research, demonstrates that mathematics is a challenging subject for students. Therefore, teaching problem-solving skills should be emphasized, practiced, and ingrained in students from an early stage. This will help students understand problems, plan calculations, and find optimal solutions to various issues (Aripin, 2018)

Meanwhile, the results of the interviews indicate that each interviewed student struggled with understanding the concepts of solid geometry and had difficulty recalling and applying the concepts or formulas needed for solving mathematical problems. These findings align with previous research that highlights common student errors, such as lack of skill in connecting different situations and comprehending given problems. Therefore, students' understanding of problem comprehension, calculation planning, and problem-solving is still relatively insufficient (Mulyanti et al., 2018).

CONCLUSION

Based on the results and discussions presented in this research, several difficulties and mistakes made by students in solving mathematical problems related to solid geometry are identified:

1. Students lack an understanding of the mathematical meaning of problems, particularly in questions presented without accompanying images.
2. Insufficient mastery of concepts or prerequisites related to solid geometry.
3. Challenges in planning solutions or interpreting solutions/answers due to not fully comprehending the problems.
4. Calculation errors resulting from lack of attention to the problem-solving process or sequence, leading to mistakes in all answers.

Inability to apply formulas to each question, leading to errors in problem-solving. Additionally, other factors contributing to student difficulties in solving

solid geometry problems are also identified, such as the discrepancy between the problems and the material taught by teachers and students' lack of interest in mathematics, particularly in solid geometry. As a result, mathematics is considered a difficult subject, and it becomes a daunting aspect for students at SMPN 2 Krounjendit Mindiptana.

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