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# ANALYSIS OF STUDENTS' DIFFICULTIES IN SOLVING PROBLEMS RELATED TO SOLID GEOMETRY

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**Abstract**

The aim of this research is to identify the challenges faced by students when solving problems related to solid geometry. The research design employed in this study is descriptive qualitative research. The target population was 23 class VI MI Muhammaduddarain students in the 2022/2023 academic year, who were selected using purposive sampling. The research sample consists of three students who encountered difficulties while solving problems in solid geometry. The selection of research subjects was based on their work, which exhibited the most errors in problem-solving related to solid geometry. Data collection techniques encompassed interviews, tests, and documentation. The research findings indicate that the students encountered various difficulties when solving problems related to solid geometry, including (1) challenges in comprehending the concepts, (2) difficulties in applying principles, and (3) struggles in employing process skills.

**Keywords:** Geometric material, Mathematical difficulties, Students' difficulties.

***Abstrak***

*Tujuan penelitian ini adalah untuk mengidentifikasi tantangan yang dihadapi oleh siswa saat menyelesaikan masalah terkait geometri ruang. Desain penelitian yang digunakan dalam studi ini adalah penelitian kualitatif deskriptif. Populasi target adalah 23 siswa kelas VI MI Muhammaduddarain pada tahun akademik 2022/2023, yang dipilih menggunakan purposive sampling. Sampel penelitian terdiri dari tiga siswa yang mengalami kesulitan saat menyelesaikan masalah dalam geometri ruang. Pemilihan subjek penelitian didasarkan pada pekerjaan mereka, yang menunjukkan kesalahan terbanyak dalam menyelesaikan masalah terkait geometri ruang. Teknik pengumpulan data meliputi wawancara, tes, dan dokumentasi. Temuan penelitian menunjukkan bahwa siswa menghadapi berbagai kesulitan saat menyelesaikan masalah terkait geometri ruang, termasuk (1) tantangan dalam memahami konsep, (2) kesulitan dalam menerapkan prinsip-prinsip, dan (3) kesulitan dalam menggunakan keterampilan proses.*

***Kata kunci:*** *Kesulitan matematika, Kesulitan siswa, Materi geometri.*

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## INTRODUCTION

In the realm of education, mathematics plays a crucial role as it is intertwined with almost all fields of study. It is essential for individuals to have a solid understanding of mathematics as it serves as a powerful tool for problem-solving in everyday life. Mathematics is an integral part of education, from elementary school to university level. However, it is worth noting that many students still perceive mathematics as a challenging

subject, leading them to avoid it (Hardiansyah et al., 2022; Kristin et al., 2021; Nursalam, 2016; Qolbi et al., 2022; Rosalinda et al., 2022). According to Zanthy (2016), studying mathematics constantly demands the development of students' thinking skills, as it is an important subject that can be applied to various real-life problems using mathematical models. Engaging with mathematics helps individuals develop logical, scientific, critical, and creative reasoning skills. Furthermore, Suherman et al. (2003) describes how mathematics teaches structured patterns and regularity. Mathematical concepts are introduced in a logical, systematic, and hierarchical manner, progressing from the simplest understanding to more complex concepts.

Abdurrahman (2012) suggests that there are five reasons for learning mathematics: as a means for clear and logical thinking, as a method for solving problems in everyday life, as a means for recognizing patterns and generalizations through experience, as a means to develop one's creativity, and as a means to increase awareness of cultural development. In the learning process carried out in schools, mathematics is one of the subjects in the spotlight. This is caused by a large number of students who experience difficulties in solving math problems, particularly those found in mathematics lessons. More specifically, students find it challenging to understand geometric material (Fauzi et al., 2019; MdYunus et al., 2019), due to difficulties in forming real and accurate constructions, requiring precision in measurement, taking a significant amount of time, and many students even face obstacles in proving their answers (Noto et al., 2019). Geometry, a branch of mathematics closely related to everyday life, studies three-dimensional geometric shapes and their elements, namely points, lines, and planes. Although it has practical applications, geometry is a branch of mathematics that poses challenges in understanding. Therefore, it is necessary to analyze the causes of the difficulties students face (Kusuma & Rahmawati, 2019). Geometry is taught as a subject in elementary schools and is closely tied to the formation of abstract concepts. To achieve this learning, direct student participation in various activities is essential, going beyond mere transmission of information through lectures or other methods (Nurhasanah et al., 2017).

In studying geometry, students need to have a mature understanding of the concepts. This enables them to apply their geometric skills, such as visualizing, identifying various shapes and areas, describing images, sketching shapes, marking specific locations, and

having the ability to distinguish and compare geometric shapes (Muhassanah et al., 2014). However, students' mastery of geometric material has a relatively low percentage compared to the material taught in class VIII (Kusuma & Susanty, 2019). Dadang's research (2018) suggests that the understanding and creative thinking capacity of junior high school students in relation to flat shape material is categorized as low due to its influence on student psychology.

According to Hasibuan (2018), students face difficulties in learning mathematics, particularly in understanding how the concept determines the surface area of a cube, beam, prism, pyramid, and the volume of a pyramid. Furthermore, students struggle to differentiate between diagonal spaces and diagonal fields. These difficulties in mathematics can be characterized by the inability to remember one or more terms of a concept within the material. This indicates that students still encounter challenges in interpreting mathematical concepts during the learning process.

Moreover, students frequently make errors when solving problems. While working on questions, several common mistakes were identified, including a lack of understanding of symbols, place values, calculations, incorrect use of processes, and illegible writing (Abdurrahman, 2012). This finding is consistent with the research conducted by Ariyani (2019), who discovered that some students made mistakes in understanding word problems.

There are several causes for the mistakes made by students, including: (a) Students often rush and fail to pay attention to the units mentioned in the questions, (b) Students may lack attentiveness when reading and comprehending the questions, (c) Students face difficulty in identifying the given information in the problem, (d) Students may overlook or misunderstand the requirements stated in the problem, (e) Students frequently forget or neglect to record the given information while solving problems. Baskorowati and Wijayanti (2020) suggest that one of the reasons students make mistakes when solving arithmetic problems presented as story problems is their incomplete understanding of the problem's intention.

The inclusion of story questions in spatial material poses a significant challenge for many students, resulting in lower performance compared to criterion-based questions in geometric shapes. According to Shoimah (2020), the abstract nature of mathematical objects, including facts, concepts, operations, and principles, requires more than just

memorization and formula usage in the learning process. To enhance the understanding of abstractness in mathematics, it is crucial to foster connections and multiply the diversity of concepts. In the context of geometric learning, students are not only expected to comprehend the abstract nature of geometric shapes but also to explain definitions by directly observing the objects.

When students engage with geometric materials, they often encounter difficulties, particularly when working on problems related to surface area and volume. This observation aligns with the research findings which indicate that students' scores in the realm of geometric shapes are consistently low and require improvement (Sumadiasa, 2014). According to information provided by teachers, students frequently make mistakes during the calculation process when solving questions related to geometric shapes.

Based on observations conducted in class VI at MI Muhammaduddarain, it has been identified that students face challenges with math lessons involving geometric materials. Additionally, the researcher conducted interviews with educators from the same class to understand their perception of the difficulties faced by students when solving mathematical problems related to geometric material. The interviews revealed that some students continue to struggle with solving questions on geometric material. The class teacher also expressed that geometric material is the most challenging topic for students to grasp. Several factors contribute to this situation, including a weak mastery of geometric material, a lack of knowledge about basic mathematical concepts, and student's inadequate attention during the teaching and learning process.

Based on the results of the Middle Semester Assessment (in Indonesia it is called *Penilaian Tengah Semester*, PTS), the overall mathematics scores of class VI at Muhammaduddarain MI are still below the Minimum Completeness Criteria (in Indonesia it is called *Kriteria Ketuntasan Minimal*, KKM) of 75. This indicates that none of the students in class VI at MI Muhammaduddarain have fully grasped the concept of spatial geometry. The low scores in mathematics can be attributed to several factors, including difficulties in understanding concepts, challenges in applying principles, and struggles with process skills. To improve the student's learning outcomes in mathematics, it is essential for them to possess strong foundational arithmetic skills. Mathematics materials are interconnected and multilevel, making a solid grasp of the basics crucial for understanding the concepts taught by the teacher. Additionally, students should

demonstrate enthusiasm and focus during their learning activities. Given the aforementioned challenges, an analysis is necessary to address the difficulties students face in solving mathematical problems related to geometric shapes. The analysis will involve the use of tests, interviews, and documentation to gather relevant data and insights.

Based on the information provided, the researcher acknowledges the necessity of conducting a study to explore the difficulties that students encounter when solving problems related to geometric materials. The proposed research will be titled "Analysis of Students' Difficulties in Solving Problems in Building Spatial Materials". The study will focus on investigating the types of difficulties students face, including challenges in understanding concepts, applying principles, and utilizing process skills. In general, this section provides an overview of the background, problem formulation, and research objectives. In scientific studies, this introductory section typically includes the background and objectives or scope of the writing, while research articles encompass the background of the problem, problem formulation, and objectives.

## RESEARCH METHODS

This research employs a qualitative descriptive research methodology. According to Moleong (2017), qualitative research aims to comprehend the phenomenon experienced by research participants holistically, such as their behaviors and perceptions, through natural methods and by utilizing descriptive language and words within a natural context. Sugiyono (2011) states that qualitative research is rooted in the philosophy of postpositivism. It is particularly suitable for studying natural objects, where the researcher serves as the key instrument, and data collection techniques involve triangulation, combining multiple approaches. The data analysis in qualitative research is inductive and emphasizes the interpretation of meaning rather than generalization.

This study will utilize the collected information to analyze the difficulties faced by students when solving mathematical problems using geometric materials. The study population consists of 26 students, including 10 boys and 16 girls. The subjects of the study are three students from class VI at MI Muhammaduddarain for the 2022/2023 Academic Year. The research sample was selected based on the students who made the most mistakes in solving problems related to geometric materials. Additionally, subjects

were chosen based on the diversity and uniqueness of their answers, as well as their communication skills. To ensure data accuracy and validity, a data validation technique will be employed during the data analysis process.

The utilization of qualitative methods in this study is highly appropriate as it aligns with the research objective of describing the types of difficulties students face when solving problems related to geometric materials. The study employs two main sources of data, namely primary data sources and secondary data sources. The primary data source in this study consists of the answer sheets of class VI students at MI Muhammaduddarain. Purposive sampling is employed as the data collection technique to select the specific students whose answer sheets will be analyzed. On the other hand, the secondary data sources encompass teachers specialized in mathematics for class VI, documents, academic records, books, and photographs from activities conducted during the research period. The data collection techniques utilized in this study include interviews, tests, and documentation. These methods, along with their respective instruments, are employed to gather relevant and comprehensive data for the analysis of students' difficulties in solving problems related to geometric materials.

In this study, the validity of the data is ensured through the use of a triangulation technique. The triangulation technique, as described by Wau, Hesti A., et al. (2022), involves cross-checking the validity of data by utilizing additional sources or methods for comparison or verification. In this research, the validity of the data is established by comparing the results obtained from student answer sheets with the findings derived from interviews conducted with the research sample, which consists of the students themselves. Through the triangulation method, the study aims to identify the types of difficulties students encounter when solving problems related to geometric materials, specifically difficulties in understanding concepts, applying principles, and utilizing process skills. The data analysis technique employed in this research follows the Miles and Huberman model, as outlined by Ananda (2018). This model includes three stages: data reduction, data presentation, and drawing conclusions or verification. In qualitative research, the validity of findings or data can be ascertained when there is consistency between the researcher's report and the actual events observed in the study. To ensure such consistency, researchers employ the triangulation method, comparing data obtained from two similar problems at different times. By implementing these methods, the study strives

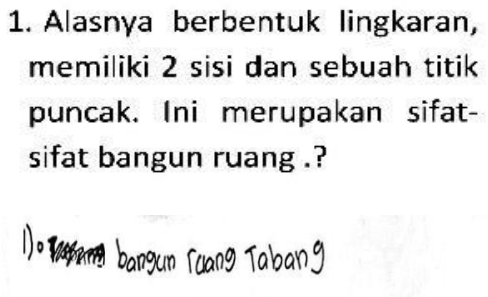
to maintain the validity and reliability of the data collected and analyzed, enhancing the overall quality of the research findings.

## RESULTS AND DISCUSSION

Based on the test results obtained from the 26 students, it was found that 5 students (19.22%) scored in the high category, 57.70% scored in the medium category, and 23.08% scored in the low category. The research commenced with learning observations on the spatial concept material in class VI. The focus of the research was to select research subjects only from students who fell into the moderate category based on their test scores. Subsequently, in-depth interviews were conducted with the selected research subjects. The teaching and learning process was monitored for a duration of 2 hours, equivalent to one class session. Following the observations, the students were provided with material related to geometric shapes, and they were subsequently given a test consisting of three questions to identify areas of difficulty. The test questions were essay-based, allowing for a more comprehensive understanding of the students' thought processes and problem-solving abilities.

### Difficulty in understanding the concept

During the interviews conducted between the researchers and the students, it was identified that students face difficulties in understanding the concepts and properties of geometric figures, specifically in relation to conical shapes. This example highlights the challenges students encounter in comprehending the nature of conical shapes.


1. Alasnya berbentuk lingkaran, memiliki 2 sisi dan sebuah titik puncak. Ini merupakan sifat-sifat bangun ruang .?

Jb bangun ruang Tabung

Figure 1. The Results of Student Worksheets for Question No.1

The interview results shed light on the specific difficulties experienced by the students.

*P : "Is there a part that you can't understand from the problem?"*
*S1 : "There is ma'am. I'm still confused on the difference between the properties of a cone and a cylinder. The problem is that both are based on a circle."*
*P : "Isn't it obvious that a cone has a peak, whereas a cylinder doesn't."*
*S1 : "So like that, ma'am."*
*P : "In addition, you need to remember that a tube has no corner points, while a cone has 1 corner point, namely at the tip of the cone."*
*S1 : "Oh, that's right ma'am, how to tell the difference. Thank you mom. The problem is that at the time of presentation and discussion of the material I did not pay much attention, that's why I did not understand this material. Because I think it's difficult, ma'am."*

Based on the interview results, it can be concluded that students exhibit a lack of attentiveness during teaching and learning activities, primarily due to perceiving geometric material as difficult to comprehend. Consequently, students' motivation and interest in learning are negatively impacted. This is evident in the interview session where students struggled to grasp the differences in characteristics. Specifically, students faced difficulties in understanding the concept of spatial properties. This finding aligns with previous research that highlights students' learning barriers concerning squares and rectangles based on their properties (Nursaidah & Pranata, 2018).

To address students' difficulties in understanding the concept of geometric properties, educators can employ teaching aids or effective learning media. This suggestion is supported by research conducted by Jagom, Uskono, and Fernandez, (2020), which demonstrated that the use of mathematical teaching aids as learning media improved students' engagement and understanding of the concepts. Despite efforts to facilitate learning, students still face challenges in understanding the material related to Flat Sided Space Construct, particularly when solving problems. This difficulty can be attributed to a lack of accuracy in comprehending the questions (Fahlevi & Zanty, 2020). Similarly, research conducted by Melisari et al. (2020) identified that grade IV SDS Pangkalan students frequently encounter difficulties in understanding questions when attempting to solve arithmetic problems involving flat shapes. These findings highlight the importance of addressing students' difficulties in understanding geometric material and developing strategies to enhance their comprehension and problem-solving skills.

In addition, students require effective learning methods to facilitate their understanding of geometric concepts. The learning methods are techniques that educators or teachers must master in order to present the subject matter to each student in the class,

both individually and in groups, thus enabling students to grasp the taught material more easily.

**Difficulty in applying principles**

The students' proficiency in understanding geometric materials can be considered inadequate. It is evident that students face difficulties when solving given questions. While attempting to answer questions, students display imprecision in identifying the appropriate formula for solving geometric problems. Some students even forget the geometric formulas that were previously taught, leading to incorrect answers. The following are samples of students' work, in Figure 2.

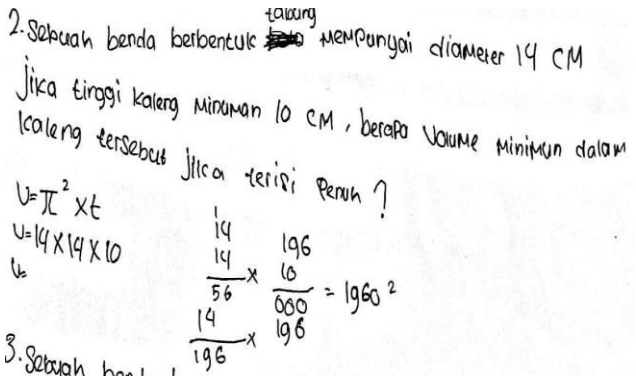



Figure 2. The Results of Student Worksheets for Question No.2

The results of the interview are as follows.

*P : "What were your difficulties when working on the problem of constructing a cylinder chamber?"*
*S2: "I feel confused when I have to calculate the volume of the cylinder."*
*P : "What is it that makes you confused?"*
*S2: "Sometimes I forget the formula for the volume of a cylinder because there are a lot of geometric shapes to learn too. Then there are many different volume formulas, so it makes me confused when I answer."*

This is evident in cases where students make mistakes or omissions in writing formulas. These students rely solely on memorization techniques, resulting in frequent forgetfulness of the formulas and a lack of comprehension of the given questions. Consequently, students experience confusion, leading to incorrect and inaccurate problem-solving. This aligns with the notion presented by Jumiati and Zanthy (2020), who state that many students face difficulties when solving problems and comprehending questions, deeming them challenging.

Hence, it is imperative for students not only to memorize formulas but also to have a thorough understanding of them and engage in extensive problem-solving practice. By practicing the resolution of questions, students will comprehend the process of utilizing the formulas, and with sufficient practice, they will easily recall the formulas on their own.

**Difficulties of students in process skills**

To identify the challenges encountered by students in problem-solving, the researcher administered a test consisting of story questions. These word problems demand systematic thinking and a step-by-step approach to finding solutions. Students are expected to analyze the given information carefully. Therefore, they should be capable of distinguishing between the known elements (what is "given") and the desired information (what is "asked") when attempting to answer the questions. However, in practice, students frequently provide only the final answers without showing any calculations or problem-solving processes. The student work sample, presented in Figure 3, provides insights into the difficulties faced by students in this regard.

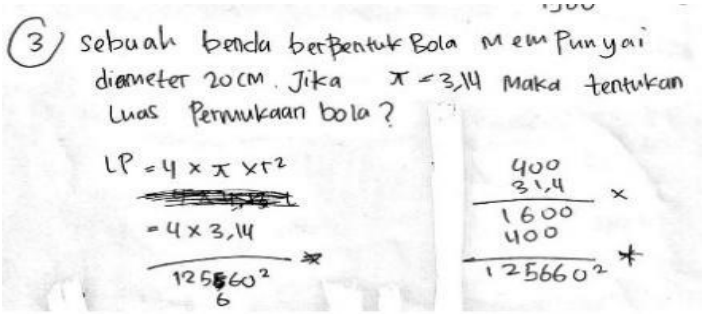



Figure 3. The Results of Student Worksheets for Question No.3

The results of the interview are as follows.

*P : What are your difficulties in doing question no. 3?*
*S3 : I'm still confused about how to calculate it.*
*P : What's confusing you? How to calculate the surface area of a sphere?*
*S3 : Yes, mother. I also find it difficult to calculate multiplication to answer that question.*
*P : From now on you have to get used to doing practice questions at home, so that you are able to solve questions correctly and correctly.*
*S3 : Okay, ma'am. Later I will study it again at home.*

Based on the student's work (S3) on question number 3, it is evident that students are still not following systematic problem-solving steps or employing proper procedures.

This is apparent from the absence of information regarding what is "known" and what is "asked" in their responses. To minimize errors in students' understanding, it is crucial for them to practice extensively, independently working on problems. This practice will help improve their problem-solving abilities and enable them to develop the habit of accurately noting the given information and the desired information in questions. This aligns with the findings of Ario (Lestari, Aripin, & Hendriana, 2018), who identified issues among students such as a lack of precision in comprehending questions, making calculations, and remembering formulas.

It is evident that students' calculation process is prone to inaccuracies, as reflected in their incorrect final answers. This error can be attributed to students' lack of attentiveness when answering questions and their insufficient mastery of basic arithmetic operations such as multiplication and division. Due to their inadequate understanding of arithmetic concepts and operations, mistakes are bound to occur, leading to incorrect results.

To minimize such errors, it is crucial to encourage students to consistently double-check their answers and problem-solving steps. Additionally, it is important to address students' weaknesses in arithmetic operations by revisiting the concepts of addition, subtraction, multiplication, and division. Students should engage in extensive practice, working on exercises that involve continuous arithmetic operations to enhance their foundational arithmetic knowledge. By doing so, they can improve their accuracy in calculations and develop a stronger grasp of arithmetic operations.

## CONCLUSION

Based on the results and discussions presented, several key difficulties have been identified in students' ability to solve mathematical problems related to geometric material. These difficulties include: (1) difficulties in understanding concepts, (2) difficulties in applying principles, and (3) difficulties in process skills. The interviews conducted with students revealed their struggles in comprehending and applying geometric concepts and principles, even when provided with visual stimuli such as pictures to enhance understanding. Therefore, it is recommended for teachers to utilize concrete or real learning media and teaching aids to facilitate better understanding.

Additionally, students have shown a lack of systematic problem-solving approaches, as evidenced by their failure to write down relevant information about what is known and

what is being asked in the questions. Furthermore, students often rely on memorization techniques, resulting in a tendency to forget formulas and consequently struggle to solve questions accurately.

To address these challenges, it is crucial to emphasize the importance of practice in problem-solving. By engaging in extensive practice, students can develop a deeper understanding of the formulae used and improve their ability to recall them. Moreover, it is necessary to consider factors that contribute to students' difficulty in understanding geometric materials, such as limited attention during lessons and low motivation and interest in learning. In light of these factors, teachers are advised to employ effective and tailored learning methods, such as Problem-Based Learning (PBL), which can enhance students' engagement and comprehension of the subject matter.

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