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HOW GOOD STUDENTS' PROBLEM-SOLVING SKILLS ON SENIOR HIGH SCHOOL? AN ANALYSIS ON SEQUENCES AND SERIES MATERIAL

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ABSTRACT

Students frequently respond to problems posed by their instructors through trial and error, without first grasping the underlying concepts. They often perceive the problems as entirely new and unrelated to their previous experiences, leading to a lack of confidence and reinforcing the belief that mathematics is a difficult subject. Consequently, their responses are often incorrect or incomplete. The objective of this study is to describe the mathematical problem-solving abilities of grade XI students on the topic of sequences and series in one of the schools in Bekasi Regency. This research employed a descriptive qualitative method, with data analysis techniques based on the interactive model developed by Miles and Huberman. The subjects of this study were 25 grade XI students selected using purposive sampling. The test instrument consisted of problem-solving tasks, while non-test data were obtained through interviews. The results indicate that students' mathematical problem-solving abilities fall into three categories: 4% of students demonstrated high problem-solving skills, 4% were in the medium category, and 92% were classified as low. A detailed analysis of problem-solving indicators reveals that: (1) in understanding the problem, many students struggled to identify the given information and the goal of the problem; (2) in devising a solution plan, most students failed to select an appropriate strategy, often guessing rather than structuring a logical approach; (3) in executing the plan, students in the low category frequently made calculation errors and misapplied formulas; and (4) in reflecting on the solution, very few students revisited their answers to verify accuracy or consider alternative methods. These findings suggest that students' mathematical problem-solving abilities remain relatively low, with significant gaps in comprehension, planning, execution, and reflection. Strengthening these aspects through targeted interventions is necessary to enhance students' overall problem-solving skills.

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INTRODUCTION

Problem-solving skills are essential in mathematics, as they enable students to apply their knowledge to real-world situations and develop logical reasoning. According to Polya (1945), problem-solving involves four stages: understanding the problem, devising a plan, executing the plan, and evaluating the solution. However, many students struggle with these steps, leading to difficulties in solving mathematical problems effectively.

In international assessments such as PISA, Indonesian students have consistently demonstrated low mathematical problem-solving abilities (OECD, 2018). This indicates challenges in applying mathematical concepts beyond routine exercises. Students often rely on rote memorization rather than conceptual understanding, making it difficult for them to recognize patterns and formulate strategies when faced with unfamiliar problems.

One of the mathematical topics where students encounter problem-solving difficulties is sequences and series. This topic requires students to analyze numerical patterns, derive general formulas, and apply them to solve contextual problems. However, research suggests that many students struggle with these concepts, resulting in errors in reasoning and incorrect solutions (NCTM, 2000).

This study aims to analyze the level of problem-solving skills among senior high school students in grade XI in solving problems related to sequences and series. By examining students' strengths and weaknesses in mathematical problem-solving, this research seeks to categorize their competency levels and identify key challenges. The findings are expected to provide insights that can inform better instructional strategies to enhance students' mathematical reasoning and critical thinking skills.

One of the key skills that students must develop to succeed in mathematics is mathematical problem-solving ability. According to the National Council of Teachers of Mathematics (NCTM, 2000), five fundamental abilities must be mastered by students to excel in mathematics: problem-solving, reasoning and proof, communication, connections, and representation. Branca (1980) emphasized that problem-solving abilities are of paramount importance for students, as they constitute the fundamental objective of mathematics instruction. Problem-solving encompasses methodologies, procedures, and strategies that form the core of mathematical learning. Consequently, mathematical problem-solving proficiency is a crucial competency in mathematics education, as it is a fundamental skill required to effectively address problems by applying appropriate methodologies, procedures, and strategies.

As outlined by Polya (1973), the key indicators of mathematical problem-solving skills can be broadly categorized into four main areas: (1) understanding the problem, (2) planning the solution, (3) solving the problem according to the plan, and (4) rechecking the process and results. Similarly, Soemarmo and Hendriana (2014) proposed a set of analogous indicators, namely: (1) identifying the given elements, the unknowns, and the adequacy of the required elements, (2) formulating mathematical problems or constructing mathematical models, (3) applying strategies to solve problems, and (4) explaining or interpreting the results of problem-solving. In this study, the indicators of mathematical problem-solving skills used include: (1) identifying the given elements, the unknowns, and the adequacy of the required elements, (2) formulating mathematical problems or constructing mathematical models, (3) applying strategies to solve problems, and (4) explaining or interpreting the results of problem-solving.

Although mathematical problem-solving skills are essential in mathematics learning, in reality, these skills remain relatively low among students. Here is the data from PISA 2022 presented in table form:

Tabel 1. PISA 2022 Results (Volume I)

Assessment	Indonesia Score	OECD Average Score
Mathematics	366	472
Reading	359	476
Science	383	485
Creative Thinking (Level 3 and Above)	31%	78%

OECD (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education.*

The average standard score set by TIMSS is 500. However, Indonesia has consistently scored below this benchmark in multiple assessments (Mullis et al., 2020). This fact demonstrates that students' mathematical problem-solving abilities remain below expectations. Consequently, one of the teacher's strategies to enhance these skills is to implement a learning approach that prioritizes problem-solving.

Notably, based on the results of observations, the situation in the field does not align with expectations. The mathematical problem-solving abilities of grade XI students remain below average. This is due to a lack of interest in mathematics, inconsistent attendance in class, and students engaging in activities such as sleeping during lessons and leaving the classroom during instructional hours. One of the primary causes is the perception that learning is monotonous, with a teacher-centered approach where students passively listen to explanations without actively engaging in the problem-solving process. The learning process has not emphasized problems that require critical thinking and systematic strategies. Consequently, students lack experience in solving non-routine problems, making them feel confused and uncertain when attempting to answer them. This often results in careless or incomplete responses.

As noted by Jatisunda (2022), students who encounter such difficulties may struggle to develop their mathematical problem-solving skills, despite problem-solving being a primary objective in mathematics education. This finding is consistent with previous research conducted by Trisniawati (2017), which found that students' mathematical problem-solving abilities in Bandung municipality were still below the 68th percentile. Similarly, the analysis by Latifah and Sutirna (2021) revealed that 46.60% of students relied on trial-and-error strategies, 6.65% used diagramming or drawing strategies, 23.30% employed pattern-finding strategies, and 23.30% utilized logical reasoning. These findings indicate that students' mathematical problem-solving abilities are still underdeveloped, with a predominant reliance on trial-and-error approaches.

Given these challenges, it is crucial for educators to implement strategic solutions. One approach is to adopt teaching methods that enhance students' enthusiasm and motivation for learning. Learning motivation is a critical factor influencing academic success, as it drives students to achieve their learning goals (Nurjan, 2016). Low motivation can negatively impact students' ability to solve mathematical problems. Therefore, effective classroom management is essential to foster a conducive learning environment (Kudsiyah, Novarina, & Lukman, 2017). Research has shown that students in experimental classes exposed to specific instructional strategies demonstrate superior mathematical problem-solving skills compared to control groups, particularly in solving systems of linear equations in two variables (Mariam et al.,

2019). However, other studies suggest that students' difficulties in solving spatial reasoning problems are often attributed to their lack of exposure to problem-based learning approaches, which emphasize conceptual understanding rather than rote memorization (Hegarty & Kozhevnikov, 1999). In light of these findings, this study aims to evaluate the mathematical problem-solving abilities of grade XI students on the topic of sequences and series.

METHOD

This study employs a descriptive qualitative research method to analyze students' mathematical problem-solving skills on sequences and series material. A qualitative approach is chosen to explore in depth how students approach and solve mathematical problems based on established problem-solving indicators.

The population of this study consists of grade XI students from a senior high school in Bekasi Regency. Participants were selected using the purposive sampling technique, which resulted in a total of 25 students taking part in the study. To gain a comprehensive understanding of students' problem-solving skills, three students were chosen one from each category of high, medium, and low problem-solving abilities to represent the responses in data analysis. This classification was determined based on the problem-solving indicators proposed by Sumarmo and Hendriana (2017).

The instruments used in this study include:

1. Mathematical Problem-Solving Test: A set of subjective problem-solving questions related to sequences and series, designed to assess students' abilities based on indicators from Sumarmo and Hendriana (2017) and Amam (2017), which include:
   a. Identifying known elements, questions, and the sufficiency of required information.
   b. Formulating mathematical problems or constructing mathematical models.
   c. Applying strategies to solve problems.
   d. Explaining or interpreting the results of problem solving.
2. Interviews: Semi structured interviews were conducted to gather qualitative data and clarify students' thought processes when solving problems.
3. Instrument Validation: The test instrument was adapted from Widyayanti (2023) and has undergone validity, reliability, distinguishing power, and difficulty index testing.

The research process was carried out in the following steps:

1. Preparation Stage
   a. Designing problem-solving test questions and interview guidelines.
   b. Validating research instruments based on expert judgment and prior studies.

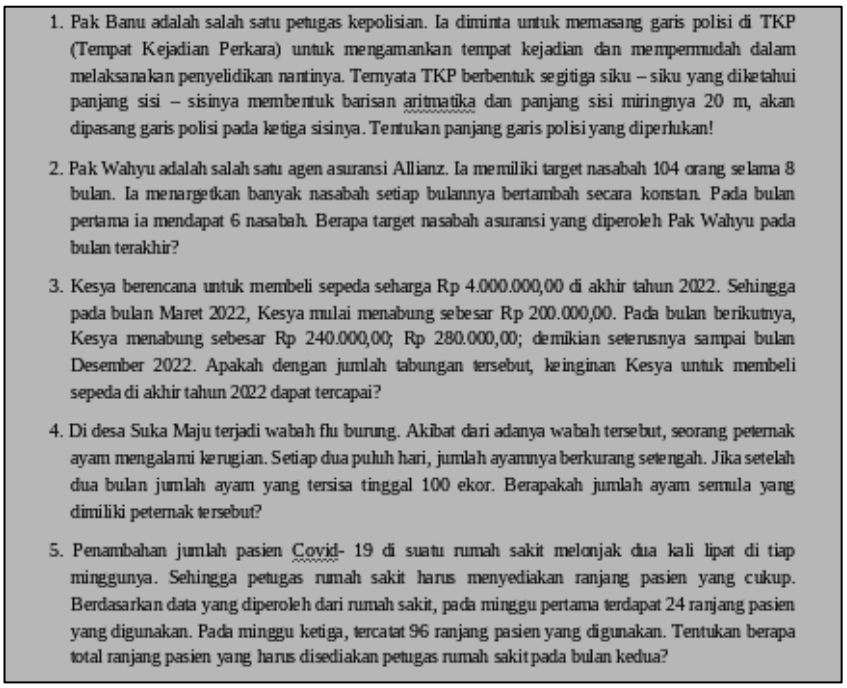
2. Data Collection
   a. Administering the problem-solving test to 25 students.
   b. Selecting three representative students (high, medium, and low problem-solving skills) for interviews.
   c. Conducting in-depth interviews to explore students' problem-solving strategies and difficulties.
3. Data Analysis

   The collected data were analyzed using the Miles and Huberman (1994) interactive model, which consists of:

   a. Data Reduction: Selecting, focusing, simplifying, and transforming raw data from test results and interviews.

b. Data Display: Organizing the reduced data into matrices, graphs, or descriptions to identify patterns.
c. Conclusion Drawing and Verification: Interpreting the findings and validating them through triangulation.

The following figure presents sample questions used to assess students' mathematical problem-solving skills.



1. Pak Banu adalah salah satu petugas kepolisian. Ia diminta untuk memasang garis polisi di TKP (Tempat Kejadian Perkara) untuk mengamankan tempat kejadian dan mempermudah dalam melaksanakan penyelidikan nantinya. Ternyata TKP berbentuk segitiga siku – siku yang diketahui panjang sisi – sisinya membentuk barisan aritmatika dan panjang sisi miringnya 20 m, akan dipasang garis polisi pada ketiga sisinya. Tentukan panjang garis polisi yang diperlukan!
2. Pak Wahyu adalah salah satu agen asuransi Allianz. Ia memiliki target nasabah 104 orang selama 8 bulan. Ia menargetkan banyak nasabah setiap bulannya bertambah secara konstan. Pada bulan pertama ia mendapat 6 nasabah. Berapa target nasabah asuransi yang diperoleh Pak Wahyu pada bulan terakhir?
3. Kesya berencana untuk membeli sepeda seharga Rp 4.000.000,00 di akhir tahun 2022. Sehingga pada bulan Maret 2022, Kesya mulai menabung sebesar Rp 200.000,00. Pada bulan berikutnya, Kesya menabung sebesar Rp 240.000,00; Rp 280.000,00; demikian seterusnya sampai bulan Desember 2022. Apakah dengan jumlah tabungan tersebut, keinginan Kesya untuk membeli sepeda di akhir tahun 2022 dapat tercapai?
4. Di desa Suka Maju terjadi wabah flu burung. Akibat dari adanya wabah tersebut, seorang peternak ayam mengalami kerugian. Setiap dua puluh hari, jumlah ayamnya berkurang setengah. Jika setelah dua bulan jumlah ayam yang tersisa tinggal 100 ekor. Berapakah jumlah ayam semula yang dimiliki peternak tersebut?
5. Penambahan jumlah pasien Covid- 19 di suatu rumah sakit melonjak dua kali lipat di tiap minggunya. Sehingga petugas rumah sakit harus menyediakan ranjang pasien yang cukup. Berdasarkan data yang diperoleh dari rumah sakit, pada minggu pertama terdapat 24 ranjang pasien yang digunakan. Pada minggu ketiga, tercatat 96 ranjang pasien yang digunakan. Tentukan berapa total ranjang pasien yang harus disediakan petugas rumah sakit pada bulan kedua?

Figure 1. Problem Solving Skills Question

RESULTS AND DISCUSSION

Results

The results of this study are based on students' mathematical problem-solving scores, analyzed to determine the maximum, minimum, average, and standard deviation values.

Table 2. Mathematical Problem Solving Skills Test Results

Number of Students	Maximum Score	Minimum Score	Standard Deviation	Mean
25	50	10	8,74	26,16

The mean score obtained was 26.16, with a standard deviation of 8.74. The highest score recorded was 50, while the lowest score was 10. Based on Sudijono's (2011) categorization method, students were grouped into three categories:

Table 3. Categorization of Mathematical Problem-Solving Skills

Category	Score Interval	Number of Students	Percentage
High	$X \geq 34,90$	1	4%
Medium	$25,16 \leq X < 34,90$	1	4%
Low	$X < 25,16$	23	92%

These results indicate that most students fall into the low category, suggesting that their mathematical problem-solving skills require further improvement. Specifically, one student was categorized as high, one student as medium, and 23 students as low.

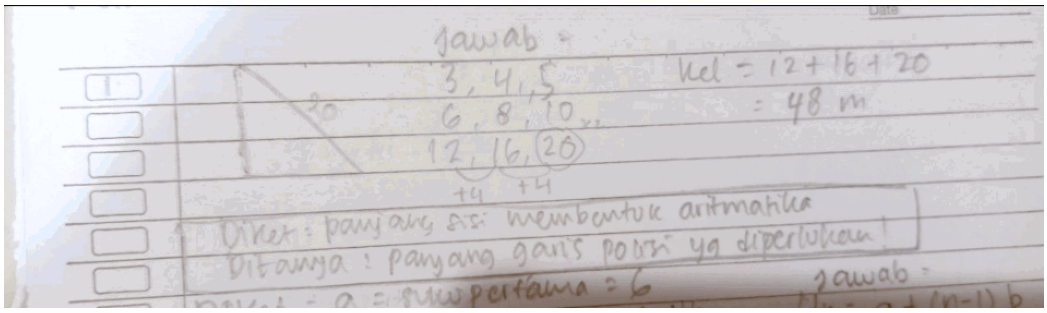


Figure 2. High Category Students' Answers for Question Number 1

The student in this category demonstrated a strong understanding of the problems and provided logical and structured solutions. However, minor errors were still observed. For example, the student stated, *"I thought I had solved it correctly, but I made a small mistake in my calculations."* This suggests a need for more careful verification of answers.

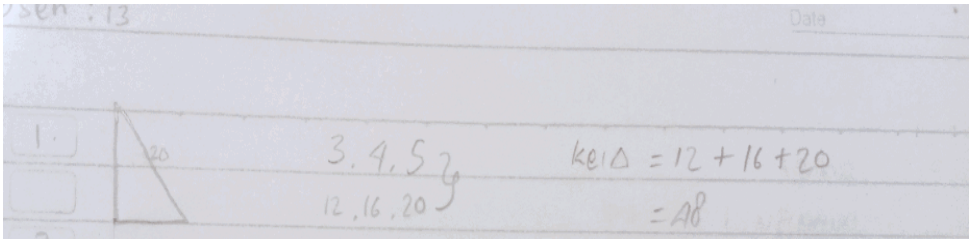


Figure 3. Medium Category Students' Answers for Question Number 1

The student in this category was able to complete the problems but showed inconsistency in presenting solutions. They often omitted important steps and lacked confidence in their approach. One student noted, *"I wasn't sure which formula to use, so I tried different methods."* This suggests a reliance on trial-and-error rather than structured problem-solving.

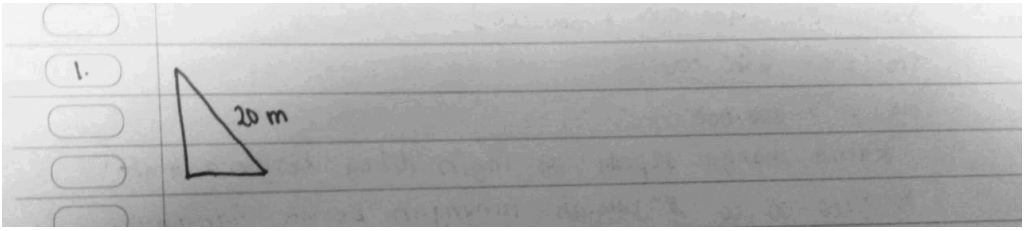


Figure 4. Low Category Students' Answers for Question Number 1

The majority of students (23 out of 25) fell into this category, indicating significant difficulties in mathematical problem-solving. These students often struggled to comprehend the questions and formulate solutions. One student admitted, *"I don't really understand how to start."* This suggests a lack of familiarity with problem-solving strategies.

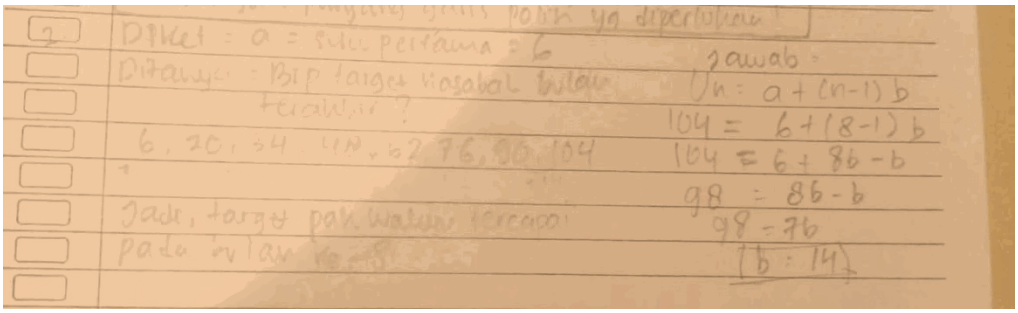


Figure 5. High Category Students' Answers for Question Number 2

For problem number two, the student initially used the Un formula instead of the Sn formula, leading to incorrect results. When asked about this mistake, the student admitted, *"I misunderstood the question and thought it asked for the last term instead of the sum."* This highlights the importance of reading comprehension and accuracy in problem-solving.

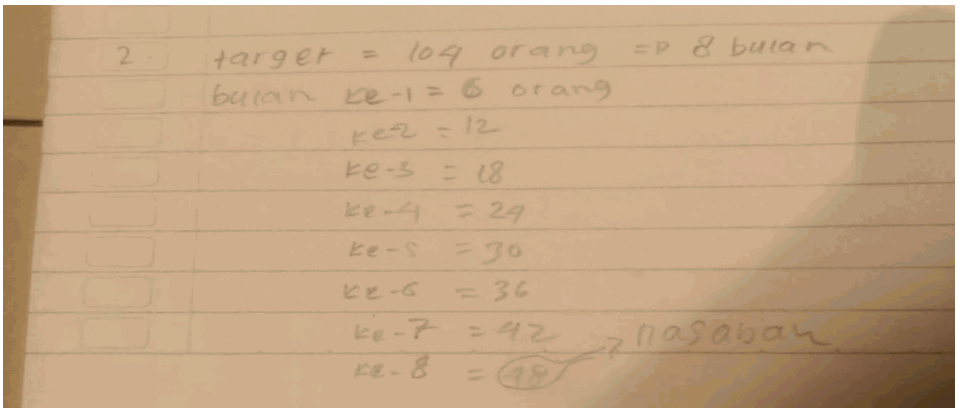


Figure 6. Medium Category Students' Answers for Question Number 2

For the second question, the student struggled to determine the correct sequence of calculations. When interviewed, they admitted, *"I got confused with the notation and ended up making mistakes."* This highlights a need for reinforcement of mathematical notation and structured approaches.

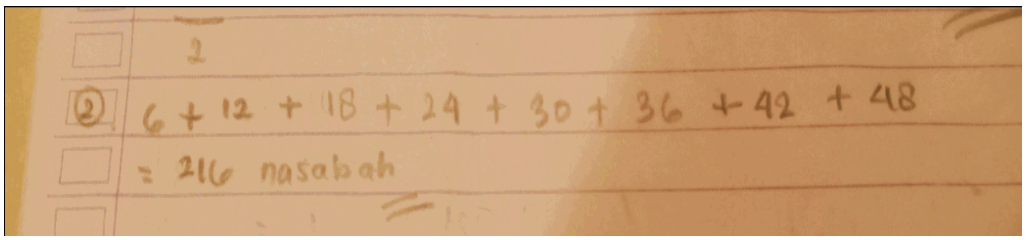


Figure 7. Low Category Students' Answers for Question Number 2

For the second question, students displayed minimal engagement in the solution process, frequently leaving their answers incomplete or incorrect. One student stated, *"I just guessed the answer because I didn't know what to do."* This reflects a fundamental gap in conceptual understanding.

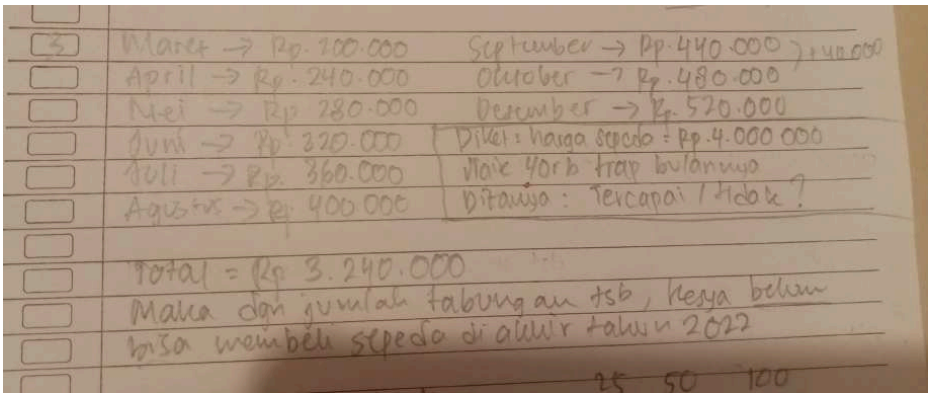


Figure 8. High Category Students' Answers for Question Number 3

In the third question, the student solved the problem systematically but had difficulty applying a previously learned method. They stated, *"I have encountered this type of problem before, but I forgot the exact steps."* This suggests that even high-performing students may struggle with long-term retention of concepts.

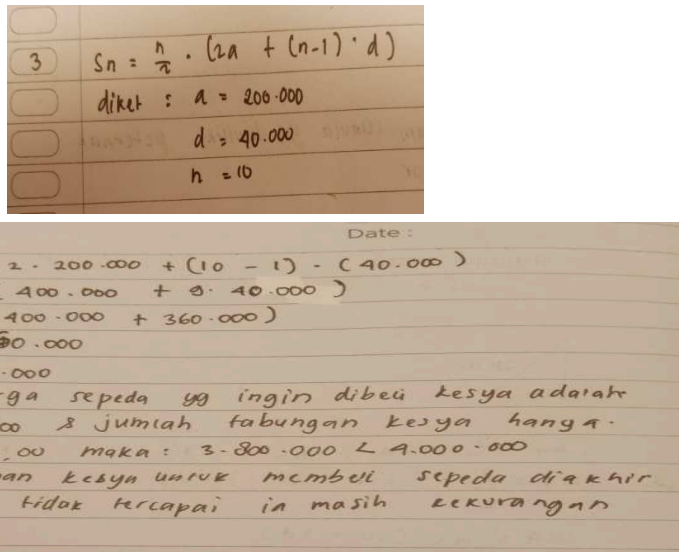


Figure 9. Medium Category Students' Answers for Question Number 3

In the third question, the student showed better comprehension than those in the low category but still made minor calculation errors. They commented, *"The problem wasn't too hard, but I should have checked my work more carefully."* This suggests that students in the medium category need to improve accuracy and verification of answers.

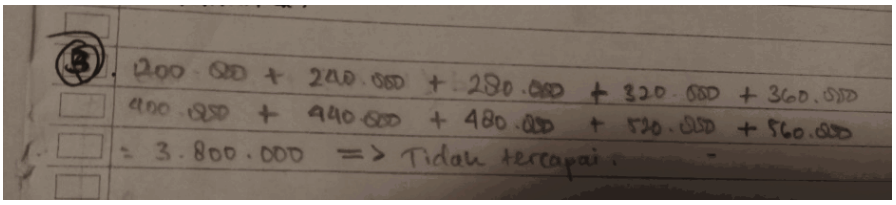


Figure 10. Low Category Students' Answers for Question Number 3

In the third question, many students failed to identify key elements and relied on brute-force calculations instead of applying the correct formulas. When asked about their approach, one

student replied, *"I wasn't sure what information was important."* This suggests a need for guided practice in identifying relevant problem elements.

Discussions

The findings indicate that students struggle with various aspects of mathematical problem-solving. Based on four key indicators of problem-solving skills, the following insights can be drawn:

1. Understanding Problem
   Many students, especially in the low and medium categories, did not explicitly identify the given and asked elements in the problem. This aligns with Ramadhani & Hakim (2021), who found that students often skip writing problem information due to a lack of structured problem-solving habits.
2. Developing a Solution Plan
   Students in the low and medium categories exhibited difficulty in formulating a solution strategy. According to Purnamasari & Setiawan (2019), the ability to create a structured plan is crucial for solving mathematical problems. The findings suggest that students in these categories are less capable of developing strategies, leading to frequent errors.
3. Executing the Plan and Obtaining Correct Answer
   Students in the medium category could often reach the correct answer, even without a clear plan. However, those in the low category struggled significantly due to misinterpretation of concepts. This aligns with Utami & Wutsqa (2017), who found that students often face difficulties in linking problem elements to the correct mathematical operations.
4. Rechecking and Interpreting Solution
   Many students failed to double-check their answers. The student in the high category demonstrated a better grasp but still exhibited occasional miscalculations due to carelessness. This supports the findings of Amaliah, Sutirna, & Zulkarnaen (2021), who emphasized the importance of rechecking work to minimize errors.

Overall, the findings suggest that students' problem-solving skills need significant improvement, particularly in understanding the problem and developing a structured solution plan. Teachers should emphasize step-by-step problem-solving strategies to enhance student comprehension and accuracy.

CONCLUSION

Based on the results of research on high school students in one of the schools in Bekasi Regency on the topic of sequences and series, it can be concluded that students' mathematical problem-solving skills can be grouped into three categories: high, medium, and low. The findings indicate that the majority of students fall into the low category, demonstrating significant difficulties in understanding problems, formulating solution strategies, and verifying their answers. Students in the medium category showed some ability to approach the problems but lacked consistency in their reasoning and solution processes, often making errors in calculations or concept application. Meanwhile, the high-category student demonstrated strong analytical skills but still exhibited minor mistakes in execution.

Overall, these results suggest that students' mathematical problem-solving skills on the subject of sequences and series are still weak, particularly in solving non-routine problems that require structured and strategic thinking. This issue may be influenced by students' learning habits, which are predominantly focused on memorization rather than problem-based learning, as well

as their heavy reliance on LKS books. Therefore, to enhance students' problem-solving abilities, it is crucial to implement learning approaches that emphasize conceptual understanding, structured problem-solving strategies, and independent reasoning rather than mere rote memorization. Future research could explore effective interventions to improve students' ability to tackle complex mathematical problems systematically.

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