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Analysis of Fourth Grade Elementary Students' Mathematical Problem-Solving Abilities

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Abstract

The purpose of this study is to describe students' mathematical problem-solving abilities and to identify the factors that influence them. This research is a qualitative study with a descriptive approach conducted at SDN 1 Mendolo Kidul, with fourth-grade students and their teacher as research subjects. Data were collected using tests, interviews, and documentation. The validity of the data was ensured through source triangulation and technique triangulation. The data were analyzed using the Miles and Huberman model, which includes data reduction, data display, and conclusion drawing. The results show that students in the high category tend to apply all problem-solving steps correctly, while those in the medium category still make mistakes in some steps. In contrast, students in the low category make errors in almost all of the steps. The factors that influence students' mathematical problem-solving abilities include experiential, affective, and cognitive factors. The results of this study can serve as a reference for teachers in designing more effective learning strategies to improve students' mathematical problem-solving abilities. In addition, the findings can assist schools in developing remedial programs tailored to students' ability levels. This study also contributes to providing empirical information on the variation of mathematical problem-solving abilities at the elementary school level and the influencing factors, which can serve as a reference for further research in this field.

INTRODUCTION

Education is one of the essential aspects of human life. This is affirmed by Putri et al. (2025), who state that education primarily functions to help individuals grow into independent and well-rounded personalities. Beyond serving as an academic platform, education also acts as an instrument for shaping self-identity and life orientation, encouraging individuals to think critically, make wise decisions, and actively participate in society. However, the results of the 2022 Programme for International Student Assessment (PISA) study conducted by the Organization for Economic Co-operation and Development (OECD) indicate that Indonesia's education system cannot yet be considered effective. Indonesia ranked 69th out of 80 participating countries, or 12th from the bottom, with scores below the OECD average: 366 in mathematics, 359 in reading, and 383 in science. According to Siswanto & Meiliasari (2024), the primary reasons for Indonesia's low PISA ranking stem from students' limited ability to solve non-routine or high-level problems. This issue arises due to insufficient exposure to high-level non-routine questions in the school curriculum. Therefore, the findings of this study are expected to serve as an evaluation for the Indonesian government in formulating and designing education policies to improve the system, particularly by optimizing the curriculum, which serves as the guiding framework for education in Indonesia.

Referring to Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 12 Tahun 2024, the current curriculum in Indonesia's education system outlines the curriculum structure, including the subjects that students must study and the time allocation for each. In this regard, mathematics is one of the subjects taught at all levels, from early childhood education, where students are introduced to basic mathematical concepts, to primary and secondary education, where more structured, complex, and progressively layered material is taught continuously. The inclusion of mathematics as a subject across all educational levels undoubtedly signifies its importance in human life. This aligns with Permatasari (2021) view that mathematics learning in elementary school is crucial for children, as the knowledge gained at this stage significantly influences subsequent levels. Nevertheless, mathematics carries a stereotype among students that it is a difficult subject, consistent with Permatasari (2021) statement that mathematics is perceived as a challenging course. It is also viewed as intimidating, uninteresting, and boring.

According to Patta & Muin (Afifah et al., 2023), mathematics is a discipline used to develop thinking patterns across various other fields, given that nearly all areas of study utilize mathematical concepts to analyze their objects of inquiry. However, school mathematics does not entirely mirror mathematics as a pure science. On this matter, Andriliani et al. (2022) explain that mathematics learning essentially involves designing a process to create an environment that enables students to engage in mathematical learning activities, where mathematics instruction should provide opportunities for students to explore and gain experiences with

mathematics. The mathematics learning process in schools can be understood as an effort to provide students with experiences through structured activities, enabling them to master competencies related to the taught mathematical content. Furthermore, the general objectives of mathematics teaching, as outlined by Usman et al. (2022) include the ability to solve problems. In addition, problem-solving, which encompasses methods, procedures, and strategies, forms the core and primary process in the mathematics curriculum, and it also serves as a fundamental skill in mathematics learning.

Based on the preceding discussion, the general objective of mathematics teaching is to develop problem-solving abilities. Therefore, students must master problem-solving skills. This is emphasized by Suryatin (Afifah et al., 2023) who explains that mathematical problem-solving skills are a key supporting factor that everyone needs to acquire for solving problems, extending beyond classroom exercises to broader applications in everyday life. According to Polya (Hidayah et al., 2023), problem-solving is the effort to find a way out of something perceived as difficult to achieve the desired goal. In mathematics learning, Arrosyad et al. (2023) describe how students can practice and develop problem-solving abilities through instruction that incorporates word problems. Presenting mathematics problems in the form of word problems allows students to experience the connection between those problems and daily life. The problem-solving process involves several stages. This study focuses on Polya's stages of mathematical problem-solving which consist of four steps: 1) understanding the problem; 2) devising a problem-solving strategy; 3) implementing the problem-solving strategy; and 4) checking the obtained solution (Usman et al., 2022).

However, the reality in the field does not align with the aforementioned theory, as fourth-grade students at SDN 1 Mendolo Kidul have not optimally applied these four problem-solving steps when tackling word problems. Based on pre-research interviews and observations, the fourth-grade teacher reported that students struggle to fully comprehend the problems presented in word problems, leading to confusion in applying the problem-solving steps. Observation results showed that while working on word problems, students frequently asked the teacher about the meaning of the presented problems and inquired about information already stated in the problems. According to the Mid-Semester Summative Assessment results for mathematics, 8 out of 10 fourth-grade students answered the word problem section incorrectly, while the 2 students who answered correctly did not fully document the problem-solving steps.

The above issues are relevant to the problem-solving abilities examined by Oktasya et al. (2022), which revealed that in fifth grade at SDN 01 Tempos in West Lombok, no students achieved the "very good" criterion. Only 1 student had good problem-solving abilities, 2 achieved adequate, 4 were below adequate, and 13 were very low. Additionally, research by Halimah et al. (2021) showed that students with

high-category problem-solving abilities could solve word problems effectively, while medium-category students could handle them adequately but with some calculation errors. Low-category students, however, could not solve word problems effectively. The factors affecting students' ability to solve word problems depend on how well they understand and address them.

Meanwhile, Nugraha et al. (2024) identified factors influencing students' success or failure in executing each problem-solving stage as internal and external. Internal factors include students' intellectual abilities, interest and talent in mathematics, attitudes during learning, and communication skills at home or school. External factors encompass the roles of teachers and parents in guiding, assisting, and directing students during learning at home or school. In this study, the factors affecting mathematical problem-solving abilities are drawn from Charles and Lester's theory (Utami, 2023), encompassing three main factors: experience, affective, and cognitive.

Although previous studies have made significant contributions to understanding mathematical problem-solving abilities among elementary school students, few have specifically examined how students execute each problem-solving stage, particularly in the context of word problems that require deep comprehension of the presented issues. Moreover, research on factors influencing mathematical problem-solving abilities, such as those proposed by Charles and Lester, has rarely been directly integrated into analyses of students' problem-solving processes for word problems at the elementary level. Therefore, this study offers novelty by combining a step-by-step analysis of Polya's problem-solving process as applied by students to word problems with the influencing factors based on Charles and Lester's theory, providing a more comprehensive overview than prior research. This study is expected to contribute to the development of more effective learning strategies for enhancing mathematical problem-solving abilities at the elementary school level.

METHODS

This study used a qualitative method with a descriptive approach. It aimed to provide an in-depth description of an existing condition, focusing on students' mathematical problem-solving abilities and the factors that influence them. No treatment, manipulation, or alteration was applied to the independent variables. The research took place at SDN 1 Mendolo Kidul, involving three fourth-grade students and their teacher. Subjects were chosen through purposive sampling based on specific criteria. One student represented the high category, one the medium category, and one the low category. A high category score ranged from 80 to 100, medium from 60 to below 80, and low below 60, following the classification by Ruqoiyyah et al. (2023).

Data collection used tests, interviews, and documentation. The test measured problem-solving ability through word problems. Interviews verified test results and explored factors affecting problem-solving. Semi-structured interviews were conducted with students and the teacher, following an interview guide. Documentation supported the findings from the other two methods. Data validity was confirmed through source and technique triangulation by comparing results for consistency. The analysis used Miles and Huberman's model, which includes data reduction, data display, and conclusion drawing.

RESULTS AND DISCUSSION

1. Mathematical Problem-Solving Abilities

The findings regarding students' mathematical problem-solving abilities are based on descriptions from test results, interviews, and documentation. The research results show that students in the high category of mathematical problem-solving abilities can solve at least 1 to 2 out of 4 given word problems. They do so by following the steps of mathematical problem-solving, from understanding the problem to verifying the answer, without committing any errors. The section below presents the test performance in mathematical problem-solving by a student in the high category.

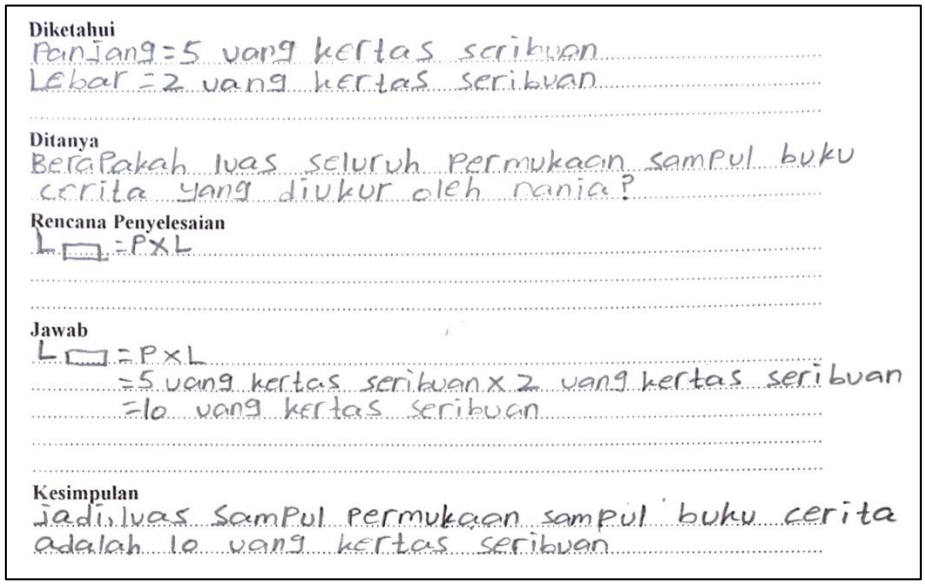
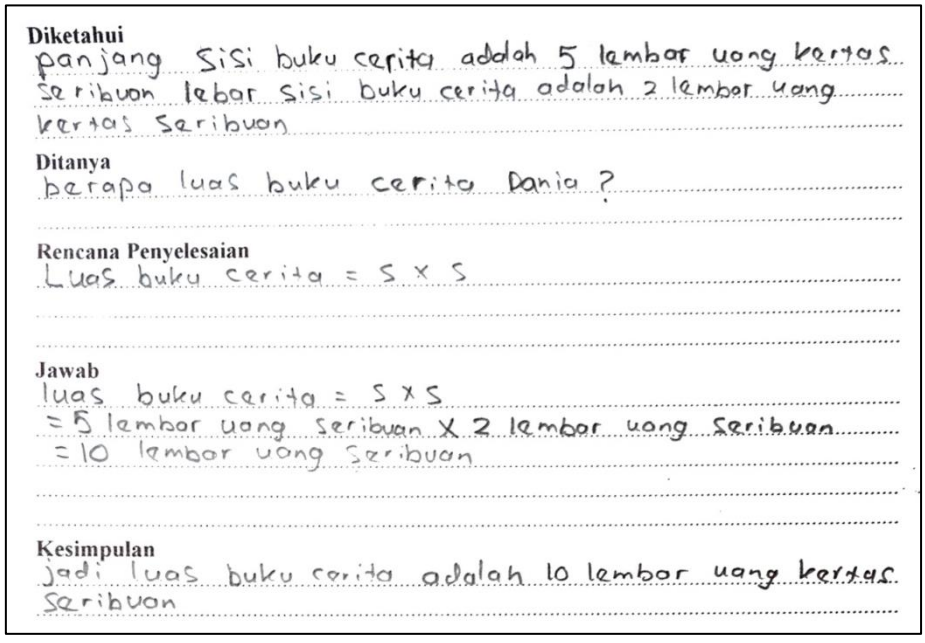


Figure 1. High Category Student Answer Sheet

The figure above illustrates that, in the step of understanding the problem, the student accurately and completely notes the known information from the problem and correctly identifies what is being asked. In the step of devising a problem-solving plan, the student creates an appropriate plan for solving the word problem, based on the known information and the question posed. In the step of carrying out the plan, the student executes the problem-solving procedures in a logical order,

performs the calculations fully, and arrives at a correct final answer. In the step of checking back, the student writes a concluding sentence from the obtained answer and records the verified final answer correctly. These test results are consistent with the interview data, which reveal that high-category students can explain the problem-solving steps for word problems with confidence.

Students in the medium category of mathematical problem-solving abilities, by comparison, demonstrate solid skills in understanding problems, but their performance is not entirely consistent across all items. They can identify the known information and what is being asked in some problems. Yet, they often make mistakes or show hesitation when explaining these elements to others. The step of devising a problem-solving plan is similarly inconsistent. Students can formulate a suitable plan for certain problems, but face challenges with the rest. This indicates that planning still relies on the problem's complexity and previous experience. In the step of carrying out the plan, students can document and describe the procedures well enough, but they frequently err during implementation. In the step of checking back, they usually do not verify their answers comprehensively. The section below presents the test performance in mathematical problem-solving by a student in the medium category.


Diketahui
panjang sisi buku cerita adalah 5 lembar uang kertas seribuan lebar sisi buku cerita adalah 2 lembar uang kertas seribuan

Ditanya
berapa luas buku cerita Dania ?

Rencana Penyelesaian
Luas buku cerita = S x S

Jawab
luas buku cerita = S x S
= 5 lembar uang seribuan x 2 lembar uang seribuan
= 10 lembar uang seribuan

Kesimpulan
jadi luas buku cerita adalah 10 lembar uang kertas seribuan

Figure 2. Middle Category Student Answer Sheet

The figure shows that, in the step of understanding the problem, the student accurately and completely notes the known information from the problem, but incorrectly states what is being asked. In the step of devising a problem-solving plan, the student describes a plan for solving the word problem. However, the plan is incorrect because the question involves the area of a rectangle, while the student uses the formula for the area of a square. In the step of carrying out the plan, the student follows the procedures in a logical order, completes the calculations fully,

and produces a correct final answer, even though the formula was wrong. In the step of checking back, the student records the verified final answer correctly, but the concluding sentence is inaccurate because it does not match the question. The interview results further indicate that medium-category students lack confidence when explaining the problem-solving steps for word problems.

In contrast, students in the low category of mathematical problem-solving abilities tend to make many errors in every step across all problems. Their understanding of word problems is still very limited, so they complete the steps carelessly. The section below presents the test performance in mathematical problem-solving by a student in the low category.

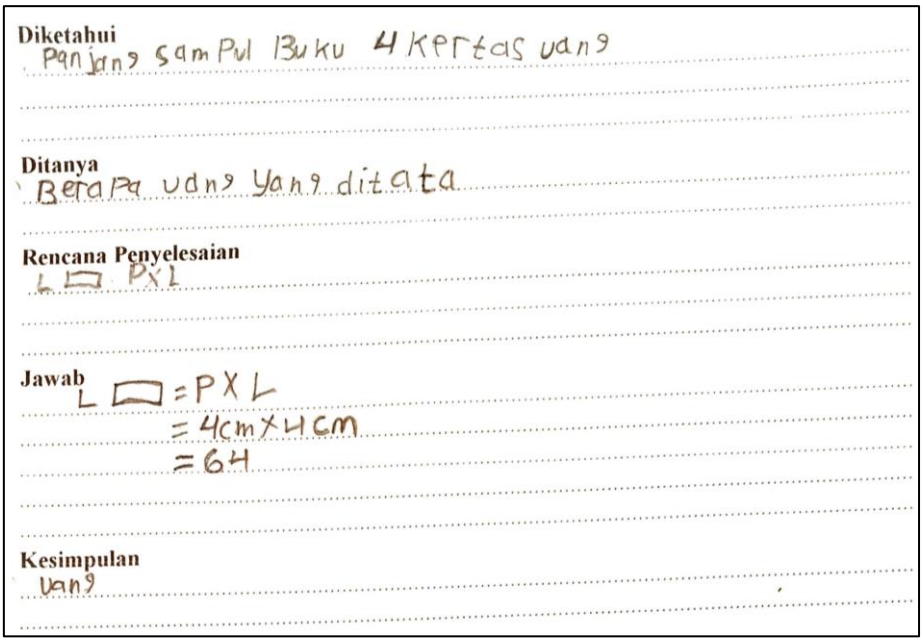


Figure 3. Low Category Student Answer Sheet

Referring to the figure above, in the step of understanding the problem, the student incorrectly notes the known information and what is being asked. In the step of devising a problem-solving plan, the student outlines a plan for solving the word problem by writing the correct formula. However, in the step of carrying out the plan, the student handles the procedures carelessly, which leads to an incorrect final answer. In the step of checking back, the student does not review the results from earlier steps and simply writes the final answer carelessly, without adding a concluding sentence. The interview results also show that low-category students lack confidence and speak haltingly when explaining the problem-solving steps for word problems.

This description aligns with the research by Halimah et al. (2021), which states that students with high-category problem-solving abilities can solve word problems effectively. Medium-category students can handle word problems adequately, though they still have some calculation errors. Low-category students, however, cannot yet solve word problems effectively. Moreover, the findings of this study are

in line with those of Simamora (2023), who reports that high-category students solve problems in questions with accuracy and care. Medium-category students, on the other hand, do not fully follow Polya's problem-solving stages. This is clear from their inability to check each step of the answer and their lack of precision in addressing word problems. Low-category students fail to meet all of Polya's stages adequately. Their skills are limited to reading the problem without real comprehension, struggling to plan solution steps, being unable to carry out the plan because they lack an earlier strategy, and skipping verification of the answer.

A more detailed review of these findings suggests that the differences in problem-solving abilities among the three categories stem from variations in mathematical thinking patterns. High-category students show reflective and systematic thinking. They review their own steps and see how the problem's information connects. Evin Gencel and Saracaloglu (Mafaza & Subekti, 2024) explain that reflective thinking helps people choose problem-solving strategies and methods to improve their mathematical skills. Similarly, Awaliya & Masriyah (2022) point out that people who use reflective thinking are usually more careful and thorough. They take longer to solve problems but produce accurate results. Medium-category students, in contrast, rely on procedural thinking. They try to apply familiar patterns to the problem-solving steps but cannot easily adapt to new contexts. This shows a lack of flexible thinking. Problem-solving, though, is more than just procedures; it requires a deep conceptual grasp of the problem. Saskia et al. (2023) support this by noting that procedural thinking focuses on "how" a process works, not "why." Students with this approach may solve problems correctly without understanding the reasons behind the steps. They handle familiar types well but struggle with small changes or the same concepts in different settings. Low-category students exhibit impulsive thinking. They rush to answer without fully understanding the context. This appears in their careless and illogical notes on the steps, which means they cannot link the known information to the question. Awaliya & Masriyah (2022) agree, stating that impulsive thinkers process ideas quickly but carelessly, often leading to wrong solutions.

Linking these findings to Polya's theory reveals that most errors happen in the first two stages: understanding the problem and planning the solution strategy. These stages set the foundation for the rest. If students do not grasp the problem well, their plans and results will be off track. The findings make it clear that not all students can complete the four stages fully. For medium- and low-category students, the hardest parts are understanding the problem and planning, which demand strong reading and interpretation skills. In short, the biggest challenge for elementary school students in problem-solving is not basic computation but understanding the problem's meaning and structure. This emphasizes the value of teaching methods that build conceptual understanding before moving to procedures.

Although this research matches several earlier studies, it differs from some others. For example, Widiasari & Hidayati (2021) describe students' mathematical problem-solving abilities using the SOLO (Structure of Observed Learning Outcome) taxonomy. They group students into four levels: prestructural, unistructural, multistructural, and relational. Then, they analyze problem-solving skills at each level. Their results highlight clear differences in mathematical problem-solving abilities across the SOLO levels.

2. Factors Affecting Mathematical Problem-Solving Abilities

Students' mathematical problem-solving abilities can be influenced by three factors: experience, affective, and cognitive. The experience factor includes knowledge of problem-solving strategies as well as knowledge of the problem's context and content. The affective factor encompasses interest, motivation, anxiety, and patience. The cognitive factor consists of reading ability, analytical ability, and computational skills. These three factors can lead to variations in mathematical problem-solving abilities among individual students. The data on these influencing factors comes from interviews with students and the teacher.

Based on the research findings, high-ability students possess strong knowledge of strategies for solving word problems, along with a solid understanding of the problem's context and content in terms of the experience factor. In this regard, these students can solve word problems by accurately applying problem-solving steps, as they have prior experience or knowledge of such strategies. According to the interview results, this knowledge of solving strategies, as well as the problem's context and content, is acquired by listening attentively to the teacher's explanations, recalling what peers have taught, and practicing word problems. Regarding the affective factor, these students exhibit high levels of patience, interest, and motivation, and they rarely feel anxious when solving word problems. The interviews revealed that high-ability students enjoy working on word problems, persist in completing them by deeply exploring the problem's intent, and have a strong internal drive to solve them. Although they occasionally feel anxious due to fear of incorrect answers, this happens infrequently. High-ability students are generally more confident when tackling word problems. As for the cognitive factor, these students demonstrate strong reading ability, analytical skills, and computational proficiency when solving word problems. The interviews indicated that high-ability students can often comprehend the presented problems independently, analyze word problems systematically by identifying known information and what is being asked, and then devise an appropriate solution plan.

Medium-ability students have adequate knowledge and understanding of word problem-solving strategies, as well as the problem's context and content, in terms of the experience factor. According to the interviews, these students gain knowledge of solving strategies from teacher or peer explanations. However, when

faced with word problems, they still make some errors in applying mathematical problem-solving steps, largely due to the problem's complexity. For the affective factor, these students show moderate interest, motivation, and patience, though they sometimes experience anxiety when solving word problems. The interviews showed that medium-ability students do not particularly enjoy word problems, have some internal drive to solve them but not strongly, occasionally feel nervous about making mistakes in the steps, and complete word problems by following the mathematical problem-solving steps from start to finish, though they tend not to recheck their work. Regarding the cognitive factor, these students possess sufficient reading ability, analytical skills, and computational proficiency for solving word problems. The interviews revealed that medium-ability students sometimes need assistance from others to understand word problems. Additionally, they often jump straight to a solution plan without fully analyzing the known information and what is being asked. As for computational skills, these students occasionally lack confidence due to past calculation errors.

Meanwhile, low-ability students have limited knowledge of solving strategies and understanding of the problem's context and content in terms of the experience factor. According to the interviews, these students have been taught methods or steps for solving word problems, but often forget them when encountering new ones. Consequently, their knowledge of word problem-solving strategies remains inadequate. Moreover, they consistently fail to grasp the intent of word problems, so their understanding of the context and content is also lacking. For the affective factor, these students exhibit low interest, motivation, and patience, and they frequently feel anxious when solving word problems. The interviews indicated that low-ability students dislike facing word problems and lack an internal drive to solve them. They also consistently feel anxious, viewing word problems as difficult, and show impatience by not attempting to deeply understand the problem before tackling it haphazardly. As a result, their application of problem-solving steps tends to involve many errors. Regarding the cognitive factor, these students have weak reading ability, analytical skills, and computational proficiency when solving word problems. The interviews showed that low-ability students always require help from others to comprehend the read word problems, struggle with analyzing them, including identifying known information and what is being asked, as well as devising an appropriate solution plan, and lack confidence in performing calculations.

The above description aligns with the theory of Charles & Lester (Utami, 2023), which states that an individual's problem-solving process is influenced by three factors: 1) the experience factor, including environmental and personal elements such as age, knowledge, problem-solving strategies, and understanding of the problem's context and content; 2) the affective factor, comprising interest, motivation, pressure, anxiety, tolerance for ambiguity, resilience, and patience; and 3) the cognitive factor, which includes reading ability, insight, analytical ability,

computational skills, and more. Additionally, the research findings are consistent with several prior studies. For instance, Sinaga et al. (2024) explain that problem-solving abilities are heavily influenced by knowledge of solving strategies, as well as the problem's context and content, since the problem-solving steps themselves involve processes such as carefully reading the problem, understanding the given information, identifying what is known and asked, and selecting an appropriate strategy. Another study by Ramadhani et al. (2023) demonstrates that students' mathematical problem-solving abilities are affected by factors such as conceptual understanding, reading and comprehension skills, logical thinking, motivation, and learning interest.

A deeper examination of these research findings from the perspective of the experience factor reveals that differences in outcomes across student categories can also be explained by the frequency and quality of exposure to word problems. High-category students typically have extensive learning experiences, both in class and through independent practice. In contrast, medium and low-category students tend to have limited experiences. In this context, Aulina et al. (2025) emphasize that students with prior experience studying a topic are generally more prepared and less nervous when facing similar problems. From an affective standpoint, the results show that interest, motivation, anxiety, and patience significantly impact students' performance in problem-solving. Students with high motivation appear more persistent and confident, even with difficult problems. On this point, Viventi (Hardianti et al., 2021) states that individuals with high motivation tend to be more enthusiastic and capable in problem-solving. Higher motivation encourages students to study more diligently, increasing their learning frequency. Conversely, low-motivation students easily give up, make errors due to carelessness and impatience, and opt for superficial solutions. Meanwhile, from a cognitive perspective, these factors contribute directly to students' success in executing each problem-solving stage. Strong reading, analytical, and computational skills enable students to understand relationships among problem information and apply them in new contexts.

Interestingly, the findings also reveal interconnections among the factors that mutually reinforce one another. The experience factor can enrich the cognitive factor, as greater and broader learning experiences expand students' knowledge of solving strategies. On the other hand, the affective factor can strengthen or weaken the effects of the other two. Students with high motivation and strong interest in mathematics more readily build new learning experiences and develop cognitive abilities. This indicates that improving problem-solving abilities cannot be addressed partially; instead, all three aspects must be considered simultaneously.

In addition to aligning with relevant theory and studies, this research also differs from others. For example, Halimah et al. (2021) suggest that factors influencing mathematical problem-solving abilities are limited to students'

understanding of word problems. Furthermore, Nugraha et al. (2024) present differences from this study. In their research, students' mathematical problem-solving abilities are influenced by internal and external factors. Internal factors include intelligence, interest, talent, attitudes, and communication skills in mathematics, while external factors involve the roles of parents and teachers in guiding and instructing students.

CONCLUSION

Based on the research findings and the discussion above, it can be concluded that students with high mathematical problem-solving skills can understand problems well, develop appropriate problem-solving plans, execute their plans logically and systematically, and tend to review the answers they obtain. Students in the medium category can understand most problems in word problems; however, they are less meticulous and sometimes make mistakes when formulating problem-solving plans. They are also able to carry out the plans, but they are less precise in writing the procedures. The step of reviewing their work is generally not always performed, or, if done, is not carried out thoroughly. Students in the low category demonstrate difficulty in understanding problems, tend to be confused when determining a problem-solving plan, execute plans in an unsystematic and careless manner, and rarely review the answers they obtain. Factors such as experience, which includes knowledge of problem-solving strategies as well as the context and content of the problem, affective factors such as interest, motivation, anxiety, and patience, as well as cognitive factors such as reading ability, analytical skills, and numerical skills, also contribute to differences in students' abilities to carry out each stage of mathematical problem-solving. These findings enhance the understanding of the diverse problem-solving abilities among students in solving word problems and highlight the importance of a learning approach that not only focuses on cognitive aspects but also takes into account affective factors and students' learning experiences.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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