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Analysis of Mathematical Problem-Solving Abilities of Elementary School Students Based on Learning Interests and Gender

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Abstract

Mathematical problem-solving is a fundamental competence in elementary mathematics because students must not only obtain correct answers but also understand problems, formulate appropriate strategies, execute solution procedures, and evaluate their results. This study aimed to analyze the mathematical problem-solving abilities of fourth-grade elementary school students according to learning interest and gender. A descriptive qualitative approach was employed involving 19 students, comprising 9 boys and 10 girls. Data were collected through a learning interest questionnaire, a mathematical problem-solving response questionnaire, written tests, semi-structured interviews, and documentation. Six students were purposively selected to represent high, moderate, and low learning interest categories across genders. Their problem-solving processes were examined using Polya's four stages: understanding the problem, devising a plan, carrying out the plan, and looking back. The findings showed that students with high learning interest successfully completed all four stages, whereas those with moderate learning interest demonstrated inconsistencies, particularly in implementing solution plans and

reviewing their answers. Students with low learning interest experienced more extensive difficulties in devising plans, carrying out solutions, and verifying results. Gender did not reveal a consistent pattern of superiority because differences in performance occurred within each learning interest category. The study also identified discrepancies between students' positive questionnaire responses and their actual written-test performance. These findings indicate that mathematical problem-solving ability is more closely associated with learning interest and individual problem-solving processes than with gender alone. This study contributes to elementary mathematics education by emphasizing the need for instructional strategies that strengthen students' learning interest, provide structured support across Polya's problem-solving stages, and accommodate individual differences in problem-solving performance.

Keywords: Elementary Mathematics Education; Gender Differences; Learning Interest; Mathematical Problem-Solving; Polya's Problem-Solving Stages

INTRODUCTION

Mathematics learning in elementary school has an important role in shaping the ability to reason and solve problems related to daily life. Mastery of mathematics is not only demonstrated through numeracy skills, but also through the ability to understand information, determine strategies, apply concepts, and interpret the results of completions. The results of PISA 2022 show that the mathematics achievements of Indonesian students still need attention because the ability to use mathematical knowledge in various problems is still not optimal (OECD, 2023). Various learning factors and educational characteristics are also related to the mathematics achievement of Indonesian students (Wijaya et al., 2024).

Mathematical problem-solving skills are an important part because students need to go through a thinking process before getting an answer (Rizqi et al., 2024). Students must recognize the available information, determine what is asked, choose a strategy, perform calculations, and assess the suitability of the results obtained. This ability helps students use mathematical concepts in a more targeted way when the form of the problem is different from the example that has been studied. Problem-solving in elementary school students needs to be understood based on the process of solving so that the difficulties that arise at each stage can be recognized more clearly (Hidayah & Murti, 2025).

Broad measurement materials provide a strong space to look at those abilities because students are not only asked to use formulas. Problems about the area of the garden,

floor, garden, board, or other objects require students to understand the shape of the building, choose the necessary size, determine the operation or formula, use the right units, and interpret the results according to the questions. The process requires the ability to connect the available information with mathematical concepts before the calculations are performed. The ability to choose and execute strategies is an important part when students face problems that cannot be solved simply by imitating previous examples (Setyawati et al., 2024).

A preliminary study on grade IV students of SD Negeri Karangjati 04 shows that the achievement of problem-solving stages is not evenly distributed. A total of 18 students were able to understand the problem and 16 students were able to develop a problem-solving plan. The number decreased to 12 students at the stage of implementing the plan, while only 4 students re-examined the completion results. The initial findings show that students are relatively able to recognize problems but have difficulty when strategies must be implemented appropriately and answers need to be re-examined. This condition reinforces the need for analysis that is not only oriented towards the right or wrong final answer.

Interest in learning is a relevant aspect because the problem-solving process requires attention, perseverance, and a willingness to keep working on problems when the solution is not immediately found. Interest in learning mathematics can be seen through the sense of pleasure, attention, desire to participate in activities, and students' involvement when completing assignments. Learning interest is related to students' involvement in mathematics activities and can shape different learning experiences between students (Putri & Adirakasiwi, 2021). The learning environment and students' interests also play a role in supporting their involvement while participating in mathematics learning (Prantauwati et al., 2021).

Gender is also used as a point of view to understand the variation in the completion process without placing male or female students as an automatically superior group. Gender characteristics need to be seen alongside learning experiences and conditions because mathematical skills are not formed by just one factor. Studies on problem-solving strategies show that male and female students can use the same or different methods of solving according to the characteristics of the problem faced (Cahyadi et al., 2023). Gender math skills also do not always show a fixed difference because other factors can contribute to student performance.

Polya's problem-solving framework is used as a basis for reading students' thinking processes gradually. The four stages used include understanding the problem, developing a plan, executing the plan, and re-examining the results of the solution. The framework allows students' abilities to be analyzed based on the process carried out, not just based on the accuracy of the final answer (Hidayah & Murti, 2025). The application of the Polya strategy in a structured manner also supports the ability of elementary school students to understand story problems and carry out the problem-solving process systematically (Fitriani, 2025).

Previous studies have discussed problem-solving abilities from various perspectives, but the focus used has not been entirely the same as this study. Elementary school students' strategies in solving broad measurement problems have been analyzed through various solutions used by students (Permatasari & Amir, 2023). Other research emphasizes student activity as one of the characteristics related to mathematical problem-solving skills (Setyawati et al., 2024). The study shows that the problem-solving process has diverse characteristics, while the analysis that simultaneously links the categories of learning interests, gender, broad measurement materials, and the achievement of each stage of problem-solving in grade IV students still needs to be expanded.

The novelty of the research lies in the analysis of students' mathematical problem-solving processes based on a combination of learning interest categories and gender through test evidence, response questionnaires, interviews, and documentation. Each category of learning interest is represented by male and female students so that a variety of abilities can be seen from understanding problems, developing plans, implementing solutions, to re-examining the results. This study aims to analyze the mathematical problem-solving ability of grade IV elementary school students based on learning interests and gender.

METHODS

This study uses a qualitative approach with a descriptive type. The design is used to describe in depth the students' mathematical problem-solving abilities based on the processes that appear in the results of the work and explanations during the interview. The research does not provide treatment in the form of specific models, methods, or learning media. The analysis is directed at four stages of problem solving, namely understanding the problem, developing a plan, implementing the plan, and re-examining the results of the solution.

The research was carried out in June-July 2026 for two months in the even semester of the 2025/2026 school year at SD Negeri Karangjati 04, Bergas District, Semarang Regency, Central Java. The research participants were 19 grade IV students consisting of 9 male students and 10 female students. All participants took part in the filling out of a learning interest questionnaire, a response questionnaire on mathematical problem-solving skills, and a written test.

The selection of subjects for in-depth analysis is done through *purposive sampling*. The learning interest questionnaire was first used to divide students into three categories based on the order of scores. The six students with the highest scores were placed in the high interest category, seven students in the middle were in the medium category, while the six students with the lowest scores were in the low category. Six subjects were then selected with the composition of one male student and one female student from each learning interest category. Selection considerations also include test results, completeness of data, communication skills, willingness to participate in interviews, and supporting information from classroom teachers.

Data collection was conducted using questionnaires, written tests, semi-structured interviews, and documentation. The learning interest questionnaire consists of 15 statements that include indicators of happiness, interest in learning, attention, and engagement. The problem-solving ability response questionnaire consists of 16 statements that describe students' habits when understanding problems, developing plans, implementing solutions, and reviewing answers. Both questionnaires used four response options with adjusted scoring between positive and negative statements.

The problem-solving ability test consists of 10 questions describing broad measurement material with a context that is close to daily life. Each question was analyzed based on four stages of problem-solving with a score range of 1–4 for each stage. The maximum overall test score is 160. The assessment pays attention to the accuracy of students identifying information, determining strategies, running calculations, using units, and checking the suitability of results. The semi-structured interview guidelines contain 12 questions that are used to explore the reasons for choosing the strategy, the calculation process, the difficulties experienced, and how students ensure the correctness of the answers.

The research instrument goes through expert assessment before being used in data collection. The assessment includes the suitability of the content with the focus of the

research, the accuracy of the construction of the instrument, the readability of the language, the suitability of the broad measurement material, and the characteristics of grade IV students. Documentation in the form of questionnaires, test work results, interview transcripts, student data, and photos of activities were used as supporting evidence during the analysis.

Data collection was carried out in stages, starting from filling out learning interest questionnaires, response questionnaires, and mathematical problem-solving ability tests. The results of the three instruments were considered in determining the six subjects interviewed. Interviews are conducted after the results of the work have been examined so that follow-up questions can be directed to unclear completion steps, miscalculations, or parts of the answers that are not written in full.

Data analysis is carried out through the process of data reduction, data presentation, and conclusion drawing and verification. The reduction was carried out by selecting relevant data, coding six subjects, grouping the results based on learning interests and gender, and selecting interview sections related to the problem-solving stage. Data presentation is carried out through tables, descriptions of work results, and interview results. Conclusions were obtained by comparing the achievement of the four stages in each subject based on the categories of learning interest and gender.

The validity of the findings was checked through triangulation techniques and source triangulation. The triangulation technique was carried out by comparing response questionnaires, written tests, interviews, and documentation of the same subject. Source triangulation was carried out through the comparison of student data with supporting information from the classroom teacher regarding students' interests, perseverance, attention, accuracy, and habits when solving math problems. Test and interview results remain the main basis for determining the achievement of mathematical problem-solving skills, while questionnaires, documentation, and teacher information serve to strengthen the interpretation of findings.

RESULTS

The study involved 19 grade IV students of SD Negeri Karangjati 04 consisting of 9 male students and 10 female students. All students took part in the filling out of the learning interest questionnaire, the mathematical problem-solving ability response questionnaire, and

the mathematical problem-solving ability test. The results of the learning interest questionnaire were used to form the categories of high, medium, and low interest. A more in-depth analysis was then carried out on six subjects representing male and female students in each category of learning interest. Problem-solving skills are analyzed through four stages of Polya, namely understanding the problem, developing a plan, implementing the plan, and re-examining the results of the completion.

1. Categories of Student Learning Interests

The results of the questionnaire showed that there was a variation in interest in learning mathematics in grade IV students. The distribution of students in each category is presented through Table 1.

Table 1. Distribution of Student Learning Interest Categories

Categories of Learning Interests	Number of Students	Percentage
Height	6	31,58%
Medium	7	36,84%
Low	6	31,58%
Quantity	19	100%

Table 1. The distribution of the Student Learning Interest Category shows that the medium category has the largest number, which is 7 students or 36.84%. The high and low categories consisted of 6 students or 31.58% each. The relatively balanced distribution provides an adequate basis for comparing the characteristics of the problem-solving process at the three levels of learning interest. These categories are then used as the basis for selecting male and female students which are analyzed in depth.

2. Mathematical Problem-Solving Ability Response

The response questionnaire is used to get an idea of students' perceptions and habits when facing math problems. The sixteen questionnaire statements represent the stages of understanding the problem, drawing up a plan, executing the plan, and re-examining the answers. The results of the grouping of responses are presented through Table 2.

Table 2. Mathematical Problem-Solving Ability Response Distribution

Category	Number of Students	Percentage
Excellent	5	26,32%
Good	14	73,68%
Pretty Good	0	0%
Not Good	0	0%
Quantity	19	100%

Table 2. The distribution of mathematical problem-solving ability responses showed that 14 students or 73.68% were in the good category, while 5 students or 26.32% were in the very good category. No students were found with responses in the categories of good or bad quality. The picture shows that students generally have a positive perception of the habit of understanding problems, determining how to solve them, carrying out calculation steps, and checking answers. The questionnaire is as supporting data because students' perceptions do not necessarily fully describe the actual ability when working on the questions.

3. Mathematical Problem-Solving Skills

The actual ability of students is obtained through 10 questions describing the broad measurement material. Each answer was assessed using four Polya indicators by paying attention to the information written the accuracy of the strategy, the calculation process, and the examination of the results. The recapitulation of the test results is presented through Table 3.

Table 3. Distribution of Mathematical Problem-Solving Ability Test Results

Category	Number of Students	Percentage
Excellent	0	0%
Good	8	42,11%
Pretty Good	11	57,89%
Not Good	0	0%
Quantity	19	100%

Table 3. The distribution of the results of the Mathematical Problem-Solving Ability Test showed that 11 students or 57.89% were still in the good category, while 8 students or 42.11% reached the good category. There are no students who reach the very good category or are in the poor category. The average class reached 51.18% so it was at the beginning limit of the good category. The findings show that problem-solving skills are not evenly distributed because most of the students individually are still in the category of doing quite well.

An interesting distinction arises when Table 2. Mathematical Problem-Solving Ability Response Distribution compared to Table 3. Distribution of Mathematical Problem-Solving Test Results. All students assessed their problem-solving habits to be in the good or very good category, but the test results showed that 57.89% of students were still in the category of quite good. The divergent findings show that there is a gap between students' perceptions of problem-solving habits and the ability that actually arises when facing problems. The data

is an important supporting finding because it shows that the assessment of problem-solving ability is not enough just using response questionnaires. The comparison of the two results is visualized in Figure 1.

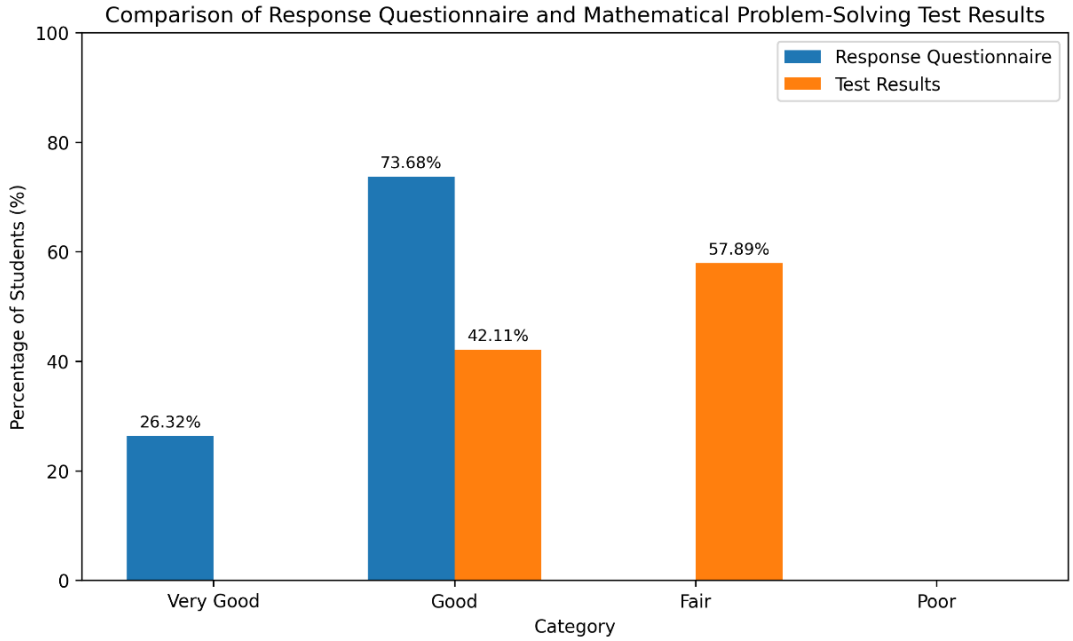

Figure 1. Comparison of Response Questionnaire and Mathematical Problem-Solving Test Results

Figure 1. Comparison of Response Questionnaire and Mathematical Problem-Solving Test Results shows a clear difference between students' responses and the abilities shown through the test. The response questionnaire showed that 26.32% of students were in the very good category and 73.68% in the good category. The test results showed a different pattern, namely 42.11% of students were in the good category and 57.89% in the good category. These differences reinforce the finding that students' positive perceptions of problem-solving habits have not been fully followed by the ability to apply problem-solving stages when facing problems directly.

4. Problem-Solving Skills Based on Learning Interests and Gender

Six subjects were selected to obtain a more in-depth picture, namely MT-L and MT-P in the high-interest category, MS-L and MS-P in the moderate-interest category, and MR-L and MR-P in the low-interest category. The results of the test and interview were analyzed according to the four stages of Polya as presented through Table 4.

Table 4. Achievement of Polya Stages Based on Learning Interests and Gender

Subject	Understanding the Problem	Crafting a Plan	Implementing the Plan	Checking Back
MT-L	Fulfilled	Fulfilled	Fulfilled	Fulfilled
MT-P	Fulfilled	Fulfilled	Fulfilled	Fulfilled
MS-L	Fulfilled	Fulfilled	Partially fulfilled	Not fulfilled
MS-P	Fulfilled	Fulfilled	Fulfilled	Partially fulfilled
MR-L	Fulfilled	Partially fulfilled	Partially fulfilled	Not fulfilled
MR-P	Partially fulfilled	Not fulfilled	Not fulfilled	Not fulfilled

Table 4. The achievement of the Polya Stages Based on Learning Interest and Gender shows an increasingly clear pattern when learning interests are used as the basis for analysis. MT-L and MT-P can meet all stages of Polya. Both subjects were able to recognize the available information, determine strategies, complete calculations, and check answers.

Moderate interest groups show different patterns. MS-L was able to understand the problem and draw up a plan, but the implementation stage was only partially fulfilled, and the re-examination was not carried out. MS-P was able to meet the first three stages and began to show an examination of the results, although it has not been carried out completely. This pattern indicates that the ability to understand problems does not always guarantee that the strategy can be implemented and evaluated until the end.

A wider difficulty is found in the low-interest category. MR-L is still able to understand the problem and has an initial idea of the solution plan but encounters obstacles when running calculations and does not check the results. MR-P has difficulties from the stage of understanding the problem completely, then has not been able to determine a plan, carry out a solution, or conduct a re-examination.

Gender does not show a fixed direction of excellence based on Table 4. Achievement of Polya Stages Based on Learning Interests and Gender. Both genders in the high-interest category showed the same achievements. Female students showed more complete completion in the medium category, while male students in the lower category still showed a clearer picture of the plan than female students. The changing pattern indicates that problem-solving skills are not properly explained through gender singularly.

1. Triangulation of Findings

The suitability of the data was checked through response questionnaires, test results, interviews, documentation, and supporting information from class teachers. A summary of the triangulation of the six subjects is presented through Table 5.

Table 5. Triangulation of Six-Subject Problem-Solving Skills

Subject	Tests and Interviews	Key Findings
MT-L	Complete completion and able to explain strategies and answer checks	Four stages of Polya fulfilled
MT-P	Complete, systematic, and able to explain each stage	Four stages of Polya fulfilled
MS-L	Know the next steps but don't complete them in writing	The implementation is incomplete and does not re-check
MS-P	Achieve the final result and be able to explain the completion steps	Most of the stages are met
MR-L	Have an initial step but experience a miscalculation	Difficulties in implementation and inspection
MR-P	Incomplete steps, experiencing confusion, and difficulty determining formulas	Difficulties arise since the preparation of the plan

Table 5. Triangulation of Six-Subject Problem-Solving Ability shows that test and interview results on most subjects are mutually supportive. The interview also revealed a process that was not entirely visible on the answer sheet. MS-L, for example, knows what the next step needs to be, but doesn't write it down until it's finished. MR-L and MR-P showed a more pronounced difference between responses to questionnaires and ability to solve questions. The triangulation emphasizes that problem-solving skills are more precisely understood through a combination of written evidence and student explanations rather than relying solely on perceptions in the questionnaire.

DISCUSSION

The results showed that there was a pattern of mathematical problem-solving abilities that differed based on the level of learning interest. Subjects with high interest in learning can complete the four stages of Polya completely, starting from understanding the problem, developing a plan, implementing a plan, to re-examining the results. This completeness shows that learning interest is related to students' seriousness in maintaining the completion process until the final stage. Learning interest plays a role in students' involvement when facing and solving mathematical problems (Peratiwi & Adzima, 2024).

The ability of subjects with high interest is not only seen from the accuracy of the final answer, but also from the ability to recognize information, determine strategies, perform sequential calculations, and re-evaluate results. The findings reinforce that problem-solving skills need to be seen as interconnected processes (Rizqi & Hawa, 2023). The Polya Stage can describe students' abilities from understanding the problem to reviewing the solutions

that have been made (Riyadi et al., 2021). Similar results can be seen in the research of Rizqi and Putra which shows that student characteristics are related to the completeness of problem-solving indicators that can be met (Rizqi & Putra, 2023).

Subjects with moderate learning interests have been able to understand the problem and determine a solution plan but begin to show inconsistencies at the implementation and reexamination stages. MS-L knows the strategy that needs to be used, but has not yet completed the solution, while MS-P is able to reach the result and start checking. This condition shows that the ability to understand problems has not always been followed by the ability to carry out the entire process completely. The rechecking stage is indeed a part that is often missed when students feel that they have obtained an answer (Sagita et al., 2023).

Broader difficulties were found in the category of low learning interest. MR-L can still understand the information and show some of the plans, but it encounters errors when executing the settlement. MR-P has experienced obstacles since determining the strategy and has not been able to continue the process until further examination. The findings suggest that low interest in learning can go hand in hand with less than optimal engagement when completion requires longer attention and perseverance (Anggraini et al., 2022).

Learning support is important because problem-solving skills do not only develop through mastery of formulas. Activities that encourage students to engage, discuss, and try strategies can help the completion process become more focused. ULTADU-assisted Team Games Tournament learning has been used to support the problem-solving abilities of elementary school students (Alifiani & Rizqi, 2025). The use of Team Games Tournament with the help of Diagram Board media also shows the relevance of learning activities involving students to problem-solving skills (Khaerunisah & Rini, 2024). Gradual assistance through scaffolding in the numeracy learning environment also provides space for students to solve problems according to their learning needs (Putra et al., 2023).

Findings by gender do not show a consistent pattern of excellence. MT-L and MT-P are both capable of meeting all stages of Polya. The medium interest category shows that MS-P has a more complete solution than MS-L, while the low interest category shows that MR-L still has a clearer picture of the article than MR-P. The variation suggests that problem-solving ability cannot be explained through gender as a single factor. Studies on elementary school students also show variations in problem-solving processes between boys and girls without showing that one group is always superior (Farokhah et al., 2026).

Learning interest showed a clearer pattern in the six subjects analyzed. The high-interest group was able to complete all the stages, the medium group started to experience obstacles at the end, while the low group had difficulties in more stages. This pattern shows the importance of paying attention to the affective aspect of students when problem-solving skills are analyzed. Learning interest is related to students' attention and involvement while participating in mathematics learning (Yuliati, 2021).

Another finding can be seen from the discrepancy between the response questionnaire and the test results. All students had a response in the good or very good category, but the test results showed that 11 of the 19 students were still in the good category. This difference indicates that students' perceptions of problem-solving habits are not always the same as actual abilities when facing problems. Interviews help explain processes that are not fully visible on the answer sheet so that students' abilities can be understood through the evidence of work and explanations provided.

The implications of the research results lead to the need for mathematics learning that pays more attention to the completion process than just the final answer. Teachers need to get students used to understanding the information of the questions, determine strategies, carry out calculations sequentially, and double-check the answers (Setiawati & Rizqi, 2025). Greater attention is needed at the implementation and re-examination stages, especially for students with moderate and low learning interest. Gradual problem-solving exercises can help students form a more systematic mathematical thinking process (Wahab et al., 2024).

The limitation of the study lies in the number of participants, which only included 19 students from one school with six subjects as the source of in-depth analysis. The research material was also limited to broad measurement, whereas each interest category was only represented by one male student and one female student. The findings regarding gender are therefore not directed to generate generalizations but rather describe the variations in problem-solving processes found in the study subjects.

CONCLUSION

The results of the study showed that the mathematical problem-solving ability of grade IV students had different patterns based on the level of learning interest. Students with a high interest in learning are able to meet all stages of Polya, while students with a moderate interest in learning begin to experience inconsistencies at the implementation and re-examination stages. Students with low interest in learning show broader difficulties, especially

when strategizing, executing solutions, and double-checking answers. Gender differences do not show a consistent pattern of excellence because male and female students show different completion characteristics in each category of learning interest.

The findings of the study also show a difference between students' perceptions through response questionnaires and actual abilities based on test results. This condition emphasizes that problem-solving ability needs to be assessed through the resolution process, not just based on perceptions or final answers. The contribution of the research lies in the description of the relationship between learning interests, gender, and the achievement of the Polya stages in elementary school students. Mathematics learning further needs to get students more used to strategizing in a series and re-examining the results of completion, especially for students with medium and low learning interest. Subsequent research may involve a wider range of subjects and more diverse mathematical materials so that problem-solving characteristics can be understood more thoroughly.

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