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Uncovering the Obstacles Faced by Fifth-Grade Students in Solving Mixed-Operation Calculation Problems: A Perspective on Conceptual Understanding and Procedural Knowledge

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Abstract

Fifth-grade students who experience obstacles when solving mixed calculation problems. The purpose of this study is to describe the obstacles in conceptual understanding and procedural knowledge experienced by fifth-grade students in solving mixed calculation problems. This study uses qualitative and methods was conducted at Public Elementray School Pandeanlamper 03, Semarang City with three research subjects using research instruments consisting of questions about mixed fraction calculations and interview guidelines to reveal the obstacles experienced by the subjects. The three subjects showed that they had organized their knowledge into a coherent whole, but the subjects where they are unable to see the relationship between concepts and procedures and are unable to provide arguments to explain why some facts are the result of other facts.

Introduction

The conceptual understanding and the procedural knowledge are two important components of mathematics learning that work hand-in-hand (Heyd-Metzuyanim et al., 2025; Göbel et al., 2026; Tandililing et al., 2025). Conceptual understanding is the ability to grasp mathematical ideas in meaningful ways and to identify relationships between ideas and explain why a particular mathematical procedure might be used to solve a problem. Procedural knowledge, on the other hand, involves the ability of students to apply rules, algorithms, calculation steps in an accurate and systematic manner (Dorner et al., 2026; Ziv & Heafner, 2025; Sugawara et al., 2026). Both aspects are important in learning mixed calculations operations as students must not only achieve accuracy in their answers but also understand the meaning of the operations, the relation between numbers, and the sequence of operations followed in the problem solving process (Al-Mutawah et al., 2019; Salim Nahdi & Gilar Jatisunda, 2020; Seloane et al., 2023).

Mixed calculation problems are frequently difficult for students to master in elementary mathematics learning due to the fact that it requires more than one mathematical idea to be learned at the same time (Lit et al., 2026; Lundkvist & Larsson, 2026; Ross et al., 2026). Students should know the order of operations, parentheses, the order of operations involving addition, subtraction, multiplication, and division, and the order with which whole numbers, fractions, decimals, or mixed numbers should be operated (Abella, 2026; Dilla et al., 2026). Students can make several mistakes if they are not familiar with these concepts and procedures, including: calculation without understanding the mathematical relationships in the problem, using an incorrect calculation strategy, converting fractions incorrectly, and using the wrong order of operation (Mutiara, 2025; Purnomo et al., 2022; Borchers et al., 2025).

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Students are still encountering difficulties in grasping concepts and using procedures in solving problems involving mixed types of calculation (Torres-Peña et al., 2025; Kania et al., 2025; Sutrisno et al., 2025). These obstacles can be identified from students' erroneous solutions of mathematical problems, particularly in applying the correct order of calculations, the correct mathematical rules, and systematic calculation. Not everything that goes wrong is due to lack of care or carelessness. They can signal greater learning difficulties, such as poor comprehension of basic concepts, erroneous conceptions about mathematical operations, lack of procedural fluency, and failure to tie information from the word problem with the proper mathematical procedure (Rio & Protacio, 2025; Žakelj et al., 2025; Boamah et al., 2025).

Importance of learning obstacle research related to conceptual and procedural knowledge is because it can be used to uncover the types of learning obstacles that are experienced by students and the cause of the learning obstacles (Maifa et al., 2025; Diputra et al., 2023; Hariyani et al., 2022). This type of information enables teachers to determine if students' errors are due to the lack of conceptual understanding, poor procedural skills, or a combination of both. The information will be useful for designing more effective learning strategies, giving scaffolding, and helping students to develop their mathematical reasoning and ability in solving problems (Hidayah & Maemonah, 2022; Rizki R et al., 2022; Wiranto Karim et al., 2023).

The focus of this study is on fifth grade students because they start to experience more complex calculation tasks, such as mixed calculation operations (fraction) and contextual problems (Benu & Lalang, 2026; Xu et al., 2026; Silla et al., 2024). These problems involve students in understanding the information provided, identifying the operation needed to solve the problem and using the correct operation to arrive at an accurate result. It is, therefore, important to look into the difficulties that are encountered by fifth grade students to understand their difficulties with conceptual and procedural issues in problem solving (Andini & Cahyaningsih, 2024; Hardiansyah et al., 2024)

Based on this background, this research is aimed to describe the problems faced by fifth grade students in solving mixed calculation problems from the conceptual understanding and procedural understanding aspects. In this study, the qualitative approach is used in analyzing the written test result of students and the students' answers obtained in the interview to determine the type of obstacles encountered. The results are expected to give a more comprehensive picture of students' learning difficulties and useful information for teachers to enhance mathematics teaching, especially teaching mixed calculation operations.

Methods

This study was conducted at SD Negeri Pandenlamper 03 in Semarang City in July 2025. Data on students' prior knowledge at the school was taken from the previous semester's grades from the teachers who taught in those classes. The main instrument in this study was the researcher himself. The auxiliary instruments used were mixed calculation questions to measure the obstacles experienced by the subjects in terms of conceptual understanding and procedural skills, as well as interview guidelines to explore the obstacles experienced by the subjects when solving mixed calculation problems. This study describes the obstacles faced by fifth-grade subjects in terms of conceptual understanding and procedural skills in mixed calculation material. Data analysis techniques include data reduction, data presentation, data interpretation, and conclusion drawing (Utami, R. W., Alawiyah, A., & Waritsman, A., 2025).

During the data reduction stage, students' written responses and interview transcripts were reviewed to identify errors related to mixed calculation problems. The identified errors were then coded according to their characteristics, such as multiplication operation errors, fraction

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conversion errors, errors in the order of operations, fraction addition errors, procedural errors, and errors in interpreting word problems. Similar codes were grouped into broader categories representing conceptual understanding obstacles and procedural knowledge obstacles.

In the data presentation stage, the coded data were organized into tables summarizing students' written test results, classifications of errors, interview excerpts, and a matrix of conceptual and procedural obstacles. The interpretation stage involved examining the relationship between the written responses and the interview findings to determine the underlying causes of students' errors and to identify patterns of learning obstacles across subjects. Finally, conclusions were drawn by synthesizing the findings from both data sources to describe the forms of conceptual understanding and procedural knowledge obstacles experienced by fifth-grade students when solving mixed calculation problems. The research design is presented in Figure 1 below.

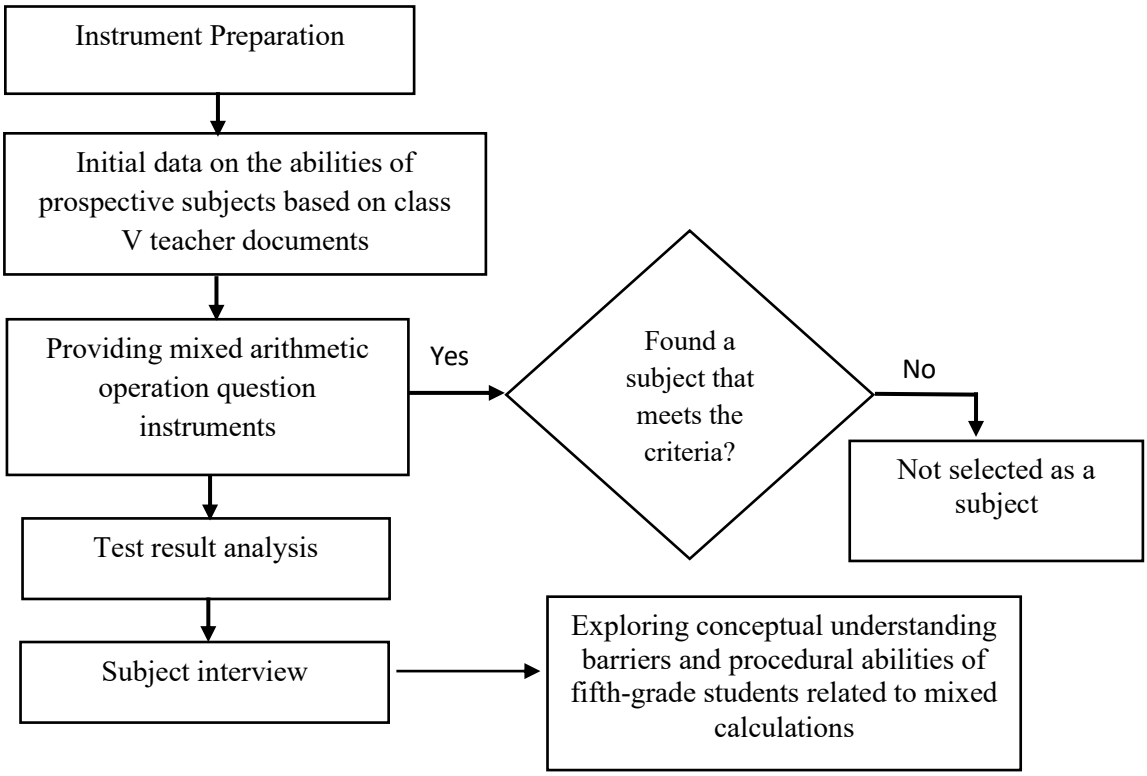

Figure 1. Research design

Determination of subjects

To ensure transparency in the selection of research subjects, the researcher conducted a multi-stage selection process. The process involved administering mixed calculation problems to students who had already studied the relevant material, identifying students who experienced difficulties, and selecting participants who could provide rich information regarding learning obstacles.

Table 1. Subject Selection Process

Selection Stage	Selection Criteria	Number of Students	Description
Stage 1	Students who had learned mixed calculation operations and completed the test	10	All students were given mixed calculation problems.

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Stage 2	Students who completed the test without significant difficulties	5	These students were not selected because they did not demonstrate learning obstacles relevant to the research objectives.
Stage 3	Students who experienced difficulties in solving the problems	5	These students became potential research subjects.
Stage 4	Students selected as research subjects	3	Selected based on the variety of errors identified, prior mathematical ability, willingness to participate, and ability to explain their reasoning during interviews.
Stage 5	Students not selected as research subjects	2	Not selected because their error patterns were similar to those of the selected subjects or because they provided less comprehensive interview data.

Based on the selection process, three students were chosen as the main research subjects. The selected students represented different characteristics of learning obstacles and levels of prior mathematical ability. Furthermore, they were able to articulate their thinking processes clearly during the interviews, enabling a more in-depth exploration of the conceptual and procedural difficulties encountered in solving mixed calculation problems.

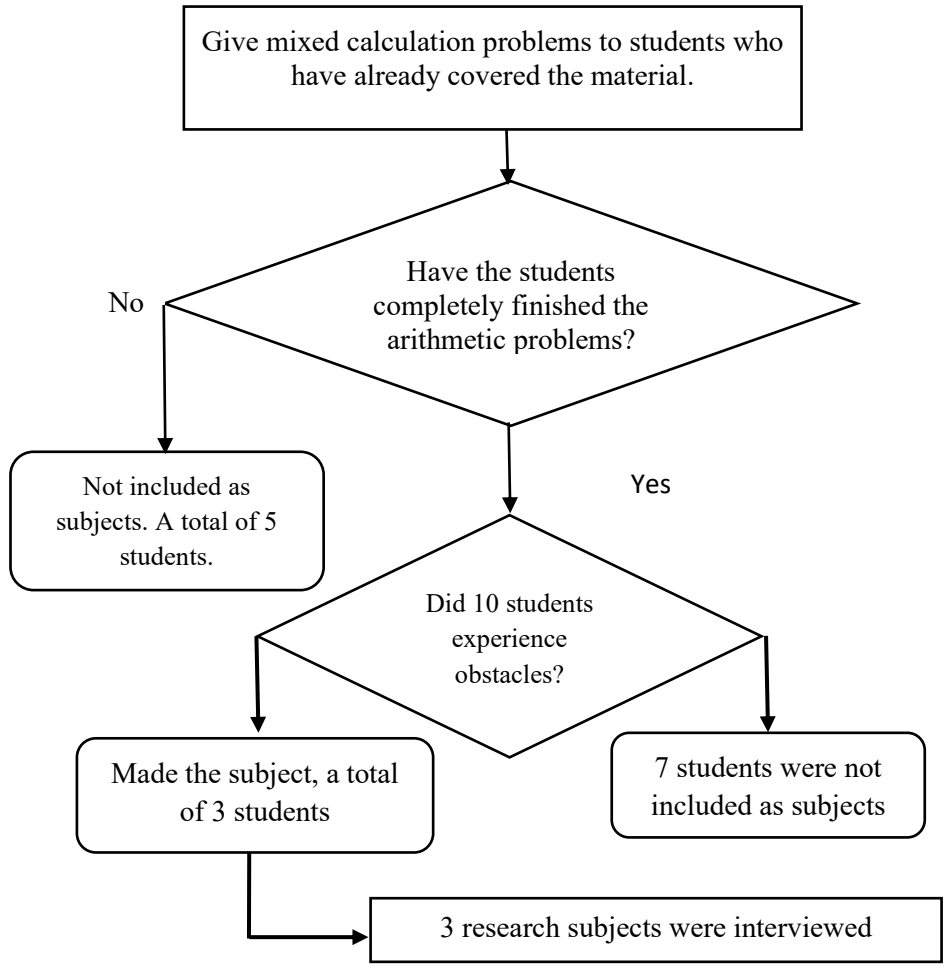

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Figure 2. Research subject selection flowchart

The remaining two students who experienced difficulties were not included as research subjects because the types of errors they demonstrated were already represented by the selected participants. Therefore, including additional participants was not expected to provide substantially new information for the analysis. The selection of research subjects in this study followed the flowchart in Figure 2.

Research instruments

The main instrument in this study was the researcher, supported by questionnaires and interview guidelines as complementary instruments for collecting more focused and systematic data. The use of the researcher as the primary instrument is consistent with the nature of qualitative research, in which the researcher plays a central role in understanding the context, interpreting participants' experiences, and capturing meanings that may not be fully represented through written responses or structured instruments alone. In the field, the researcher was directly involved throughout the research process, beginning from planning the data collection procedures, approaching the research participants, observing relevant activities, administering questionnaires, conducting interviews, recording important information, and interpreting the data based on the research focus.

The researcher's involvement was important because the obstacles experienced by fifth-grade students in solving mixed-operation calculation problems cannot be understood only through numerical answers or written responses. These obstacles also need to be examined through students' explanations, reasoning processes, hesitation, strategies, and errors when dealing with calculation tasks. Therefore, the researcher observed how students responded to the problems, how they explained their understanding of mathematical concepts, and how they applied procedural steps in solving the given questions. Through this direct involvement, the researcher was able to obtain richer and more contextual data related to students' conceptual understanding and procedural knowledge.

In addition to acting as the primary instrument, the researcher also functioned as a planner, data collector, analyst, data interpreter, and reporter of the research findings. As a planner, the researcher prepared the research design, determined the participants, and developed the supporting instruments. As a data collector, the researcher gathered information through questionnaires and interviews. As an analyst and interpreter, the researcher examined the data to identify patterns of students' difficulties, especially those related to conceptual misunderstanding and procedural errors. Finally, as a reporter, the researcher presented the findings in a systematic and academically accountable manner. This role reflects the idea that in qualitative research, the researcher is not only a technical executor but also an active interpreter of meaning within the research setting (Riyatuljannah & Suyadi, 2020; Soraya et al., 2023).

The instruments used in this study consisted of two main instruments. The first instrument was a written test containing problems related to mixed fraction operations, while the second instrument was an interview guide prepared to explore students' thinking processes, difficulties, and strategies in solving the given problems. The written test was administered before the interview to identify students' initial understanding and the types of errors they made when working on mixed fraction operations. After completing the test, selected students were interviewed based on their answers to obtain deeper information about the reasons behind their

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mistakes, their level of conceptual understanding, and their procedural knowledge. The mixed fraction problems given to the students were as follows.

1. Mr. Dahlan has $2\frac{1}{2}$ hectares of land, $\frac{1}{3}$ of which is used for corn crops, $\frac{1}{4}$ of which is used for vegetable crops, and the rest is used for fruit gardens. If the land used for fruit gardens is x hectares, what is the value of x?
2. Question involving fraction conversion.
   Mama Ita bought $3\frac{1}{4}$ kg of apples and $2\frac{1}{3}$ kg of oranges.
   If 1 kg of apples costs Rp. 12,000 and 1 kg of oranges costs Rp. 15,000,
   what is the total price of the fruit that Mama bought?
3. Comparison question
   The distance from Ambarawa district to Bawen district is 20 km.
   A public minibus travels $\frac{3}{5}$ of that distance in 1 hour. If the speed of the car remains constant.
   How long will it take for the minibus to travel the remaining distance?
4. One plastic bag contains 15 kg of granulated sugar. If the granulated sugar is put into 25 plastic bags, then the weight of granulated sugar in each plastic bag is ... grams.
5. The result of $\left(2\frac{1}{2}\ x\ 0{,}25\right) + \left(1\frac{1}{8} : \frac{3}{4}\right)$ is ...
6. A swimming pool can be filled with water in 5 hours using pump A, and in 8 hours using pump B. If the swimming pool is filled using both pumps simultaneously, how long will it take to fill it? (Requires understanding of fractions related to time intervals).
7. Tifa, Fani, and Isyana were playing together while enjoying the cake made by Fani's mother. The cake they were eating was circular in shape and of equal size. Tifa brought $4\frac{5}{12}$ cakes, Fani brought $6\frac{3}{7}$ cakes, and Ina brought $9\frac{5}{6}$ cakes. Then Yudha arrived and brought a cake three times the size of Fani's. Whose cake is the smallest?
8. Mom had $1\frac{1}{2}$ meters of fabric to make a prayer robe. After cutting the fabric, Mom realized that she didn't have enough, so she bought another $4\frac{1}{2}$ meters. It turned out that she used $4\frac{1}{3}$ meters of fabric to make the prayer robe. Determine how much fabric is left.

Figure 3. Mixed calculation operation questions

Results and Discussion

Students' Prior Knowledge Based on Previous Semester Scores

Students' prior knowledge was identified using their mathematics scores from the previous semester. These scores were used to provide an overview of students' initial academic abilities before completing the mixed calculation test and served as one of the considerations in selecting the research subjects.

Table 2. Students' Prior Knowledge Based on Previous Semester Mathematics Scores

Student Code	Previous Semester Mathematics Score	Ability Category
S1	65	Low
S2	72	Moderate
S3	68	Low
S4	80	High

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S5	78	High
S6	75	Moderate
S7	82	High
S8	70	Moderate
S9	67	Low
S10	76	Moderate

As shown in Table 2, students' prior knowledge varied across low, moderate, and high ability categories. Among the ten students who completed the mixed calculation test, five students experienced difficulties in solving the problems. From these students, three were selected as the main research subjects based on their test performance, the variety of errors identified, their ability to communicate their thinking processes during interviews, and the representation of different levels of prior knowledge reflected in their previous semester mathematics scores.

The data indicate that learning obstacles were not limited to students with low prior achievement but were also observed among students with moderate levels of mathematical ability. Therefore, the use of previous semester scores provided a stronger basis for identifying students' initial abilities and supported the selection of research subjects. This information also helped the researchers gain a more comprehensive understanding of the relationship between students' prior knowledge and the learning obstacles they encountered when solving mixed calculation problems.

Recapitulation of Written Test Results

To provide a comprehensive overview of students' performance on the mixed calculation test, the results of each subject's written work were summarized according to the correctness of answers, the type of error identified, and the category of learning obstacle. The recapitulation was developed based on the analysis of students' written responses and was subsequently confirmed through interviews.

Table 3. Recapitulation of Written Test Results for Each Subject

Subject	Question Number	Correct/Incorrect	Type of Error Identified	Category of Learning Obstacle
S1	2	Incorrect	Error in multiplication operation when calculating the cost of apples	Procedural Knowledge
S1	Other questions	Correct	–	–
S2	5	Incorrect	Incorrect execution of multiplication and addition involving fractions and decimals	Conceptual Understanding and Procedural Knowledge
S2	Other questions	Correct	–	–
S3	1	Correct	–	–
S3	2	Correct	–	–

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S3	3	Correct	–	–
S3	6	Correct	–	–
S3	7	Correct	–	–
S3	8	Incorrect	Incorrect interpretation of relationships among quantities and errors in mixed calculations involving fractions and decimals	Conceptual Understanding
S3	Other questions	Correct	–	–

Table 3 shows that each subject demonstrated different forms of learning obstacles when solving mixed calculation problems. Subject 1 mainly experienced difficulties in carrying out arithmetic procedures correctly, particularly during multiplication operations. Subject 2 exhibited both conceptual and procedural difficulties, as evidenced by the inability to relate multiplication and addition procedures involving fractions and decimals. Subject 3 generally solved most problems correctly; however, the subject encountered conceptual difficulties when interpreting information and determining the appropriate operations required to solve Question 8.

The recapitulation indicates that the identified errors were not merely computational mistakes but reflected deeper difficulties related to conceptual understanding and procedural knowledge. These findings were further validated through interview data, which provided additional evidence regarding the reasoning processes used by each subject while solving the problems.

Interview Evidence Supporting Learning Obstacles

To strengthen the findings obtained from the written test, interview data were used to confirm the difficulties experienced by each subject when solving mixed calculation problems. The interview excerpts provide evidence that the identified obstacles were not only reflected in students' written responses but also in their explanations of the solution process.

Subject 1 (S1): Procedural Knowledge Obstacle

The written test showed that Subject 1 made an error in multiplying (3\frac{1}{4}) kg by Rp. 12,000. Instead of obtaining Rp. 39,000, the subject wrote Rp. 156,000. The interview revealed that the error originated from an incorrect multiplication procedure.

Interview Excerpt

A : For question number 2, how did you solve it? Can you explain the steps?

S1 : First, I multiplied the price per kilogram by the number of kilograms of apples. Then I did the same for the oranges.

A : How did you get the result of Rp. 156,000 for the apples?

S1 : I multiplied 12,000 by 13 because I saw (3\frac{1}{4}) and thought I should multiply by 13.

A : Why did you use 13?

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S1 : I was not sure how to multiply mixed fractions, so I used the numbers that appeared in the fraction.

A : So what do you usually do when you encounter mixed calculation problems?

S1 : Sometimes I just multiply the numbers directly because I get confused about the correct steps.

The interview indicates that Subject 1 experienced a procedural knowledge obstacle, particularly in performing multiplication involving mixed fractions and applying the correct calculation algorithm.

Subject 2 (S2): Conceptual Understanding and Procedural Knowledge Obstacles

Subject 2 incorrectly solved (2\frac{1}{2} \times 0.25) and directly added the result to (\frac{1}{8}). The interview showed that the subject had difficulty understanding the relationship between concepts and procedures.

Interview Excerpt

A : Can you explain how you solved question number 5?

S2 : I changed (2\frac{1}{2}) into (5/2), then multiplied it by (1/4).

A : How did you get (10/4)?

S2 : I multiplied 5 by 2 and 2 by 4.

A : After that, why did you directly add the result to (1/8)?

S2 : I thought that after multiplying, I could immediately add the next number.

A : Did you consider simplifying the fraction first?

S2 : No, I was not sure whether I had to simplify it first or add it directly.

A : How do you decide which operation should be done first?

S2 : I usually follow the order I see in the problem, but sometimes I am not sure.

These responses indicate that Subject 2 experienced conceptual difficulties in understanding the relationship among mathematical operations and procedural difficulties in applying the correct sequence of operations.

Subject 3 (S3): Conceptual Understanding Obstacle

Although Subject 3 correctly answered most questions, an error occurred in Question 8. The interview revealed that the subject had difficulty interpreting the information in the problem and selecting the appropriate mathematical operations.

Interview Excerpt

A : Can you explain how you solved question number 8?

S3 : First, I multiplied (4\frac{3}{4}) by 2 because there were two sides with the same length.

A : What did you do next?

S3 : I added (7\frac{1}{2}) and (4\frac{1}{4}), then subtracted the result of the multiplication.

A : Why did you choose those operations?

S3 : I thought all the lengths needed to be added first and then reduced by the other side.

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A : Were you confident that the operations matched the information in the problem?

S3 : Not really. I was confused about which lengths should be added and which should be multiplied.

A : What was the most difficult part of the problem?

S3 : Understanding what the problem was asking and deciding which operation to use.

The interview demonstrates that Subject 3's difficulty was primarily conceptual. The subject struggled to interpret the problem situation and determine the mathematical relationships among the quantities involved, leading to an incorrect solution strategy.

The interview findings confirmed the results of the written test. Subject 1 demonstrated procedural difficulties in performing multiplication involving mixed fractions. Subject 2 exhibited both conceptual and procedural obstacles related to fraction operations and operation sequences. Subject 3 mainly experienced conceptual difficulties in interpreting problem information and selecting appropriate mathematical operations. Therefore, the interview data strengthened the conclusion that the identified learning obstacles were not merely computational errors but reflected deeper difficulties in conceptual understanding and procedural knowledge.

Classification of Students' Errors

Based on the analysis of written test results and interview data, the errors committed by the subjects were classified into several categories. This classification was used to identify the nature of the learning obstacles experienced by the students when solving mixed calculation problems.

Table 4. Classification of Students' Errors

Subject	Question Number	Type of Error	Description
S1	2	Multiplication operation error	Incorrectly multiplied (3\frac{1}{4}) kg by Rp. 12,000 and obtained Rp. 156,000 instead of Rp. 39,000.
S1	2	Procedural error	Applied an incorrect multiplication algorithm when dealing with mixed fractions.
S2	5	Fraction conversion error	Incorrectly transformed and manipulated fractions during multiplication.
S2	5	Error in operation sequence	Failed to apply the correct order of multiplication and addition operations.
S2	5	Fraction addition error	Added results without simplifying or applying the correct fraction procedure.
S2	5	Procedural error	Used inappropriate computational steps when combining multiplication and addition.
S3	8	Context interpretation error	Misinterpreted the information provided in the word problem.
S3	8	Operation selection error	Chose inappropriate operations to represent the relationships among quantities in the problem.

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S3	8	Procedural calculation error	Produced inaccurate calculations after establishing an incorrect solution strategy

The findings indicate that students' errors were not limited to computational mistakes. Some errors reflected conceptual misunderstandings, such as difficulties in understanding mathematical relationships and selecting appropriate operations, while others reflected procedural weaknesses in executing mathematical algorithms correctly.

Matrix of Conceptual Understanding and Procedural Knowledge Obstacles

To distinguish between conceptual understanding obstacles and procedural knowledge obstacles, the findings from written tests and interviews were organized into the following matrix.

Table 5. Matrix of Conceptual Understanding and Procedural Knowledge Obstacles

Subject	Question	Error Identified	Evidence from Written Test	Evidence from Interview	Researcher's Interpretation	Obstacle Category
S1	2	Incorrect multiplication involving mixed fractions	Wrote Rp. 156,000 instead of Rp. 39,000	"I multiplied 12,000 by 13 because I saw 3¼ and thought I should use 13."	The subject failed to apply the correct multiplication procedure involving mixed fractions.	Procedural Knowledge
S2	5	Incorrect fraction multiplication and direct addition	Performed (\frac{5}{2} \times \frac{1}{4} = \frac{10}{4}) and directly added the result to (\frac{1}{8})	"I thought after multiplying I could immediately add the next number."	The subject did not understand the relationship between operations and applied inappropriate procedures.	Conceptual Understanding and Procedural Knowledge
S3	8	Misinterpretation of problem information and operation selection	Added and subtracted quantities using an incorrect solution strategy	"I was confused about which lengths should be added and which should be multiplied."	The subject had difficulty interpreting the context of the problem and translating it into mathematical operations.	Conceptual Understanding

The matrix demonstrates that the learning obstacles identified in this study emerged from both conceptual and procedural dimensions. Subject 1 primarily experienced procedural difficulties related to multiplication algorithms. Subject 2 experienced both conceptual and procedural obstacles because the subject failed to understand the relationships among mathematical operations and also applied incorrect computational procedures. Subject 3 mainly experienced conceptual obstacles associated with interpreting problem situations and selecting appropriate mathematical operations. These findings were consistently supported by both written test results and interview evidence, indicating strong triangulation between the two data sources.

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Forms of obstacles to conceptual understanding experienced by subjects

Conceptual understanding refers to an integrated and functional understanding of mathematical ideas. Students with conceptual understanding can see the relationship between concepts and procedures and can provide arguments to explain why some facts are consequences of other facts. They have organized their knowledge into a coherent whole, which allows them to learn new ideas by connecting them to ideas they already know. In this case, a concept is the meaning or significance of an expression that marks that concept. This meaning is often expressed as a "rule" to distinguish what is included in the concept, i.e., what fulfills the rule, or what is not included in the concept because it does not conform to the rule or definition (Gregorio & Rabut, 2024; Lenz & Wittmann, 2020; Magfirotin & Amir, 2024).

Barriers arising from the subject's lack of understanding of basic concepts in mixed calculations are obstacles to conceptual understanding. These barriers are often caused by: errors in understanding the order of calculations (priority of operations), errors in understanding the nature of addition, subtraction, multiplication, and division, and a lack of in-depth understanding of integers and decimals. (Rahmatin & Dahlan, 2025).

Forms of obstacles to procedural knowledge experienced by subjects

Procedural knowledge includes various numerical algorithms in mathematics that are created as tools to find more specific results accurately. Procedural knowledge also directs the ability to read and create graphs and tables, perform geometric constructions, and display noncomputational skills such as rounding and classifying. Understanding. Procedural understanding also directs the subject's ability to argue through a situation, describing why a careful procedure will provide the correct answer to a problem in the context described (Murni et al., 2024; Parycek et al., 2024; Polas, 2025).

The obstacles that occur when subjects have difficulty applying problem-solving steps are obstacles to procedural knowledge. These obstacles include the following: errors in the sequence of arithmetic operations, difficulty in using parentheses and operation priorities, and calculation errors in the algorithm process (Fauziah, A., & Pandra, V. (2024).

Thus, the relationship between the written test results and the interview findings showed that the errors identified in students' answer sheets were consistent with the explanations provided by the subjects during the interviews. Subject 1 made an error in multiplying (3\frac{1}{4}) by Rp. 12,000 and obtained Rp. 156,000 instead of Rp. 39,000. This finding was supported by the interview in which the subject explained that he multiplied 12,000 by 13 because he interpreted the mixed fraction incorrectly. Similarly, Subject 2 incorrectly performed fraction multiplication and directly added the result to the next fraction. During the interview, the subject stated that he believed the result of the multiplication could be added immediately, indicating difficulty in understanding the relationship between mathematical operations and the correct sequence of procedures.

A similar pattern was found in Subject 3. Although the written test showed an incorrect solution strategy in Question 8, the interview revealed that the subject was confused about which quantities should be added and which should be multiplied. This explanation clarified the source of the error observed in the written response and demonstrated difficulty in interpreting the context of the problem and selecting appropriate mathematical operations. Therefore, the interview data provided evidence that the errors found in the written tests were associated with underlying difficulties in conceptual understanding and procedural knowledge rather than merely computational mistakes.

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Conclusion

Based on the results of the written tests and interviews, this study found that fifth grade students experienced learning obstacles in solving mixed operation calculation problems, particularly in relation to conceptual understanding and procedural knowledge. The obstacles were reflected in students' errors in multiplying mixed fractions, converting and manipulating fractions, applying the correct order of operations, interpreting word problem information, and selecting appropriate mathematical operations.

The findings show that each subject demonstrated different forms of difficulty. Subject 1 mainly experienced procedural knowledge obstacles, as shown by the incorrect multiplication of mixed fractions when solving a problem involving the total cost of fruit. Subject 2 experienced both conceptual understanding and procedural knowledge obstacles because the subject was unable to understand the relationship between multiplication and addition operations and also applied incorrect fraction procedures. Subject 3 mainly experienced conceptual understanding obstacles, particularly in interpreting the context of the word problem and translating the given information into appropriate mathematical operations.

These findings indicate that students' mistakes were not merely caused by calculation errors, but were closely related to deeper difficulties in understanding mathematical concepts and applying procedures correctly. Therefore, mathematics learning in elementary school should not only emphasize obtaining correct answers, but also guide students to understand the meaning of operations, the relationship among mathematical concepts, and the reasons behind each procedure used in problem solving. Teachers need to provide more contextual practice, encourage students to explain their reasoning, and strengthen the connection between conceptual understanding and procedural knowledge when teaching mixed operation calculation problems.

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Author Contributon

K.: conceived the idea of the research presented and collected the data. The three authors K., D.P., and A.T.D. actively participated in the development of the theory, methodology, data organisation and analysis, discussion of results and approval of the final version of the work

Conflict of Interest

The author declares that there are no conflicts of interest related to the publication of this article. The author confirms that this paper is free of plagiarism

References

Abella, R. (2026). Level of Mastery in Fraction Computation Among Grade 10 Students at Dimasalang National High School: Basis for Intervention Program. *International Journal of Sustainability and Advanced Integrated Research*, *2*(2), 1707-1716. https://doi.org/10.65339/ijsair.V2.I2.374

Al-Mutawah, M. A., Thomas, R., Eid, A., Mahmoud, E. Y., & Fateel, M. J. (2019). Conceptual understanding, procedural knowledge and problem-solving skills in mathematics: High school graduates work analysis and standpoints. *International Journal of*

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Education and Practice, *7*(3), 258–273. https://doi.org/10.18488/journal.61.2019.73.258.273

Andini, I., & Cahyaningsih, U. (2024). An analysis of students' learning difficulties in solving plane geometry problems among seventh-grade students. *International Journal of Advance Research in Mathematics Education*, *2*(2), 110-121. https://doi.org/10.56916/ijr.v2i2.2657

Benu, R. S. M., & Lalang, A. R. (2026). ANALYSIS OF ELEMENTARY STUDENTS'LEARNING OBSTACLES IN UNDERSTANDING FRACTIONS: A CASE STUDY IN SOUTH CENTRAL TIMOR REGENCY. *Prima Magistra: Jurnal Ilmiah Kependidikan*, *7*(2), 462-474. https://doi.org/10.37478/jpm.v7i2.7204

Boamah, S., Asemani, E., Koranteng, E. K., & Mensah, R. O. (2025). Effect of cognitive-communicative model on senior high school students' proficiency in solving algebraic word problems. *Discover Education*, *4*(1), 188. https://doi.org/10.1007/s44217-025-00619-y

Borchers, C., Fleischer, H., Yaron, D. J., McLaren, B. M., Scheiter, K., Aleven, V., & Schanze, S. (2025). Problem-solving strategies in stoichiometry across two intelligent tutoring systems: A cross-national study. *Journal of Science Education and Technology*, *34*(2), 384-400. https://doi.org/10.1007/s10956-024-10197-7

Dilla, F. I., Sutama, Novitasari, M., & Adnan, M. (2026, March). Cultivation of counting in elementary school students' mathematics learning. In *AIP Conference Proceedings* (Vol. 3412, No. 1, p. 020017). AIP Publishing LLC.

Diputra, K. S., Suryadi, D., Herman, T., & Jupri, A. (2023). Analysis of the Elementary School Students' Learning Obstacles: A Case Study on the Concept of Fractions. *Al Ibtida: Jurnal Pendidikan Guru MI*, *10*(1), 13-28. https://doi.org/10.24235/al.ibtida.snj.v10i1.13078

Dorner, C., Ableitinger, C., & Krammer, G. (2026). Revealing the nature of mathematical procedural knowledge by analysing students' deficiencies and errors. *International Journal of Mathematical Education in Science and Technology*, *57*(3), 413-434. https://doi.org/10.1080/0020739X.2024.2445666

Göbel, S. M., Landerl, K., & Lervag, A. (2026). Longitudinal Predictors of Conceptual Understanding of Arithmetic Principles. *Journal of Numerical Cognition*. https://doi.org/10.5964/jnc.19523

Gregorio, J. M. V., & Rabut, J. F. (2024). Strategic intervention materials using Lumi Education (SIMULE) and students' conceptual understanding and procedural fluency. *9*, 5–20. https://doi.org/10.5281/zenodo.11651941

Hardiansyah, F., Armadi, A., AR, M. M., & Wardi, M. (2024). Analysis of field dependent and field independent cognitive styles in solving science problems in elementary schools. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1159-1166. https://doi.org/10.29303/jppipa.v10i3.5661

Hariyani, M., Herman, T., Suryadi, D., & Prabawanto, S. (2022). Exploration of student learning obstacles in solving fraction problems in elementary school. *International Journal of Educational Methodology*, *8*(3), 505-515.

Heyd-Metzuyanim, E., Cohen, B., Elbaum-Cohen, A., & Tabach, M. (2025). Regulative routines and their relation to the process of de-ritualization in mathematics learning:

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Heyd-Metzuyanim et al. *Educational Studies in Mathematics*, *120*(3), 525-548. https://doi.org/10.1007/s10649-025-10401-4

Hidayah, A., & Maemonah, M. (2022). Analisis hambatan belajar siswa kelas IV pada mata pelajaran matematika. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education, 7*(2), 232–240. https://doi.org/10.23969/symmetry.v7i2.6737

Kania, N., Saepudin, A., & Gürbüz, F. (2025). Assessing Cognitive Obstacles in Learning Number Concepts: Insights from Preservice Mathematics Teachers. *Journal of Research and Advances in Mathematics Education*, *10*(3), 146-166.

Lenz, K., & Wittmann, G. (2020). Individual differences in conceptual and procedural fraction knowledge: What makes the difference and what does it look like? *International Electronic Journal of Mathematics Education, 16*(1), em0615. https://doi.org/10.29333/iejme/9282

Lit, S., Kool, M., & Drijvers, P. (2026). Teacher knowledge and skills for mathematical problem solving: a systematic literature review. *Journal of Mathematics Teacher Education*, 1-28. https://doi.org/10.1007/s10857-025-09737-8

Lundkvist, M., & Larsson, K. (2026). 'For a moment I thought maths could be fun': the case of one student's enhanced motivation in mathematics when experiencing thinking classroom. *Scandinavian Journal of Educational Research*, 1-14. https://doi.org/10.1080/00313831.2026.2671727

Magfirotin, E. S., & Amir, M. F. (2024). Elementary school students' conceptual and procedural knowledge in solving fraction problems. *Kreano, Jurnal Matematika Kreatif-Inovatif, 15*(1), 109–122. https://doi.org/10.15294/0m58xs24

Maifa, T. S., Suryadi, D., & Fatimah, S. (2025). Identifying learning obstacles in proof construction for geometric transformations: Conceptual, procedural, and visualization errors. *Infinity Journal*, *14*(3), 673-694. https://doi.org/10.22460/infinity.v14i3.p673-694

Murni, D., Amelia, E., Lestari, I. D., Suryaningsih, S., Indriyani, R., & Zahra, I. A. (2024). Pengetahuan prosedural dan korelasinya dengan pengetahuan konseptual mahasiswa pada topik genetika populasi berbasis molekuler. *Bioedusiana: Jurnal Pendidikan Biologi, 9*(2), 99–114.

Mutiara, A. (2025). Error Analysis in Fraction Arithmetic Operations Among Fourth Grade Students. *JTP-Jurnal Teknologi Pendidikan*, *27*(1), 199-207. https://doi.org/10.21009/jtp.v27i1.52943

Parycek, P., Schmid, V., & Novak, A. S. (2024). Artificial Intelligence (AI) and automation in administrative procedures: Potentials, limitations, and framework conditions. *Journal of the Knowledge Economy*, *15*(2), 8390-8415. https://doi.org/10.1007/s13132-023-01433-3

Polas, M. R. H. (2025). Common method bias in social and behavioral research: Strategic solutions for quantitative research in the doctoral research. *Journal of Comprehensive Business Administration Research*. https://doi.org/10.47852/bonviewJCBAR52024285

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Purnomo, Y. W., Aziz, T. A., Shahrill, M., & Prananto, I. W. (2022). Students' Failure to Understand Fraction Multiplication as Part of a Quantity. *Journal on Mathematics Education*, *13*(4), 681-702.

Rahmatin, T., & Dahlan, J. A. (2025). Students' mathematical creative thinking and learning obstacles in solving ill-structured exponential problems. *4185*, 53–74.

Rio, R. M. D., & Protacio, J. V. (2025). Explanatory Sequential Study on Word Problem-Solving and Mathematical Cognitive Skills of College Students: Implications for STEM Competencies Development. *Educational Process: International Journal*, *18*, e2025506.

Riyatuljannah, T., & Suyadi, S. (2020). Analisis perkembangan kognitif siswa pada pemahaman konsep matematika kelas V SDN Maguwoharjo 1 Yogyakarta. *EduHumaniora: Jurnal Pendidikan Dasar Kampus Cibiru, 12*(1), 48–54. https://doi.org/10.17509/eh.v12i1.20906

Rizki R, R., Suryadi, D., & Nurlaelah, E. (2022). Learning obstacle dalam pemecahan masalah matematis siswa pada materi bangun ruang sisi datar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 11*(4), 3671. https://doi.org/10.24127/ajpm.v11i4.5900

Ross, E., Marshman, M., & McMaster, N. (2026). Teaching the incidental mathematics: How integrated tasks with digital technologies unlocked mathematics concepts in primary school classrooms: E. Ross et al. *Mathematics Education Research Journal*, *38*(2), 301-322. https://doi.org/10.1007/s13394-025-00529-0

Salim Nahdi, D., & Gilar Jatisunda, M. (2020). Conceptual understanding and procedural knowledge: A case study on learning mathematics of fractional material in elementary school. *Journal of Physics: Conference Series, 1477*(4). https://doi.org/10.1088/1742-6596/1477/4/042037

Seloane, P. M., Ramaila, S., & Ndlovu, M. (2023). Developing undergraduate engineering mathematics students' conceptual and procedural knowledge of complex numbers using GeoGebra. *Pythagoras, 44*(1), 1–14. https://doi.org/10.4102/PYTHAGORAS.V44I1.763

Silla, E. M., Barbieri, C. A., & Newton, K. J. (2024). Procedural flexibility on fraction arithmetic and word problems predicts middle-schoolers' differential algebra skills. *Journal of educational psychology*, *116*(2), 195. https://psycnet.apa.org/doi/10.1037/edu0000822

Soraya, D., Jupriyanto, J., & Sari, Y. (2023). The effect of a realistic mathematics education on the problem-solving ability of mathematics. *EduHumaniora: Jurnal Pendidikan Dasar Kampus Cibiru, 15*(2), 207–214. https://doi.org/10.17509/eh.v15i2.49718

Sugawara, M., Sekao, D., & Sibiya, M. R. (2026). Investigating learners' misconceptions on division of whole numbers to identify a goal of research lesson–a case of lesson study. *International Electronic Journal of Mathematics Education*, *21*(1), em0863.

Sutrisno, A. B., Kaharuddin, A., & Gupta, V. (2025). Analysis Of Student Difficulties in Solving Problems on Statistics Material. *EduTransform: Multidisciplinary International Journal*, *1*(1), 27-39.

Tandililing, P., Sirampun, E., Kho, R., & Ruamba, M. Y. (2025). Geometric Thinking Levels in Learning Quadrilaterals: A Van Hiele-Based Case Study in a Papuan Junior High

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

School. *Edumatica: Jurnal Pendidikan Matematika*, *15*(2), 124-136. https://doi.org/10.22437/edumatica.v15i2.43719

Torres-Peña, R. C., Peña-González, D., Lara-Orozco, J. L., Ariza, E. A., & Vergara, D. (2025). Enhancing numerical thinking through problem solving: A teaching experience for third-grade mathematics. *Education Sciences*, *15*(6), 667. https://doi.org/10.3390/educsci15060667

Wiranto Karim, A., Majid, & Bito, N. (2023). Analisis kesulitan pemahaman konsep siswa dalam menyelesaikan soal pada materi himpunan di SMP Negeri 2 Bolangitang Timur. *Innovative: Journal of Social Science Research, 3*(2), 7066–7078.

Xu, C., Di Lonardo Burr, S., Rodgers, L. J., Wylie, J., Si, J., Huang, B., ... & Li, H. (2026). A longitudinal investigation of the codevelopment and bidirectional relations among whole number arithmetic and conceptual and procedural fraction knowledge. *Journal of Educational Psychology*, *118*(2), 224. https://psycnet.apa.org/doi/10.1037/edu0000942

Žakelj, A., Štemberger, T., & Klančar, A. (2025). An empirical study on basic and conceptual knowledge, procedural knowledge and problem solving among primary school students. *International Journal of Instruction*, *18*(4), 627-650.

Ziv, E., & Heafner, T. L. (2025). A comparative analysis of ChatGPT's trigonometry tutoring capabilities: Progressing from model 3.5 to reasoning o1. *Journal of Technology and Teacher Education*, *33*(4), 785-832. https://doi.org/10.70725/554492exncrp

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)