

Patterns of Fifth-Grade Students' Difficulties in Solving Fraction Problems Across Mathematical Ability Levels

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ABSTRACT

Fractions remain a challenging topic in elementary mathematics because successful problem solving requires students to coordinate problem comprehension, conceptual understanding, procedural knowledge, and mathematical representation. This study aimed to analyze the patterns of fifth-grade students' difficulties in solving fraction problems across different mathematical ability levels. A descriptive qualitative design was employed involving 30 fifth-grade students at SD Negeri 8 Baubau, Indonesia. Data were collected through a 10-item open-ended fraction test administered to all participants and semi-structured interviews with three students representing high-, medium-, and low-ability levels. The data were analyzed through data reduction, data display, comparison of written responses and interview evidence, and conclusion drawing. The results showed that 20.00% of students were classified as high ability, 36.67% as medium ability, and 43.33% as low ability. Three major patterns of difficulty were identified: understanding fraction problems, performing fraction operations, and mathematical problem solving. High-ability students generally understood the problems and selected appropriate operations but still made minor procedural and accuracy-related errors. Medium-ability students demonstrated partial conceptual understanding accompanied by unstable procedural knowledge, particularly in converting fraction forms, finding common denominators, and selecting appropriate operations. Low-ability students showed the most complex pattern, involving interconnected difficulties in understanding problem situations, representing quantitative relationships, performing fraction operations, and organizing complete solution procedures. These findings indicate that fraction difficulties differ qualitatively across ability levels; therefore, instruction should be differentiated by emphasizing accuracy and verification for high-ability students, conceptual-procedural connections for medium-ability students, and integrated comprehension-representation-procedure scaffolding for low-ability students.

Keywords: Fraction Difficulties, Mathematical Ability Levels, Fraction Problem Solving, Conceptual and Procedural Knowledge, Elementary Mathematics

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INTRODUCTION

Fractions constitute a foundational component of elementary mathematics because they support the development of rational-number reasoning and provide an important bridge toward more advanced mathematical ideas. Competence with fractions is not limited to performing arithmetic procedures; it involves understanding magnitude, equivalence, part-whole relationships, measurement, quotient, and the relationships among different representations of rational numbers. Recent longitudinal evidence further indicates that fraction proficiency is closely connected with subsequent mathematical development,



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including algebraic achievement, making the elementary years a critical period for establishing robust fraction knowledge (Pedersen et al., 2023; Spitzer & Moeller, 2022). Recent research also shows that students' fraction knowledge is neither uniform nor static; understanding can develop differently across fraction subconstructs and may fluctuate as students encounter increasingly complex concepts (Burr et al., 2026).

Despite its importance, fractions remain one of the most conceptually demanding topics in elementary mathematics. One major source of difficulty is the transition from whole-number reasoning to rational-number reasoning. A meta-analytic structural equation modeling study involving 6,096 students demonstrated that whole-number knowledge significantly predicts both conceptual and procedural fraction knowledge, while students experiencing mathematical difficulties exhibit patterns that differ from those of typically achieving students (Lin & Powell, 2021). Fraction understanding therefore cannot be reduced to memorizing algorithms. Students need to coordinate conceptual knowledge such as recognizing the meaning and magnitude of a fraction with procedural knowledge required to manipulate fractions accurately. Lenz et al. (2024) showed that students' conceptual and procedural knowledge may vary considerably across fraction topics and that lower conceptual knowledge is associated with more frequent conceptual errors.

The complexity of fractions becomes more evident when students perform arithmetic operations. Successful fraction computation requires students to understand why denominators must sometimes be made equivalent, how mixed numbers can be transformed, how numerators and denominators function within an operation, and why procedures that are valid for whole numbers cannot always be transferred directly to fractions. Studies have consequently emphasized the need to develop conceptual and procedural knowledge simultaneously rather than treating them as independent learning outcomes (Mavrikis et al., 2022). Instructional studies involving elementary students have also shown that multiple representations and concrete-representational-abstract approaches can support fraction magnitude and fraction-operation understanding, particularly among students who experience mathematical difficulties (Flores et al., 2022, 2024; Zhang et al., 2022).

Recent evidence suggests, however, that students' difficulties should not be interpreted merely as isolated computational mistakes. Errors can reveal the structure of students' underlying mathematical understanding. For example, research on equivalent fractions has identified persistent errors related to recognizing and constructing equivalence (Girgin & Altay, 2024), while studies of fraction addition have found misconceptions associated with the treatment of numerators and denominators and the inappropriate application of whole-number procedures (Husna et al., 2024). More importantly, a large-scale longitudinal study following 1,055 students across Grades 4 and 5 demonstrated that fraction misconceptions may change, disappear, and re-emerge as students encounter different fraction subconstructs. Correct responses at one point in time, therefore, do not necessarily indicate stable conceptual understanding (Burr et al., 2026). These findings strengthen the need for diagnostic analyses that examine how students reason, rather than evaluating performance solely through final answers.

The challenge becomes greater when fractions are embedded in mathematical word problems. Solving a word problem requires students to move beyond computation by interpreting linguistic information, identifying relevant quantities, determining mathematical

relationships, selecting appropriate operations, constructing a mathematical representation, performing calculations, and interpreting the resulting answer. A recent systematic review and meta-analysis found that several linguistic and numerical characteristics of word problems are significantly associated with elementary students' performance, particularly lexical inconsistency, realistic considerations, the position of the unknown, and the number of operations required (Vessonen et al., 2024). Similarly, Wong & Yip (2023) found that fifth-grade students' ability to identify the semantic role of the unknown in word problems longitudinally predicted their subsequent mathematical problem-solving performance. This relationship was partially mediated by students' ability to translate word problems into correct number sentences or equations, indicating that difficulties in mathematical word problems can emerge during problem representation before calculation begins.

This issue has also been documented in the Indonesian elementary-school context. Hariyani et al. (2022) identified learning obstacles ranging from basic fraction concepts and arithmetic operations to fraction problem solving. Rosmayasari et al. (2024) reported that fifth-grade students experienced difficulty understanding problems, transforming mixed numbers, selecting and implementing solution strategies, applying fraction-operation concepts and procedures, and formulating conclusions. In addition, Agusfianuddin et al. (2024) found that fifth-grade students with different ability levels experienced difficulties in mathematical language when solving word problems. More recent research has similarly reported that students may have difficulty recording known and required information, choosing appropriate operations, and evaluating the reasonableness of solutions to fraction problems (Izzati & Maula, 2025).

An important dimension that requires greater attention is the heterogeneity of students' fraction difficulties across mathematical ability levels. Students who achieve different levels of mathematical performance may not merely differ in the number of correct answers; they may employ different reasoning processes and exhibit qualitatively different difficulties. Pedersen et al. (2023), for example, found distinct developmental trajectories between high- and low-performing students, with the proficiency gap widening across a school year. Lenz et al. (2024) likewise demonstrated that profiles of conceptual and procedural fraction knowledge were related to different types of errors. Studies in Indonesia that classify students into high, medium, and low performance groups have also revealed variation in fraction problem-solving processes (Agusfianuddin et al., 2024; Izzati & Maula, 2025). These findings suggest that treating all students who answer incorrectly as a homogeneous group can obscure important differences in the nature and depth of their mathematical difficulties.

Although a growing body of research has investigated fraction misconceptions, fraction arithmetic, learning obstacles, and word-problem solving, existing studies frequently emphasize a particular fraction concept, a specific operation, an intervention, or selected stages of problem solving. Studies that categorize learners according to achievement levels have also tended to focus on particular dimensions of performance. Consequently, there remains a need for an integrated diagnostic account of how difficulties in understanding fraction problems, performing fraction operations, and constructing mathematical solutions appear and interact across different mathematical ability levels. Such an analysis is pedagogically relevant because effective instructional support should respond not only to whether a student produces an incorrect answer, but also to the specific conceptual,

procedural, or problem-representation difficulty underlying that answer. Evidence from intervention meta-analyses similarly indicates that students experiencing mathematics difficulties benefit from targeted and structured support rather than undifferentiated instruction (Myers et al., 2022; Rojo et al., 2023).

Accordingly, this study aims to analyze the patterns of fifth-grade students' difficulties in solving fraction problems across different mathematical ability levels. Specifically, the study examines students' difficulties in understanding the information and demands of fraction problems, performing fraction operations, and translating contextual problems into appropriate mathematical models and solution procedures. By combining evidence from students' written responses with in-depth interviews and comparing patterns across high-, medium-, and low-ability groups, the study seeks to provide a more differentiated account of fraction difficulties. The contribution of this study lies in positioning students' errors not merely as incorrect outcomes but as diagnostic evidence of how conceptual understanding, procedural competence, and mathematical problem solving differ across ability levels. This perspective can provide a stronger empirical basis for designing differentiated and targeted fraction instruction in elementary mathematics.

METHODS OF RESEARCH

This study employed a descriptive qualitative design to investigate patterns of fifth-grade students' difficulties in solving fraction problems across different mathematical ability levels. The qualitative approach was selected because the study focused not only on students' final scores but also on the characteristics of their errors, solution processes, and explanations of the difficulties they experienced when working with fraction problems. Quantitative scores from the written test were used only as a basis for classifying students into mathematical ability levels, whereas the primary analysis focused on students' written responses and interview data. The study was conducted during the second semester of the 2025/2026 academic year at SD Negeri 8 Baubau, Indonesia. The participants consisted of all 30 fifth-grade students in the selected class.

Data were collected using a written fraction test and semi-structured interviews. The written test consisted of 10 open-ended items designed to assess students' understanding and solution processes across several fraction contents. The items covered the basic concept of fractions, addition of fractions with equal and different denominators, addition of mixed fractions, subtraction of fractions with equal and different denominators, and subtraction involving mixed fractions. The test was administered after students had completed instruction on fractions, and students worked independently for 70 minutes (2×35 minutes). In addition to identifying students' performance levels, the written responses provided diagnostic evidence regarding the procedures, representations, and errors produced during problem solving.

Prior to the main data collection, the fraction test was pilot-tested with 20 students who were not included in the main study sample. The pilot testing was conducted to examine the item validity and internal consistency of the instrument before its administration to the research participants. Item-total Pearson correlations for the 10 test items ranged from .471 to .815, and all item-total correlations were statistically significant at the .05 level or better.

The 10-item test yielded a Cronbach's alpha coefficient of .844, indicating satisfactory internal consistency. Following this pilot testing, the instrument was administered to the 30 fifth-grade students who participated in the main study.

After the written test was scored, students were classified into three mathematical ability levels based on the performance classification used by [Balik et al. \(2023\)](#): high ability (81–100), medium ability (65–80), and low ability (0–64). In this study, these cut-points were used operationally to classify students according to their performance on the fraction test and to support comparisons of difficulty patterns across groups; they were not intended as national or school-wide grading standards. This classification was used as an analytical framework for comparing patterns of difficulty rather than as a basis for inferential statistical comparison. Following the classification, three students were selected for further investigation, with one student representing each ability level. The selection was based on the students' test results. For confidentiality in reporting the qualitative findings, the participants were identified using the codes HA (high ability), MA (medium ability), and LA (low ability).

Semi-structured interviews were conducted after the written test to obtain deeper information about students' reasoning and the difficulties underlying their written responses. The semi-structured format enabled the interviewer to use predetermined questions while allowing follow-up questions to emerge from each student's test responses. The interviews were recorded, important responses were documented, and the recordings were subsequently transcribed for analysis. The interview protocol focused on three dimensions of difficulty: (1) understanding fraction problems, including interpreting the meaning, information, and language of the problem; (2) performing fraction operations, particularly difficulties in addition, subtraction, and determining equivalent denominators; and (3) mathematical problem solving, including determining appropriate solution procedures, translating word problems into mathematical operations, and drawing conclusions. These dimensions were used consistently to organize evidence from both written responses and interviews.

Data analysis was conducted interactively through three main processes: data reduction, data display, and conclusion drawing. During data reduction, students' written solutions and interview transcripts were examined, and relevant evidence of difficulty was selected and organized according to the three analytical dimensions. Interview statements were compared with the corresponding written responses to identify consistency between what students produced and how they explained their reasoning. During data display, the reduced data were organized according to mathematical ability level and type of difficulty, allowing patterns within and across the high-, medium-, and low-ability groups to be examined. Finally, conclusions were drawn by identifying recurring patterns of conceptual, procedural, and problem-solving difficulties and comparing how these patterns manifested across the three ability levels. No formal second-coder procedure or inter-rater agreement coefficient was employed. To enhance consistency of interpretation, the same three analytical dimensions were applied systematically across all written responses and interview data, and interpretations were cross-checked through triangulation between students' written work and interview explanations.

RESULTS AND DISCUSSION

The results revealed distinct patterns of difficulty in solving fraction problems across mathematical ability levels. Of the 30 fifth-grade students, 6 students (20.00%) were classified as high ability, 11 students (36.67%) as medium ability, and 13 students (43.33%) as low ability. This distribution indicates considerable heterogeneity in students' fraction performance and provides an initial indication that fraction knowledge was not equally established across students. Such variation is consistent with recent evidence showing that elementary students may possess markedly different levels of conceptual and procedural fraction knowledge even when they have experienced comparable classroom instruction ([Magfirotn & Amir, 2024](#); [Pedersen et al., 2023](#)).

Table 1 Distribution of Students by Mathematical Ability Level

Mathematical ability level	Score interval	Number of students	Percentage
High	81–100	6	20.00%
Medium	65–80	11	36.67%
Low	0–64	13	43.33%
Total		30	100.00%

Further analysis identified three major dimensions of difficulty: understanding the problem, performing fraction operations, and mathematical problem solving. These dimensions correspond closely with findings from previous elementary-school fraction studies. [Hariyani et al. \(2022\)](#), for example, identified learning obstacles ranging from fundamental fraction concepts and fraction arithmetic to fraction problem solving, while [Rosmayasari et al. \(2024\)](#) reported difficulties in understanding problems, transforming fraction forms, selecting strategies, applying operations, and interpreting final solutions.

Table 2 Distribution of Difficulties Across Mathematical Ability Levels

Ability level	n	Understanding the problem, n (%)	Performing fraction operations, n (%)	Mathematical problem solving, n (%)
High	6	0 (0.0%)	20 (33.3%)	0 (0.0%)
Medium	11	13 (11.8%)	69 (62.7%)	13 (11.8%)
Low	13	71 (54.6%)	102 (78.5%)	71 (54.6%)

Note. Percentages indicate the proportion of responses within each ability group in which each type of difficulty was identified.

Table 2 shows that difficulty in performing fraction operations was the most prominent dimension at all three ability levels. However, the profile became increasingly complex as ability level decreased. High-ability students primarily demonstrated procedural inaccuracies; medium-ability students showed a combination of partial understanding and unstable procedures; and low-ability students displayed substantial difficulties in comprehension, operations, and mathematical problem solving. A similar differentiation was reported by [Saleh et al. \(2023\)](#), whose analysis of high-, medium-, and low-ability elementary students showed that high-performing students could complete problem-solving stages more successfully, whereas low-performing students had difficulty translating fraction situations into mathematical forms.

Difficulties Among High-Ability Students

High-ability students generally demonstrated adequate understanding of the meaning of the problems and correctly identified the operations required by contextual situations. Figure 1 shows that the student was able to interpret most problem statements, use appropriate fraction procedures, and organize the solution coherently. The errors identified were relatively minor and primarily involved computational accuracy or insufficient attention to details such as measurement units.

The image shows handwritten student work for three math problems. The first problem involves a semangka (watermelon) divided into 8 parts, with 3 parts eaten, resulting in $3 - 8 = \frac{3}{8}$. The second problem involves a journey of $2\frac{3}{5}$ km and $1\frac{1}{5}$ km, with the sum $\frac{13}{5} + \frac{6}{5} = \frac{19}{5}$ km. The third problem involves 6 $\frac{3}{4}$ liters of oil, with $2\frac{3}{4}$ liters used, resulting in $\frac{21}{4} - \frac{11}{4} = \frac{10}{4} = \frac{5}{2}$ liters.

Figure 1 Written Response of a High-Ability Student

The interview reinforced this interpretation. The student stated:

"There was no part that was difficult to understand. The mistakes I made were only because I was not careful."

This self-assessment was also supported by the student's written responses. Across the test, the student generally interpreted the problem situations appropriately and selected the required mathematical operations. For example, the student correctly recognized the fraction representation required in Item 1, identified addition as the appropriate operation in Item 4, and used subtraction to determine the remaining quantity in Item 10. The observed errors occurred mainly during calculation or in attending to details, such as the measurement unit in Item 4, rather than in identifying the mathematical meaning or operation required by the problems. Thus, the written evidence was consistent with the student's explanation that the errors primarily reflected accuracy-related difficulties rather than a broad conceptual misunderstanding.

The student also explained an orderly problem-solving process that involved reading carefully, identifying known and unknown information, determining the appropriate operation, calculating, and writing the final answer.

This pattern suggests that high performance does not necessarily imply completely error-free fraction knowledge. Lenz et al. (2024), based on data from 1,005 students,

demonstrated that conceptual and procedural fraction knowledge may differ considerably within the same student across fraction topics. Students with relatively strong knowledge in one area may therefore remain vulnerable to errors in another.

The result also accords with Pedersen et al. (2023), who found different developmental trajectories of fraction proficiency among high- and low-performing students across a school year. Their results indicate that performance groups differ not simply in score but in how fraction knowledge develops and responds to instruction.

More recent longitudinal evidence further demonstrates that fraction misconceptions and errors are dynamic rather than fixed. Burr et al. (2026) found that students' errors may disappear, recur, or change when they encounter different fraction subconstructs. This finding supports the present observation that even relatively successful students may still demonstrate local procedural vulnerabilities.

The result is also compatible with Azis et al. (2023), who showed that students' mathematical difficulties can occur at different cognitive levels. Thus, an error committed by a high-performing student should not automatically be interpreted as evidence of fundamental conceptual failure.

Difficulties Among Medium-Ability Students

The medium-ability group demonstrated a different profile. These students had begun to develop basic fraction understanding but were inconsistent in translating that understanding into appropriate procedures. Figure 2 shows errors in interpreting the requirements of problems, choosing operations, converting mixed fractions, finding common denominators, and conducting fraction arithmetic.

1. Dik: Ibu mempunyai sebuah semangka. 8 bagian sampai dipotong
 dan An. memakan 3 bagian dari 8 bagian semangka. 9
 Dit: Berapa bagiankah semangka yang dimakan An. sisa dalam
 bentuk Pecahan?
 Pen: $\frac{8}{8} + \frac{3}{8} = \frac{32 + 32}{8} = \frac{64}{8}$
 Jadi, semangka yang dimakan An. $\frac{64}{8}$

2. Dik: Sebuah botol berisi $\frac{5}{6}$ liter air.
 Pindahkan $\frac{1}{4}$ liter
 Dit: Berapa literkah sisa air dalam botol?
 Pen: $\frac{5}{6} + \frac{1}{4} = \frac{4}{12}$
 Jadi, sisa air tersebut adalah $\frac{4}{12}$

9. Dik: Ibu memiliki kain sepanjang $5\frac{1}{2}$ meter
 Disutakan $3\frac{3}{4}$ meter
 Dit: Berapa meterkah sisa kain ibu?
 Pen: $5\frac{1}{2} - 3\frac{3}{4} = \frac{11}{2} - \frac{15}{4} = \frac{14}{8}$
 Jadi, sisa kain ibu adalah $\frac{14}{8}$

10. Dik: Putri memiliki $6\frac{2}{3}$ liter minyak goreng
 - $2\frac{3}{4}$ liter untuk memasak.
 Dit: Berapa literkah sisa minyak goreng Putri?
 Pen: $6\frac{2}{3} + 2\frac{3}{4} = \frac{20}{12} + \frac{9}{12} = \frac{29}{12}$
 Jadi, sisa minyak goreng Putri adalah $\frac{29}{12}$

Figure 2 Written Response of a Medium-Ability Student

The student's interview responses directly reflected this instability:

"Sometimes I am still confused about how to make the denominators the same."

and:

"I am confused about which operation to use and where to start."

These statements indicate that the difficulty was not purely computational. It involved the connection between conceptual understanding, mathematical interpretation, and procedural execution.

This finding strongly corresponds with [Azis et al. \(2022\)](#), who identified conceptual, principle, and skill difficulties in students' addition and subtraction of fractions. Skill-related difficulties were the most frequently observed category, indicating that fraction procedures may remain problematic even when some conceptual knowledge has already been established.

[Magfirotin & Amir \(2024\)](#) similarly emphasized the interdependence of conceptual and procedural knowledge in elementary students' fraction problem solving. Their qualitative study involving 86 elementary students showed that understanding concepts and correctly executing procedures are both necessary for comprehensive fraction problem solving.

The medium-ability pattern is also consistent with [Lenz et al. \(2024\)](#), who found that low conceptual knowledge within a particular fraction topic was associated with characteristic conceptual errors, while conceptual and procedural profiles varied across topics.

Furthermore, [Girgin & Altay \(2024\)](#) reported common difficulties among fifth-grade students when working with equivalent fractions, including errors in generating and recognizing equivalent forms. Such weaknesses are highly relevant to the present students' difficulties in establishing common denominators because successful addition and subtraction of unlike fractions depend fundamentally on understanding equivalence.

[Saleh et al. \(2023\)](#) also found that medium-ability elementary students could understand some initial stages of fraction problem solving but were unable to complete all stages consistently. This closely resembles the present finding that medium-ability students possessed partial understanding but experienced difficulty transforming that understanding into complete and accurate solutions.

The linguistic dimension may also contribute to procedural performance. [Lin & Powell \(2023\)](#) demonstrated that explicit fraction-vocabulary instruction for Grade 4 students with mathematics difficulties improved fraction vocabulary and also produced gains in fraction arithmetic. Their findings suggest that understanding mathematical terminology can support students' ability to correctly interpret and execute fraction procedures.

Difficulties Among Low-Ability Students

The low-ability group exhibited the most extensive pattern of difficulty. Problems emerged not only during calculation but also while interpreting situations and constructing mathematical representations. On Item 1, for example, a situation requiring the representation of three out of eight equal parts as $\frac{3}{8}$ was instead interpreted by the student as the subtraction $8-3$. Difficulties were also visible in contextual subtraction problems, conversion of mixed fractions, determination of common denominators, and completion of solution procedures.

Figure 3 Written Response of a Low-Ability Student

The interview illustrates how these difficulties were interconnected. The student acknowledged:

"I do not understand all of them."

The student also explained:

"Sometimes I change the fraction incorrectly, make the denominators equal incorrectly, and calculate the numbers incorrectly."

When describing the process of solving word problems, the student stated:

"I read the problem, take the numbers, and try to calculate, but the steps are not yet in order."

This response is important because it suggests a tendency to operate directly on the numerical information before constructing an appropriate model of the situation. Consequently, difficulties in reading and understanding the problem can propagate into operation selection and subsequent computation.

This pattern closely resembles [Azis \(2019\)](#), who found that students solving mathematical word problems experienced conceptual difficulties in identifying known and required information, principle-related difficulties in selecting mathematical relationships, and algorithmic difficulties in executing solution steps.

Similarly, [Azis et al. \(2022\)](#) found conceptual, principle, and operational errors in mathematical problem solving. Their study reinforces the interpretation that an incorrect numerical answer can originate much earlier in the problem-solving process, particularly during conceptualization or selection of the appropriate mathematical principle.

The fraction-specific results of [Azis et al. \(2022\)](#) provide additional support. Their findings showed that difficulties in concepts, principles, and fraction skills coexist when students perform addition and subtraction operations.

[Hariyani et al. \(2022\)](#) similarly identified epistemological obstacles extending from basic fraction concepts to arithmetic operations and problem solving among elementary students. This indicates that difficulties in fraction learning can form a chain in which incomplete knowledge at an earlier stage constrains later reasoning.

[Rosmayasari et al. \(2024\)](#), specifically working with fifth graders, found difficulty

understanding fraction word problems, converting mixed numbers, constructing and implementing strategies, applying fraction operations, drawing conclusions, and validating answers. These results closely parallel the present low-ability students' difficulties.

A similar pattern was also reported by [Izzati & Maula \(2025\)](#), who examined fifth-grade fraction problem solving in terms of understanding the problem, planning the solution, and evaluating the result. Their study reinforces the importance of analyzing problem solving as a sequence of cognitive processes rather than merely evaluating the final answer.

More recent evidence from [Fitri et al. \(2026\)](#) again shows that fifth-grade students with high, medium, and low problem-solving performance experience different forms of difficulty when solving fraction problems, supporting the continued relevance of diagnostic analyses across ability levels.

The students' difficulty in understanding contextual problems can also be interpreted in light of [Vessonen et al. \(2024\)](#). Their systematic review and meta-analysis of 69 studies showed that several linguistic and numerical characteristics of word problems are associated with elementary students' performance, including schematic structure, lexical consistency, realistic considerations, the position of unknown quantities, and the number of operations required. Thus, unsuccessful fraction word-problem solving may reflect an interaction between fraction knowledge, language comprehension, and mathematical representation.

Cross-Level Patterns of Fraction Difficulties

Comparison across the three groups reveals increasingly complex patterns of difficulty: High ability → primarily accuracy and local procedural vulnerability; Medium ability → partial conceptual understanding and unstable procedural execution; Low ability → interconnected comprehension, representation, procedural, and problem-solving difficulties. The significance of this pattern lies in the fact that students at different ability levels did not merely produce different numbers of errors; they exhibited qualitatively different structures of difficulty.

[Saleh et al. \(2023\)](#) provide particularly relevant comparative evidence. In their study of elementary students classified as high, medium, and low performers on fraction problems, high-performing students successfully applied all major problem-solving stages, whereas medium- and low-performing students demonstrated progressively greater difficulty, particularly in representing fraction problems mathematically.

[Pedersen et al. \(2023\)](#) likewise showed a widening gap between high- and low-performing students' fraction proficiency during Grade 4, suggesting that prior ability interacts with subsequent fraction learning.

The findings are further supported by [Lenz et al. \(2024\)](#), whose results indicate that diagnostic support should take students' topic-specific conceptual and procedural profiles into account rather than treating fraction performance as a single uniform ability.

Recent diagnostic research also supports the need to examine what lies behind an incorrect answer. [Hakqi et al. \(2025\)](#), using a three-tier diagnostic assessment, emphasized that conventional correct-incorrect scoring may fail to detect underlying misconceptions in elementary students' fraction understanding. This is consistent with the present use of written solutions and interview explanations to distinguish minor inaccuracies from deeper conceptual and procedural difficulties.

Instructional Implications

The differentiated patterns suggest that instructional responses should also be differentiated. For high-ability students, the priority is to develop accuracy, verification, mathematical explanation, and reflective checking. Worked-example research with Grade 5 students experiencing mathematics difficulties also indicates that carefully designed examples can support students' mathematical explanations and conceptual reasoning, suggesting value in asking students not only to produce answers but to justify and evaluate solution steps.

For medium-ability students, instruction should emphasize the relationship between conceptual and procedural knowledge. Equivalent-fraction models, number lines, diagrams, and explicit explanation of why denominators must be equivalent can support the transition from conceptual representation to symbolic procedures. [Powell \(2023\)](#), for example, demonstrated the potential of measurement-based approaches to strengthen elementary students' understanding of fraction magnitude.

The importance of multiple representations is also supported by research on elementary fraction learning. [Unaenah & Suryadi \(2023\)](#) identified learning obstacles associated with insufficiently varied representations in fraction instruction, emphasizing the need for learning trajectories that connect different ways of representing fractions.

For low-ability students, instructional support needs to integrate comprehension, representation, and computation. Explicit scaffolding should help students determine known and unknown information, identify the mathematical relationship among quantities, select an operation, carry out fraction procedures, and evaluate the resulting answer.

This recommendation is supported by the meta-analysis of [Rojo et al. \(2023\)](#), which synthesized 43 rational-number intervention studies and found a substantial overall positive effect for students experiencing mathematics difficulties. The majority of interventions addressed fraction magnitude and arithmetic, and the overall estimated effect favored targeted intervention over regular instruction.

The result also reinforces the importance of diagnostic rather than uniform remediation. Because the three ability groups exhibited different difficulty profiles, providing identical additional exercises to all students would risk addressing symptoms rather than the underlying source of the difficulty.

CONCLUSIONS

This study aimed to examine the patterns of fifth-grade students' difficulties in solving fraction problems across mathematical ability levels. The findings demonstrate that students' difficulties were not merely different in frequency but also differed qualitatively across ability levels. High-ability students generally understood the problems and selected appropriate mathematical operations but still exhibited minor procedural and accuracy-related errors. Medium-ability students showed partial conceptual understanding accompanied by unstable procedural knowledge, particularly when converting fraction forms, determining common denominators, selecting appropriate operations, and solving contextual problems. Low-ability students exhibited the most complex pattern, characterized by interconnected difficulties in understanding problem situations, representing quantitative relationships mathematically, performing fraction operations, and organizing complete problem-solving procedures. These

findings indicate that fraction difficulties should not be treated as a homogeneous learning problem and that instructional support needs to be differentiated according to the nature of students' difficulties. High-performing students require greater emphasis on accuracy, verification, and mathematical justification; medium-performing students need stronger connections between conceptual and procedural fraction knowledge; while low-performing students require integrated scaffolding of problem comprehension, mathematical representation, operation selection, and procedural execution. The study contributes a differentiated diagnostic perspective by showing how the structure of fraction difficulties changes across performance levels rather than merely documenting students' incorrect answers. However, the findings are limited to 30 fifth-grade students in one school context, with in-depth interviews conducted with one representative student from each ability level; therefore, the results are intended as contextual qualitative patterns rather than statistical generalizations. In addition, the qualitative coding was not independently verified by a second coder; therefore, interpretive consistency relied on the systematic application of the analytical framework and triangulation between written and interview data rather than on formal inter-rater agreement. Future research should involve larger and more diverse samples, include several participants from each performance level, incorporate classroom observations and teacher perspectives, and examine through longitudinal, experimental, or design-based studies how differentiated interventions addressing conceptual, procedural, and problem-solving difficulties influence students' fraction learning.

REFERENCES

- Agusfianuddin, A., Herman, T., & Turmudi, T. (2024). Investigation of students' difficulties in mathematical language: Problem-solving in mathematical word problems at elementary schools. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, 10(2), 629–640. <https://doi.org/10.33394/jk.v10i2.11257>
- Azis, A. (2019). Analisis kesulitan siswa dalam menyelesaikan soal cerita pada pembelajaran matematika kelas VIII. *Jurnal Akademik Pendidikan Matematika*, 5(1), 64–72. <https://doi.org/10.31219/osf.io/7fpjz>
- Azis, A., Handayani, I. T., Ferniati, F., Anggriana, N., & Aisyah, A. (2023). Analysis of students' cognitive difficulties based on the revised Bloom's taxonomy in solving mathematics problems. *Journal Focus Action of Research Mathematic (Factor M)*, 6(1), 1–12. https://doi.org/10.30762/factor_m.v6i1.1057
- Azis, A., Iriana, A., & Sudin, L. (2022). Analisis kesalahan siswa dalam menyelesaikan soal-soal pemecahan masalah matematika pada siswa kelas XI MIA SMA. *Jurnal Akademik Pendidikan Matematika*, 8(1), 101–108. <https://doi.org/10.55340/japm.v8i1.697>
- Azis, A., Nurlita, M., & Zulkifran, Z. (2022). Analisis kesulitan siswa dalam menyelesaikan soal operasi bilangan pecahan pada siswa SMP. *Jurnal Akademik Pendidikan Matematika*, 8(2), 231–237. <https://doi.org/10.55340/japm.v8i2.875>
- Balik, Y. R., Sulistyarningsih, M., & Manurung, O. (2023). Analisis kemampuan pemecahan masalah dalam menyelesaikan soal cerita SPLDV berdasarkan Polya. *Jurnal Pendidikan dan Keguruan*, 1(1), 140–153.
- Burr, S. M. D. L., Xu, C., Li, H., Si, J., Huang, B., & Guo, K. (2026). Finding their way: Students'

- fraction misconceptions and errors over two years of fraction learning. *Learning and Instruction*, 106, Artikel 102454. <https://doi.org/10.1016/j.learninstruc.2026.102454>
- Fitri, Y., Turmuzi, M., Wahyuningsih, B. Y., & Alimuddin, N. (2026). Analisis kesulitan siswa dalam pemecahan masalah matematika materi pecahan kelas V SDN 2 Paokmotong tahun ajaran 2025/2026. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal)*, 7(3), 3589–3595.
- Flores, M. M., Hinton, V. M., & Schweck, K. B. (2024). Teaching rational number concepts to fifth-grade students who struggle with mathematics. *Remedial and Special Education*, 45(5), 312–323. <https://doi.org/10.1177/07419325231217315>
- Flores, M., Morano, S., Meyer, J., & Hinton, V. (2022). Teaching fraction magnitude to elementary students. *Journal of Education for Students Placed at Risk*, 27(2), 173–193. <https://doi.org/10.1080/10824669.2021.2009346>
- Girgin, F., & Altay, M. K. (2024). Fifth grade students' performance and common errors in equivalent fractions. *Cumhuriyet International Journal of Education*, 13(1), 27–42. <https://doi.org/10.30703/cije.1328901>
- Hakqi, A. N., Nusantara, T., & Rufiana, I. S. (2025). Analisis pemahaman konsep pecahan siswa sekolah dasar menggunakan tes diagnostik three tier multiple choice. *Ideguru: Jurnal Karya Ilmiah Guru*, 10(3), 2404–2410. <https://doi.org/10.51169/ideguru.v10i3.1384>
- 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), 505–516. <https://doi.org/10.12973/ijem.8.3.505>
- Husna, A., Bahri, S., & Aulia Safira, S. (2024). Analisis miskonsepsi operasi penjumlahan pecahan siswa SD kelas 5 Nisam Antara Aceh Utara. *Jurnal Pendidikan Matematika*, 5(1), 45–54.
- Izzati, N., & Maula, M. (2025). Analysis of students' mathematical problem-solving ability on fraction material. *Mosharafa: Jurnal Pendidikan Matematika*, 14(1), 89–100. <https://doi.org/10.31980/mosharafa.v14i1.2681>
- Lenz, K., Reinhold, F., & Wittmann, G. (2024). Topic specificity of students' conceptual and procedural fraction knowledge and its impact on errors. *Research in Mathematics Education*, 26(1), 45–68. <https://doi.org/10.1080/14794802.2022.2135132>
- Lin, X., & Powell, S. R. (2021). Examining the relation between whole numbers and fractions: A meta-analytic structural equation modeling approach. *Contemporary Educational Psychology*, 67, Artikel 102017. <https://doi.org/10.1016/j.cedpsych.2021.102017>
- Lin, X., & Powell, S. R. (2023). Initial efficacy of a fraction-vocabulary intervention for students experiencing mathematics difficulty in grade 4. *Learning Disabilities Research & Practice*, 38(4), 289–302. <https://doi.org/10.1111/ldrp.12321>
- 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), 112–124. <https://doi.org/10.15294/kreano.v15i1.48912>
- Mavrikis, M., Rummel, N., Wiedmann, M., Loibl, K., & Holmes, W. (2022). Combining exploratory learning with structured practice educational technologies to foster both conceptual and procedural fractions knowledge. *Educational Technology Research and Development*, 70(3), 881–909. <https://doi.org/10.1007/s11423-022-10104-0>
- Myers, J. A., Witzel, B. S., Powell, S. R., Li, H., Pigott, T. D., Xin, Y. P., & Hughes, E. M. (2022). A

- meta-analysis of mathematics word-problem solving interventions for elementary students who evidence mathematics difficulties. *Review of Educational Research*, 92(5), 695–736. <https://doi.org/10.3102/00346543211070049>
- Pedersen, P. L., Aunio, P., Sunde, P. B., Bjerre, M., & Waagepetersen, R. (2023). Differences in high- and low-performing students' fraction learning in the fourth grade. *The Journal of Experimental Education*, 91(4), 621–642. <https://doi.org/10.1080/00220973.2022.2107603>
- Powell, A. B. (2023). Enhancing students' fraction magnitude knowledge: A study with students in early elementary education. *The Journal of Mathematical Behavior*, 70, Artikel 101042. <https://doi.org/10.1016/j.jmathb.2023.101042>
- Rojo, M., King, S., Gersib, J., & Bryant, D. P. (2023). Rational number interventions for students with mathematics difficulties: A meta-analysis. *Remedial and Special Education*, 44(3), 180–194. <https://doi.org/10.1177/07419325221105520>
- Rosmayasari, R., Suryadi, D., Herman, T., & Prabawanto, S. (2024). Problem-solving ability of fifth-graders in mathematical word problem. *KnE Social Sciences*, 9(8), 342–353. <https://doi.org/10.18502/kss.v9i8.15321>
- Saleh, S. F., Sirajuddin, Ernawati, & Damayanti, N. (2023). Analysis of students' mathematical ability in solving fraction problems at elementary school level. *AULADUNA: Jurnal Pendidikan Dasar Islam*, 10(1), 105–118. <https://doi.org/10.24252/auladuna.v10i1a9.2023>
- Spitzer, M. W. H., & Moeller, K. (2022). Predicting fraction and algebra achievements online: A large-scale longitudinal study using data from an online learning environment. *Journal of Computer Assisted Learning*, 38(6), 1640–1653. <https://doi.org/10.1111/jcal.12721>
- Unaenah, E., & Suryadi, D. (2023). Students' learning obstacles on fractions in elementary school. Dalam A. G. Abdullah et al. (Ed.), *Proceedings of the International Conference on Education 2022 (ICE 2022)* (hlm. 148–157). Atlantis Press. https://doi.org/10.2991/978-2-38476-060-2_17
- Vessonen, T., Dahlberg, M., Hellstrand, H., Widlund, A., Korhonen, J., Aunio, P., & Laine, A. (2024). Task characteristics associated with mathematical word problem-solving performance among elementary school-aged children: A systematic review and meta-analysis. *Educational Psychology Review*, 36(4), Artikel 112. <https://doi.org/10.1007/s10648-024-09954-2>
- Wong, T. T. Y., & Yip, E. S. K. (2023). What is the unknown? The ability to identify the semantic role of the unknown from word problems longitudinally predicts mathematical problem solving performance. *Contemporary Educational Psychology*, 73, Artikel 102183. <https://doi.org/10.1016/j.cedpsych.2023.102183>
- Zhang, S., Yu, S., Xiao, J., Liu, Y., & Jiang, T. (2022). The effects of Concrete-Representational-Abstract sequence instruction on fractions for Chinese elementary students with mathematics learning disabilities. *International Journal of Science and Mathematics Education*, 20(7), 1435–1457. <https://doi.org/10.1007/s10763-021-10215-9>