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Profiles Of Elementary Students' Fraction Conceptual Understanding Across Collaboration Ability Levels: A Qualitative Inquiry

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ABSTRACT

Conceptual understanding is an important goal in elementary school mathematics learning, especially in fractions, which form the basis for comparison, decimals, and percentages. However, previous studies rarely profile conceptual understanding of fractions based on students' collaborative abilities, even though social interaction plays a significant role in knowledge construction. Based on social constructivism and Vygotsky's interaction theory, this study examines how the quality of collaboration contributes to conceptual understanding of fractions through dialogue and peer support within the Zone of Proximal Development. The method used was descriptive qualitative, with nine fifth-grade students grouped into high, medium, and low collaboration groups based on an assessment rubric covering participation, idea contribution, communication, and conflict management skills. Data were collected through open-ended tests, classroom observations, semi-structured interviews, and documentation, then analyzed thematically using source triangulation and member checking. The results showed a consistent pattern: students with high collaboration had a complete conceptual understanding encompassing visual, symbolic, and procedural representations; students with moderate collaboration showed partial understanding accompanied by misconceptions; while students with low collaboration experienced fundamental difficulties and tended to be passive. These findings contribute by clarifying the relationship between the quality of collaboration and the depth of conceptual understanding of fractions. Although this study was limited to a small number of subjects and the context of one school, its implications underscore the need for more meaningful collaborative learning designs and further research in broader contexts.

Keywords:

ABSTRAK

Pemahaman konsep merupakan tujuan penting dalam pembelajaran matematika di sekolah dasar, terutama pada materi pecahan yang menjadi dasar bagi perbandingan, desimal, dan persentase. Namun, penelitian sebelumnya jarang memprofilkan pemahaman konseptual pecahan berdasarkan kemampuan kolaborasi siswa, padahal interaksi sosial berperan besar dalam konstruksi pengetahuan. Berlandaskan konstruktivisme sosial dan teori interaksi Vygotsky, penelitian ini menelaah bagaimana

kualitas kolaborasi berkontribusi terhadap pemahaman konsep pecahan melalui dialog dan dukungan teman sebaya dalam Zona Perkembangan Proksimal. Metode yang digunakan adalah kualitatif deskriptif dengan sembilan siswa kelas V yang dikelompokkan ke dalam kolaborasi tinggi, sedang, dan rendah berdasarkan rubrik penilaian meliputi partisipasi, kontribusi ide, komunikasi, dan kemampuan mengelola konflik. Data dikumpulkan melalui tes terbuka, observasi kelas, wawancara semi-terstruktur, dan dokumentasi, lalu dianalisis secara tematik dengan triangulasi sumber serta member checking. Hasil penelitian menunjukkan adanya pola yang konsisten: siswa dengan kolaborasi tinggi memiliki pemahaman konseptual utuh mencakup representasi visual, simbolik, dan prosedural; siswa dengan kolaborasi sedang menunjukkan pemahaman parsial disertai miskonsepsi; sementara siswa dengan kolaborasi rendah mengalami kesulitan mendasar dan cenderung pasif. Temuan ini memberikan kontribusi dengan memperjelas hubungan antara kualitas kolaborasi dan kedalaman pemahaman konsep pecahan. Meskipun penelitian ini terbatas pada jumlah subjek kecil dan konteks satu sekolah, implikasinya menegaskan perlunya rancangan pembelajaran kolaboratif yang lebih bermakna serta penelitian lanjutan dalam konteks yang lebih luas.
Kata Kunci: pecahan; pemahaman konsep; kolaborasi, sekolah dasar; konstruktivisme

INTRODUCTION

Conceptual understanding is one of the main objectives in elementary school mathematics learning, as it serves as the foundation for mastering more advanced materials (Purwandari et al., 2024). One important topic in the elementary school mathematics curriculum is fractions, which require not only numeracy skills but also an understanding of the meaning of fractions in various representations. This material forms the basis for many other mathematical concepts such as ratios, decimals, and percentages, making its mastery crucial for students' cognitive development. However, in reality, many students experience difficulties in understanding fractions. Several studies have revealed students' difficulties, including those involving dividing, simplifying, and comparing fractions (Rahma et al., 2025) These difficulties often arise because they tend to simply memorize procedures without understanding the underlying meaning. This shallow understanding often leads to errors in solving problems, both numerically and contextually (Saputro, 2025). Therefore, it is important for educators and researchers to explore further how to develop a more meaningful and sustainable understanding of fraction concepts through approaches that are appropriate to students' learning characteristics.

This problem becomes increasingly apparent based on observations, when teachers are faced with the fact that many students are unable to correctly solve fraction problems, especially those requiring conceptual understanding, such as comparing two different fractions or representing fractions in visual form. Based on field findings, students tend to rely on memorizing procedural steps without understanding the rationale behind the mathematical operations they perform. Daily tests in fifth grade, for example, show that more than half of students make errors when comparing simple fractions. This fact reinforces that their difficulties are not only procedural but also conceptual. In fact, in daily learning, teachers often complain about the low level of active student participation in discussions or group work, which results in limited opportunities to construct shared meaning through social interaction. This indicates that the learning process has not fully accommodated students' needs to develop collective and dialogical understanding.

One approach that can provide space for students to actively build conceptual understanding is collaborative learning (Putri & Fauzi, 2025; Rini & Mandailina, 2024). Through interactions between students in groups, they not only share answers but also explain strategies, debate ways of thinking, and strengthen understanding through mutual clarification (Mariyono, 2024). This is in line with Vygotsky's cognitive development theory which emphasizes that knowledge is built through social interactions in the Zone of Proximal Development (ZPD), where a child can achieve higher understanding with the help of peers or more competent people (Salsabila & Muqowim, 2024; Suardipa, 2020). In this context, collaboration is not just technical cooperation, but a dialogic process that allows students to reflect on and reorganize their understanding. In addition, collaborative learning allows for peer tutoring interactions that are expected to improve the conceptual understanding of other group members who do not yet understand. Several studies have shown that collaborative learning that emphasizes discussion activities, cooperation between students and solving problems in groups is more effective in improving students' conceptual understanding (M. Ahmad & Dogar, 2023; Nilimaa, 2023). Collaboration skills have been proven to improve mathematical connection skills, which are very necessary in building conceptual understanding(Anisa et al., 2023). Thus, the level of student collaboration ability is expected to influence variations in the quality of understanding of the concept of fractions. Students with high collaboration have the potential to construct deeper understanding than students with low collaboration.

Collaborative skills encompass a range of social and cognitive abilities that enable students to work effectively in groups (Habibi et al., 2024). These skills include active listening, expressing opinions clearly, respecting the opinions of others, contributing to task completion, and making decisions together (Eka Ayu Lestari, 2025; Noviani & Firmansyah, 2024). In mathematics learning, these collaborative skills are highly relevant because they can facilitate cooperative problem-solving, especially when students face problems that require in-depth conceptual understanding, such as fractions. Students with strong collaborative skills tend to be more open to discussions, asking questions, and receiving feedback from their group mates, all of which are part of the knowledge construction process (Khoiriyah, 2016; Sufajar & Qosyim, 2022). Conversely, students with low collaborative skills may be more passive or tend to rely on the dominance of other students, thus limiting opportunities to actively build conceptual understanding (Switri, 2025). This variation in collaborative skill levels is important to pay attention to because it can influence the process and outcomes of student learning in the context of group learning.

Various previous studies have demonstrated the importance of active student engagement in mathematics learning to improve conceptual understanding. For example, a study by Diana et al.(Diana et al., 2023) found that the use of the Numbered Heads Together cooperative learning model can increase student participation and improve their understanding of fraction concepts. Another study showed that students who actively discuss in groups tend to have better conceptual understanding than students who learn individually (Aditya & Hakiem, 2025). However, both studies did not differentiate how variations in students' levels of collaborative ability affect their learning processes and outcomes. Meanwhile, a study by Mailani et al. (Mailani et al., 2025) which focused on analyzing fraction misconceptions, emphasized the importance of social interaction-based interventions but did not explicitly examine the collaboration aspect. These studies indicate that although the benefits of group work and discussion have been widely discussed, few studies have specifically mapped the profile of students' mathematical conceptual understanding based on their level of

collaboration ability, especially in the context of fractions in elementary school. This suggests the need for a more qualitative and in-depth research approach to student learning dynamics in collaborative settings.

Various other studies have also demonstrated the benefits of collaborative learning in improving mathematics learning outcomes (Darmawan & Pujiastuti, 2023; N. K. N. S. Dewi et al., 2020; Zamhari et al., 2025). However, most studies still focus on the influence of learning models in general without specifically examining how students' levels of collaborative skills relate to their understanding of mathematical concepts. Previous studies tend to measure learning outcomes quantitatively, such as final test scores, without in-depth investigation of the thinking processes or forms of understanding that emerge during group work. Furthermore, very little research has explored the profile of students' conceptual understanding based on their level of collaborative ability, especially in the context of fraction learning in elementary schools. However, conceptual understanding is complex and cannot be reduced solely to numbers or scores; it needs to be analyzed from how students represent, explain, and apply the concept in various situations. This means that there is still a research gap in mapping the profile of students' conceptual understanding of fractions in detail based on different levels of collaborative ability.

In line with the need for more in-depth research, it is important to first understand the main concepts that are the focus of the study. Conceptual understanding in mathematics learning refers to students' ability to understand the meaning of a mathematical idea, explain the reasoning behind the procedures used, and relate various representations and situations to the concept being studied (Mailah & Sujarwo, 2023). Conceptual understanding not only includes the ability to answer questions correctly but also involves mastery of the overall structure of mathematical ideas (Safari & Nurhida, 2024). In the context of fractions, conceptual understanding includes understanding parts of a whole, the relationship between different fractions, conversions (e.g., from fractions to decimals), and application in contextual problems. Meanwhile, students' collaborative ability is an individual's capacity to work with others to achieve a common goal, which involves effective communication, collective decision-making, collaborative problem-solving, and positive interdependence among group members (I. Dewi et al., 2024; Rofiudin et al., 2024). In this study, understanding of the concept of fractions was operationalized through indicators of visual representation, symbolic meaning, and application in everyday contexts. Meanwhile, collaboration skills were operationalized through active involvement, listening skills, sharing tasks, and contributing to group discussions.

In the context of mathematics learning, mapping collaboration skills and conceptual understanding is a crucial step in understanding how students construct knowledge together (Anisa et al., 2023). Collaboration in this study is understood as the skill of working actively and productively in groups, which includes the following indicators: communication, participation, interaction, responsibility, conflict management, and group leadership . These indicators not only reflect the quality of students' involvement in social activities but also serve as a bridge for their thinking processes when constructing, testing, and revising mathematical ideas. Correspondingly, the understanding of the concept of fractions is mapped through three main aspects, namely visual representation, symbolic representation (writing fractions in the form a/b along with its meaning), and procedural representation (the ability to use fraction operations meaningfully, not merely algorithmically). By combining these two groups of

indicators, this study examines how the quality of interaction in groups affects the completeness and depth of students' understanding. This relationship is important to study because effective collaboration theoretically allows for the exchange of strategies, clarification of concepts, and correction of misconceptions in a social space that supports the construction of deeper mathematical knowledge..

Based on the previously described study, conceptual understanding in mathematics learning and the strategic role of collaborative skills in supporting students' learning processes, it is relevant to explore how the two interact in the context of classroom learning. This study was specifically designed to answer the question: What is the profile of students' conceptual understanding of fractions in terms of their collaborative skills in fifth grade elementary school? With this focus, the study is expected to explain not only the extent to which students understand fraction concepts, but also how their social interactions and variations in collaborative skills contribute to the formation of this understanding.

METHODS

Type and Design

This research uses a descriptive qualitative approach (Sugiyono, 2021), with the aim of describing and analyzing the profile of students' understanding of the concept of fractions based on their level of collaboration ability in group learning. This approach was chosen because researchers wanted to gain a deep understanding of how students' collaborative abilities can influence the way they build and construct understanding of mathematical concepts, especially fractions. The research was carried out in class V at one of the Muhammadiyah elementary schools in Batang district which is used to implementing the cooperative learning model. Subject selection was carried out purposively by considering variations in students' collaborative abilities. A total of nine students were chosen as the main research subjects, consisting of three students with high collaboration abilities, three students with medium abilities, and three students with low abilities. Assessment of collaboration skills is obtained from observations during group learning, student self-assessment questionnaires, and class teacher considerations.

Data collection technique

Data collection was carried out through several complementary techniques. The first step is to obtain data by administering a questionnaire on students' collaboration skills. This data is used to group students' collaboration abilities into high, medium and low. The method for determining high, medium and low categories is shown in tables 1 and 2. Next, subjects were taken based on collaboration ability categories, each taking 3 subjects per category. The next data is related to knowing the concept understanding. Students are given a concept understanding test which is carried out by giving a fraction concept understanding test which measures students' understanding of the concept of fractions, including visual representation, symbolic meaning, and application in everyday contexts. In addition, observations were made of student activities during group learning to identify characteristics of collaborative behavior, such as active involvement, listening ability, sharing tasks, and willingness to help friends. To strengthen the data, semi-structured interviews were conducted with selected students to dig deeper into their reasons for answering questions, their way of thinking, and their experiences

in the group work process. Documentation such as field notes, student work results, and recordings of group interactions are also used as supporting data

Table 1. Determination of categories of student collaboration skills

Kategori	Interval nilai
Rendah	$x < M - 1SD$
Sedang	$M - 1SD \leq x < M + 1SD$
Tinggi	$M + 1SD \leq x$

Table 2. Categories of Student Collaboration Skills

Kategori	Interval nilai
Rendah	$x < M - 1SD$
	$x < 78 - 9$
	$x < 69$
Sedang	$M - 1SD \leq x < M + 1SD$
	$78 - 9 \leq x < 78 + 9$
	$69 \leq x < 87$
Tinggi	$M + 1SD \leq x$
	$78 + 9 \leq x$
	$87 \leq x$

Data analysis

The instrument used in this study was pre-tested at another school with similar characteristics to the study site. To ensure the validity of the questionnaire, two validators conducted a validity check. To ensure the reliability of the instrument, SPSS 21 was used to test the validity and reliability of the questionnaire. The Cronbach's alpha test yielded a value of 0.792, indicating the questionnaire's reliability. Before the data is analyzed, the data is proven to be valid through technical triangulation (Moleong, 2020). Data from various methods that have been used to collect data are triangulated to ensure the validity of the data. All data collected was analyzed thematically by following the steps for data reduction, data presentation and drawing conclusions. The data reduction process was carried out by arranging categories based on indicators of conceptual understanding and collaboration skills. Then the data is presented in the form of a descriptive narrative that shows patterns of understanding in each collaborative category. Conclusions are drawn inductively, by considering the relationship between collaborative behavior tendencies and the quality of concept understanding demonstrated by students. To increase the validity of the data, triangulation techniques of sources and methods were used, as well as validation through member checking with teachers and research subjects. Through this procedure, it is hoped that research can provide a comprehensive picture of the relationship between collaboration abilities and understanding of fraction concepts in elementary school students.

RESULTS AND DISCUSSION

his research began with the process of identifying the level of collaboration skills of 27 class V students. By administering a questionnaire based on indicators of collaborative skills such as active participation, listening ability, and contribution of ideas, students are grouped

into three categories, namely high, medium, and low. Three students were selected from each category as subjects for more in-depth analysis using fraction concept understanding tests, classroom activity observations, and semi-structured interviews. Data on the results of the student collaborative skills questionnaire are shown in table 3.

Table 3. Collaboration questionnaire results

	N	Minimum	Maximum	Mean	Std. Deviation
Nilai	27	65	100	77.8	9.233
Valid	27				

The results of the analysis of students with high collaboration skills show that they generally have good conceptual understanding. In the written test, the majority of answers are correct and accompanied by logical reasons. For example, in the question " $\frac{3}{4}+\frac{4}{8}=?$ " , one of the students answered: "$\frac{3}{4}$ is the same as $\frac{6}{8}$, then after the denominators are the same, add them to $\frac{4}{8}$, so the total is $\frac{10}{8}$ or $1\frac{2}{8}$. I equate the denominators first so we can add them together." This answer shows that students understand the principle of equivalence of fractions as well as the procedure for equating denominators before carrying out addition operations..

Further interviews with high collaboration students showed that group interaction played an important role in strengthening their understanding. One student said: "If I'm confused, I usually ask a friend or teacher. Sometimes the method is different, but it makes me understand better." Observations in class also support this, where students appear to actively ask questions, provide input, and help explain to their friends. This is in accordance with the findings of other researchers (Aprianti et al., 2025; Damanik et al., 2025) who emphasize that social interaction can be a means of internalizing knowledge through the zone of proximal development.

In contrast, the profile of students with moderate collaboration skills shows partial conceptual understanding. In the same question " $\frac{3}{4}+\frac{4}{8}$ ", a student answered: "The result is $\frac{7}{12}$, because $3+4=7$ and $4+8=12$". This answer reflects the classic misconception that the numerator and denominator are added directly without paying attention to the rules for equating denominators. The results of this research are in line with Sulistyo's research (Sulistyo & Saputro, 2023) where the research revealed that there are still many students who have difficulty solving fraction problems with different denominators. However, there are attempts to find a solution pattern, even though the pattern is wrong. This indicates that students already understand that fractions consist of a numerator and a denominator, but have not yet fully mastered the relationship between the two.

Interviews with collaboration students are corroborating these findings. One student stated: "I think if you add, top plus top, bottom plus bottom. My friends are like that too, so I follow." This quote shows that although students were involved in group work, the quality of the interactions they experienced was not enough to correct conceptual errors. They tend to follow friends' answers without evaluating them critically. This is in accordance with the findings of (Dube & Maseko, 2024; Yakubu & Jungdo, 2023) who identified direct addition of the numerator and denominator as a common misconception in fraction operations.

Meanwhile, students with low collaboration skills show the most limited understanding profile. In a fraction comparison question, for example "Which is bigger, $\frac{2}{3}$ or $\frac{3}{4}$", a student answers: "$\frac{2}{3}$ is smaller, because the number 2 is smaller than 3." This answer shows that students only focus on the numerator or denominator separately, not on the concept of fractions as representing parts of a whole. This error shows a fundamental limited understanding of the meaning of fractions.

Interviews with low collaboration students showed a tendency towards individual and passive learning. One student said: "I prefer to do it myself, sometimes I get confused but I just leave it alone. If I'm with a friend, I just keep quiet." Class observations also show that this category of students rarely ask questions or provide responses, even when facing difficulties. This confirms that low collaboration skills make students lose the opportunity to get clarification of concepts through discussion (Al Hasanah & Hasruddin, 2025). agrees with Jannah (Jannah et al., 2025), the quality of group interaction determines the extent to which students can obtain conceptual understanding.

When compared between categories, a consistent pattern can be seen: the higher the student's collaboration skills, the better their conceptual understanding. Students with high collaboration not only benefit from individual practice, but also from exchanging ideas with friends, so that misconceptions can be minimized. In line with Sapitri's research (Sapitri et al., 2025) with the help of friends or peer tutors it is felt to be very effective in helping students' understanding, especially when providing understanding of concepts and implementing these concepts either through examples or information on problem solving steps. Students with moderate collaboration gain partial understanding, but misconceptions persist because there is no critical evaluation in group interactions. Meanwhile, students with low collaboration are actually trapped in basic mistakes due to minimal involvement in discussions (C. V Ahmad, 2021).

These findings show that collaboration skills are not just social skills, but also factors that support students' cognitive development. Collaboration provides space for the exchange of ideas, clarification of concepts, and reflection on existing understanding (Thornhill-Miller et al., 2023). In other words, collaboration acts as a catalyst or peer tutor in the process of constructing mathematical knowledge. The social constructivism perspective emphasizes that learning is a social activity, so that rich interactions will accelerate the formation of deeper understanding.

Overall, the results of this study confirm that the profile of understanding the concept of fractions in elementary school students is determined not only by individual cognitive abilities, but also by the collaboration skills they have. Students with high collaboration show complete conceptual understanding, students with moderate collaboration still harbor misconceptions, while students with low collaboration face basic difficulties in understanding fractions. The practical implication of these findings is that teachers need to design meaningful collaborative learning, for example through structured group discussions, scaffolding between students, and the habit of reflecting together, so that each student can develop their conceptual understanding optimally. The results of this study are in line with the misconception framework (Ni & Zhou, 2016) that the causes of student misconceptions occur due to several factors, including learning that does not facilitate critical dialogue, minimal student

participation in class, a class culture that emphasizes finding results quickly, and a lack of diverse representational experiences.

Table 4. The relationship between collaboration levels and concept understanding

Collaboration Category	Characteristics of Collaborative Behavior	Conceptual Understanding Profile	Findings
High	Actively participate, ask questions, provide input, help friends; effective communication; able to manage differences of opinion	Complete conceptual understanding: understand the relationship between numerator, denominator, principles of equality of fractions, and procedures for equating denominators; able to connect procedural symbolic visual representations; misconceptions hardly arise	Finish adding fractions by making the denominators equal, giving a logical reason: "I'll make the denominators equal first so they can be added."
Medium	Engaged but inconsistent; contributes but tends to follow friends; low critical evaluation; communication is quite good but not in depth	Partial understanding: recognizes the structure of fractions but does not understand their relationships; common misconceptions still arise, such as adding the numerator and denominator directly; Weak procedural representation	Answering the addition of fractions by adding the numerator and denominator: "top plus top, bottom plus bottom... my friend does the same."
Low	Passive; work alone; rarely ask; not responding; difficulty following discussions; minimal social interaction.	Limited/basic understanding: sees fractions as just two separate numbers; does not understand the concept of part–whole; fundamental	Judging fractions only by numbers: "½ is less than ⅓ because 2 is less than 3."."

	error in fraction comparison; unable to link representations.	

However, this study has limitations that may be corrected through further research. First, the number of subjects analyzed in depth was limited to only nine students so that the findings cannot be generalized to the entire population of class V students. Second, the test and interview instruments were focused on certain aspects of the concept of fractions, so they did not cover all the in-depth competencies that might be relevant. Third, external factors such as teacher teaching style, class conditions and student background are not fully controlled, so they have the potential to influence results. Therefore, further research with wider subject coverage, instrument variations, and tighter variable control is needed to strengthen these findings.

CONCLUSION

Based on the results of research on the Profile of Students' Concept Understanding in Fraction Material in View of the Level of Collaboration Ability in Class V of Elementary Schools, it can be concluded that there are differences in the profile of concept understanding in each category of students' collaborative skills. Students with high collaboration skills show a more complete conceptual understanding, are able to connect visual and symbolic representations and use appropriate procedures in fraction operations. Students with moderate collaboration have partial understanding with a tendency for misconceptions, such as adding numerators and denominators directly. Meanwhile, students with low collaboration show fundamental limitations, tend to be passive, and more often make elementary mistakes, for example only paying attention to the numerator or denominator without understanding the meaning of fractions as part of a whole. This shows that the level of collaboration skills contributes significantly to the quality of students' understanding of the concept of fractions.

Based on these research, it is recommended that teachers design learning that encourages meaningful collaboration, for example through structured group discussions, providing scaffolding between students, and the habit of reflecting together. Teachers also need to pay attention to variations in students' levels of collaborative skills so that each individual gets appropriate opportunities to develop their conceptual understanding. In addition, further research is recommended to involve a larger number of subjects, use more varied instruments, and control external factors such as the role of the teacher and class dynamics, so that the results obtained are more comprehensive and can be generalized more widely.

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