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Analysis of Seventh-Grade Students' Understanding of Fraction Material Based on SOLO Taxonomy

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ABSTRACTS

This study aims to describe the understanding and factors influencing students' understanding of fraction material based on the SOLO taxonomy. This qualitative descriptive research involves five purposively selected subjects based on the conformity of students' responses at each level within the SOLO taxonomy. Data collection techniques include tests and interviews. Data analysis comprises data condensation, data presentation, and conclusion. The research findings indicate that: (1) Students' understanding of fraction concepts is at the prestructural, unistructural, and extended abstract levels; students' understanding of ordering fractional numbers is at the prestructural, unistructural, multi structural, and extended abstract levels; students' understanding of solving fractional number calculations is at the prestructural, unistructural, multi structural, and relational levels; and students' understanding of solving contextual problems related to fractions is at the prestructural, unistructural, and multi structural levels. (2) Factors influencing students' understanding include students' limitations in following school lessons, low interest and learning motivation; students' confusion in understanding the taught material concepts, lack of precision in students' calculation operations; less varied exercise questions provided by teachers; and students can understand the taught material concepts but are unable to generalize their knowledge.

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1. INTRODUCTION

Mathematics learning involves numerous concepts, ranging from the concrete to expanding and deepening into abstract understanding. Sarwadi and Shahrill (2014), state that mathematics learning is a systematic process that involves the development of previous knowledge and the connection of various skills and basic concepts to achieve mastery of mathematical calculations and procedures. Mathematical understanding is crucial for students in solving mathematical problems (Rochim, 2021). Students are required to comprehend mathematical concepts in order to solve mathematical problems correctly. However, according to Hendriana (2012), students tend to memorize mathematical concepts based on the definitions given by teachers or written in books without attempting to understand their meanings and content. This learning tendency can impact students' ability to solve mathematical problems.

One of the important mathematical topics that requires understanding from students is fractions. According to Widiyanti et al. (2014), students not only need to memorize fraction concepts but also must be able to comprehend and practice solving fraction problems. According to Son (2011), effective teaching of operations involving fractions is crucial because the understanding of concepts such as rates, percentages, slopes, or decimals depends on learning fractions. Moreover, fractions are commonly encountered in everyday life, such as discounts offered by stores, dividing a cake into several parts, and so on.

Fractions are introduced in the curriculum starting from the 3rd grade of elementary school, as outlined in the 2013 curriculum, and the topic is further expanded in grades 4, 5, and 6. Since students in junior high school have completed their education at the elementary school level, they should have mastered the basic fraction material that has been taught. However, in reality, many junior high school students struggle to solve arithmetic problems involving fractions accurately. This is because the concept of fractions in mathematics is often perceived as a complex one. Alghazo (2017), in his research, stated that a significant number of students find fractions too difficult and complicated when engaged in calculations. They struggle to visualize and relate it to their daily lives. Based on research conducted by Siegler and Pyke (2013), the low understanding of fraction concepts is attributed to students who learn by memorizing procedural rules without understanding the relevant fraction concepts. As a result, many operational rules are not truly comprehended by students.

The responses given by students reflect their level of understanding in the learning process. Therefore, it is necessary to analyze and examine students' responses to understanding the material and solving given problems. One tool that can be used to measure students' understanding based on their responses is the Structure of Observed Learning Outcome (SOLO) taxonomy. According to Putri and Manoy (2013), the SOLO taxonomy can be used as a tool to measure students' ability to respond to a problem. In other words, the SOLO taxonomy can help depict the level of complexity in a student's understanding of a particular subject matter.

The SOLO taxonomy was developed by Biss and Collis (1982) by classifying the characteristics of students' thinking into five levels, namely: (1) prestructural level, where students lack any skills that can be used to solve given problems; (2) unistructural level, where students use at least one piece of information to solve a problem, but the obtained answer is incorrect; (3) multi structural level, where students can connect several pieces of information, but the relationships made are not appropriate, resulting in incorrect answers; (4) relational level, where students can connect all available information and obtain correct answers in several ways; and (5) extended abstract level, where students can solve problems correctly

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using multiple methods and can provide new approaches to the given answers. According to Biggs & Collis (1982), each cognitive stage has the same response and progressively increases from simple to abstract.

Many studies have explored the SOLO taxonomy (Ekawati et al., 2013; Febiyanti et al., 2020; F. Hidayah, 2011; Widyawati et al., 2018). In her research titled "Analysis of Students' Response Abilities in Solving Mathematics Problems Based on the SOLO Taxonomy," Hidayah (2011), stated that the SOLO taxonomy model is considered highly interesting for application in school learning. This is because, in addition to being hierarchical, the SOLO taxonomy also demands students' ability to provide alternative answers (ability at the multi structural level), compare one alternative with another (ability at the relational level), and offer students the opportunity to provide a new and different alternative from the usual (ability at the extended abstract level).

Ekawati et al. (2013), conducted a study titled "A Study of Students' Responses in Solving Mathematical Problem-Solving Based on the SOLO Taxonomy." The data for this research were obtained from 18 male students and 24 female students in the eighth grade. The results of the study showed that the responses of male students at the prestructural level were 16.67%, unistructural level 9.44%, multistructural level 32.22%, relational level 38.33%, and extended abstract level 3.33%. On the other hand, the responses of female students indicated prestructural level 25.42%, unistructural level 10.83%, multi structural level 32.92%, relational level 20.83%, and extended abstract level 10%. This indicates that the SOLO taxonomy can identify patterns of students' response levels in solving mathematical problem-solving based on the SOLO taxonomy.

The research conducted by Widyawati et al. (2018), aimed to describe students' errors in solving mathematical problems, including the location, type, and factors causing errors when solving circle-related problems. The results of the study conducted in eighth-grade classes showed that students at the prestructural level tended to make mistakes in understanding the problem, planning, conceptual errors, and principle errors. Students at the unistructural level tended to make mistakes in executing and completing plans, errors in writing final answers, conceptual errors, and principle errors. Students at the relational and extended abstract levels did not make errors in solving problems. However, in this study, no students identified with a tendency at the multistructural level.

Similar research was also conducted by Febiyanti et al. (2020) with the title "Analysis of Students' Ability in Solving Mathematics Problems on Plane Figures Using the SOLO Taxonomy in Elementary School." The study involved 31 students from the fourth-grade class as the research subjects. The results of this research showed the percentage of the quality of students' responses in solving written tests on plane figures, including 6.45% at the prestructural level, 32.26% at the unistructural level, 35.48% at the multi structural level, 25.81% at the relational level, and no students at the extended abstract level. Overall, the quality of responses from the fourth-grade students in solving mathematics problems was at the multi structural level, indicating that students could understand the problems and plan appropriately but still could not solve the problems well and accurately.

2. METHOD

This study is qualitative research with a descriptive approach conducted in the seventh grade of junior high school (SMP). The subjects in this research consist of 5 students selected purposively based on the diversity of answers and the number of response indicators fulfilled by students at each level in the SOLO taxonomy. Students with relatively similar levels of

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understanding are used as triangulation data tetst tools. The data collection techniques used in this research are tests conducted to determine the level of understanding achieved by students on the fraction material and interviews conducted to gather more in-depth information related to students' understanding in order to clarify the test data results and reveal the factors influencing the understanding of students. The test instrument used consists of 4 essay questions and a semi-structured interview guide.

Data collection in this research begins by giving a written test to seventh-grade students, then analyzing each student's answers and grouping students into five levels of understanding based on the SOLO taxonomy for each possible question. It is followed by determining research subjects purposively, with five subjects participating in the interviews. The data from the test results and interview subjects are analyzed to obtain an overview of students' understanding levels and factors influencing students' understanding, which will be presented in narrative form. Additional supporting information is presented in the form of tables and figures, which are then explained in narrative form as well.

In this study, to ensure the validity of the findings, four criteria, according to Moleong (2016) are used: (1) credibility by employing two techniques, namely persistent observation, where the researcher observes diligently and continuously during the research process, and triangulating data by comparing the data from the written test results with interview data; (2) dependability by discussing the research process with the advisor; (3) confirmability by discussing the research results with the advisor; and (4) transferability by providing detailed, clear, and systematic descriptions of the research results, making them easily understandable by others and applicable to the places where the research subjects are taken

3. RESULTS AND DISCUSSION

The student response indicators based on the SOLO taxonomy used in this research were adapted from various researchers and are presented in Table 1.

Table 1. Student Response Indicators Based on The SOLO Taxonomy

Understanding Aspect	Response Indicators Based on the Levels of the SOLO Taxonomy				
	Prestructural	**Unistructural**	**Multistructural**	**Relational**	**Extended Abstract**
Understanding the meaning of the problem	Difficulty in understanding the question (Luruk et al., 2021; Marisa et al., 2020; Putri & Manoy, 2013)	Not understanding the problem well (Marisa et al., 2020) Mampu memahami soal (Luruk et al., 2021)	Able to comprehend the problem (Fauziyah & Wiryanto, 2021; Luruk et al., 2021)	Able to comprehend the problem (Ekawati et al., 2013)	Able to comprehend the problem (Ekawati et al., 2013)
Locating information in the given problem	Unable to locate information (Pesona & Yunianta, 2018) Only able to find minimal information (Luruk et al., 2021)	Only able to find a small amount of information (Pesona & Yunianta, 2018)	Able to find some information (Ekawati et al., 2013; Pesona & Yunianta, 2018)	Able to find all the information in the problem (Ekawati et al., 2013)	Able to find all the information in the problem (Ekawati et al., 2013)
Associating the found information	Unable to connect the information	Unable to connect information	Unable to connect information (Pesona & Yunianta, 2018)	Able to link information (Ekawati et	Able to associate the found

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Understand-ing Aspect	Response Indicators Based on the Levels of the SOLO Taxonomy				
	Prestructural	**Unistructural**	**Multistructural**	**Relational**	**Extended Abstract**
	(Luruk et al., 2021; Marisa et al., 2020)	(Marisa et al., 2020) Associating information but not yet accurate (Arico & Wahyudi, 2021)	Able to connect some information (Ekawati et al., 2013; Luruk et al., 2021)	al., 2013; Pesona & Yunianta, 2018)	information (Ekawati et al., 2013)
Designing a problem solution	Unable to design a solution to the problem (Ekawati et al., 2013; Marisa et al., 2020)	Not yet able to design problem-solving effectively (Luruk et al., 2021)	Able to design problem-solving (Ekawati et al., 2013; Fauziyah & Wiryanto, 2021)	Able to design problem-solving (Puspitasari & Setyaningsih, 2016)	Able to design problem-solving (Ekawati et al., 2013)
Solving the problem with a single solution	Unable to solve the problem accurately (Luruk et al., 2021)	Unable to solve the problem accurately (Ekawati et al., 2013)	Unable to solve the problem accurately (Luruk et al., 2021; Marisa et al., 2020) Able to solve the problem (Marisa et al., 2020)	Able to solve the problem (Luruk et al., 2021; Puspitasari & Setyaningsih, 2016)	Able to solve the problem (Ekawati et al., 2013)
Solving the problem with multiple solutions	Unable to solve the problem in another way	Unable to solve the problem in another way	Able to solve the problem with multiple solutions, but the answers provided are not yet accurate (Hamdani, 2009; Marisa et al., 2020)	Solves the problem, but not all problems are solved correctly (Ekawati et al., 2013)	Able to solve the problem (Ekawati et al., 2013; Luruk et al., 2021)
Making generalizatio-ns from several solutions given	Unable to make generalizations	Unable to make generalizations	Unable to make generalizations	Unable to make generalizatio ns	Able to make generalizatio ns (Pesona & Yunianta, 2018)

The results of the student's understanding test on fractions based on the SOLO taxonomy are presented in Table 2.

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Table 2. Student Understanding Test Results

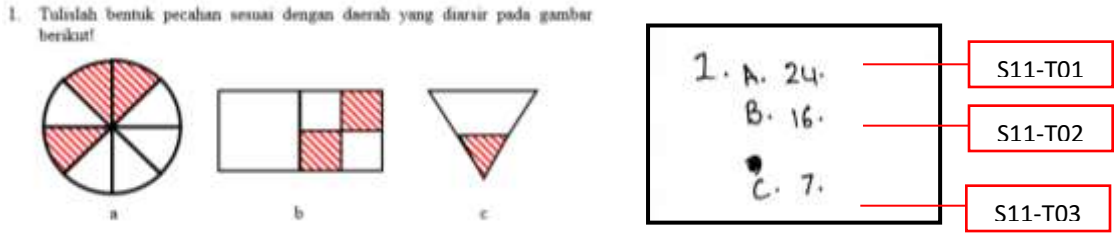
No	Fraction Understanding	Level of Understanding Based on the SOLO Taxonomy				
		P	U	M	R	EA
1	Fraction concept	9 (43%)	10 (48%)	0 (0%)	0 (0%)	2 (10%)
2	Arranging fractions	4 (19%)	2 (10%)	14 (67%)	0 (0%)	1 (5%)
3	Solving operations with fractions	5 (24%)	7 (33%)	8 (38%)	1 (5%)	0 (0%)
4	Solving contextual problems	5 (24%)	11 (52%)	5 (24%)	0 (0%)	0 (0%)

Explanation of SOLO Taxonomy Levels: P (Prestructural); U (Unistructural); M (Multistructural); R (Relational); EA (Extended Abstract)

Out of 21 students, 5 students were selected as research subjects based on the diversity of answers and the number of response indicators fulfilled by students at each level in the SOLO taxonomy. The test results and excerpts from the interview with the subjects are presented below and will be briefly described.

Analysis of Students' Understanding of The Fraction Concept

Response of Subject 1 (S1)



(a) (b)

Figure 1. (a) Problem about Fraction Concept, (b) Answer from Subject 1 (S1)

The results of the written test in Figure 1 indicate that S1 has not been able to solve the problem about the fraction concept properly. This is evident in S1's answer, which only writes whole numbers as the answer to the given problem (S11-T01, S11-T02, & S11-T03). To reveal the student's understanding and identify the contributing factors, excerpts from the interview related to this are presented in Interview Transcript 1.

Interview Transcript 1

P1-W01 : *Do you understand the meaning of this problem?*
S11-W01 : *I don't understand*
P1-W03 : *What do you remember about fractions?*
S11-W03 : *I forgot.*
P1-W04 : *But you used to understand the material?*
S11-W04 : *Not really, because the material is difficult, and the teacher explains too quickly. But what I know is that fractions are about dividing.*
P1-W06 : *Okay, when reading the problem, what information did you get?*
S11-W06 : *This picture is divided because of the red lines*
P1-W07 : *What else do you know?*
S11-W07 : *This is a circle, rectangle, and triangle. That's all.*

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P1-W08 : *Okay, how did you solve this problem?*
S11-W08 : *I counted the lines.*
P1-W09 : *Which lines?*
S11-W09 : *These red lines represent 24 lines in total.*
P1-W10 : *The question asks to write the value of the fraction; why do you think these lines are the fraction's value?*
S11-W10 : *Because these lines divide the picture.*
P1-W11 : *Why didn't you pay attention to these other parts?*
S11-W11 : *Because they don't have red lines.*
P1-W12 : *How about part B?*
S11-W12 : *It's the same, this part has 16 red lines, and part C has seven red lines.*
P1-W15 : *Do you understand the material when studying?*
S11-W15 : *Not yet.*
P1-W16 : *Why don't you ask the teacher or your friends again?*
S11-W16 : *I'm shy. I think math is difficult, and I wouldn't say I like this subject.*

Based on the test results and interviews, the analysis of the fulfillment of aspects of Subject 1 understanding of the concept of fractions is presented based on the levels of understanding in the SOLO taxonomy in Table 3

Table 3. Analysis of Subject 1 Understanding of the Concept of Fractions

Aspect of Understanding	Data	Description
Understanding the meaning of the problem	**S11-W01**	Unable to understand the problem
Finding information in the given problem	**S11-W06, S11-W07**	Unable to find accurate information
Linking the found information	**S11-W10**	Unable to link information
Designing problem-solving	**S11-W08**	Unable to design problem-solving
Solving the problem with one solution	**S11-T01, S11-T02, S11-T03, S11-W09, S11-W12**	Unable to solve the problem
Solving the problem with multiple solutions	-	-
Generalizing from several given solutions	-	-

In solving problems related to the concept of fractions, Subject 1 is at the prestructural level in the SOLO taxonomy. This is indicated by Subject 1's lack of understanding of the given problem. Subject 1 has forgotten the material on fractions and states that fractions are difficult to learn because they are unable to keep up with the lessons presented by the teacher. The subject has only a little unrelated information, considering that hatched lines divide the picture into several parts. Moreover, the subject is less accurate in planning problem-solving, determining the value of fractions by counting the number of hatched lines in the picture, resulting in an incorrect answer.

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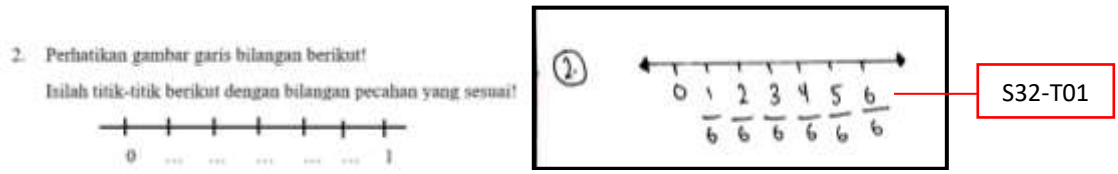
This aligns with the perspective of Widyawati et al. (2018), stating that students at the prestructural level have only a little information about a question that does not form a concept and does not have any meaning in solving problems, making them unable to answer the given questions correctly. Factors influencing students' understanding of the concept of fractions include the students' limitations in following the lessons conducted by the teacher and their low interest and motivation to learn because they perceive mathematics as a difficult subject.

Analysis of Students' Understanding in Ordering Fraction Numbers

Response of Subject 3 (S3)



(a) (b)

Figure 4. (a) Problem about Ordering Fraction Numbers, (b) Answer from Subject 3 (S3)

The written test results in Figure 2 show S3's ability to order fraction numbers. The subject is observed to write fractions in ascending order, and these fractions have a denominator of 6. Based on the written test results, S3 is able to write the values of fractions on the number line accurately. To reveal the student's understanding and identify the contributing factors, the following are excerpts from the related interview

Interview Transcript 2

P2-W01	:	*Alright, for question number 2, did you understand the meaning of the question?*
S32-W01	:	*Here, we're asked to fill in the dots with fractions between 0 and 1.*
P2-W02	:	*What information did you get after understanding the question?*
S32-W02	:	*The first number is 0, then there are five dots to be filled, and in the seventh place, there's the number 1.*
P2-W03	:	*How did you solve this problem?*
S32-W03	:	*Because the one in front is the number Zero, I didn't count it, I only counted six numbers. Ms. Aisyah (mathematics teacher) once explained that a number divided by itself results in one. Therefore, when six is divided by six, the result is one. So, I divided all of them into six.*
P2-W04	:	*Why did it turn out like that?*
S32-W04	:	*Because that's all I remember.*
P2-W05	:	*Where did the numbers 1, 2, 3, 4, and 5 come from?*
S32-W05	:	*From the number line. The number line is in order from 0, 1, 2, 3, 4, 5, 6, and so on.*
P2-W10	:	*Why not choose another number as the denominator, such as 5 or 7?*
S32-W10	:	*Because if it's 5, the fifth dot with a value of 1 can't have two ones. If it's 7, it means the one should be shifted again, so 6 is the right fit there.*
P2-W11	:	*Is there another way to solve this problem?*
S32-W11	:	*I don't know another way. I only know this one.*

Based on the test results and interview, the following is the analysis of the fulfillment of aspects of S3's understanding in ordering fractional numbers based on the level of understanding of the SOLO taxonomy.

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Table 4. Analysis of S3's Understanding of Ordering Fractional Numbers

Aspects of Understanding	Data	Description
Understanding the purpose of the problem	**S32-W01**	Able to understand the problem
Finding information in the given problem	**S32-W02**	Able to find information on the problem
Linking found information	**S32-W03, S32-W04**	Able to link information
Designing problem-solving	**S32-W03**	Able to design problem-solving accurately
Performing problem-solving with one solution	**S32-T01, S32-W03, S32-W04**	Able to perform problem-solving
Performing problem-solving with several solutions	**S32-W10**	Unable to perform problem-solving
Generalizing from several given solutions	-	-

Based on the analysis of the fulfillment of these aspects, it can be concluded that the understanding of S3 is at the multistructural level in the SOLO taxonomy. This is evident as the subject is able to convey the given problem's objective accurately, which is to fill in the blanks with fractions located between 0 and 1. S3 is also able to convey the information found in the given problem. To solve this problem, S3 first determines which number occupies the 7th position, which, when divided by itself, will result in the answer 1. S3 uses the information found in the problem and solves it by linking the concept of number lines in general. S3 can only solve the given problem in one way, based on the method recalled from the teacher's explanation. However, S3 does not fully understand the taught material because the subject does not know the conditions for a number to be a denominator in a fraction. This aligns with the opinion of Pesona and Yunianta (2018), who state that students at the multi structural level can use several pieces of information but cannot connect them cohesively.

Response of Subject 5 (S5)

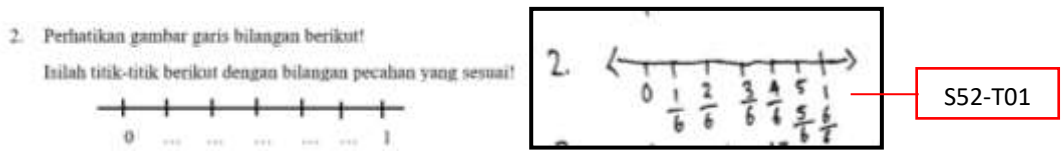

Figure 5. (a) Problem about Ordering Fraction Numbers, (b) Answer from Subject 5 (S5)

The written test results above demonstrate S5's ability to arrange fractional numbers. The subject is observed to write fractional numbers on the number line with a denominator of 6. S5 successfully completes the given problem quite well. To uncover the student's understanding and identify the contributing factors, the following excerpts from the interview are presented.

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Interview Transcript 3

P2-W01	:	*For question number two, do you understand the purpose of the question?*
S52-W01	:	*Actually, I was confused at first, but then I managed to work on it*
P2-W02	:	*What information did you get from the question?*
S52-W02	:	*Here, five points need to be filled in, so I wrote numbers one to five as usual on the number line, but the number one reappeared after number five. I reread the question and found that the solution to the problem was in the form of fractions, so I remembered what the teacher taught, that if all the fractions are combined, it will become a whole.*
P2-W03	:	*So, how did you solve this problem?*
S52-W03	:	*I drew a rectangle and divided it into six equal squares. Then, I wrote the number in each box from one to six. Because six divided by six results in one, I gave all the numbers in the boxes a denominator of 6, so I got fractions one-sixth, two-sixths, up to six-sixths*
P2-W05	:	*How can you be sure that the answer is like that?*
S52-W05	:	*You can use a skipping method. From zero to the number one, because six divided by six results in one, and zero divided by six is still zero, then all numbers can be divided by six. So everything has a denominator of 6, but some can be simplified to one-sixth, one-third, one-half, two-thirds, and five-sixths*
P2-W06	:	*Do you know the conditions for a number to have a denominator?*
S52-W06	:	*The denominator must not be zero.*
P2-W07	:	*Are your two answers related?*
S52-W07	:	*Actually, they are related. Because everything is divided by six, the main thing is we have to know which number results in one first, and because the distances are the same, they will definitely be in order. If they are not the same, they must be equalized first.*

Based on the results of the test and interview, the following presents the analysis of the fulfillment aspects of S5's understanding in sorting fractional numbers based on the level of understanding in the SOLO Taxonomy.

Table 5. Analysis of S5's Understanding of Sorting Fractional Numbers

Aspects of Understanding	Data	Description
Understanding the purpose of the problem	**S52-W01**	Able to understand the problem
Finding information in the given problem	**S52-W02**	Able to find information on the problem
Linking found information	**S52-W02**	Able to connect information
Designing problem-solving	**S52-W02, S52-W04**	Able to design problem-solving
Performing problem-solving with one solution	**S52-T01, S52-W03**	Able to solve problems with a single solution
Performing problem-solving with several solutions	**S52-W04**	Able to solve problems with alternative solutions
Generalizing from several given solutions	**S52-W06**	Able to provide a connection between the given solutions

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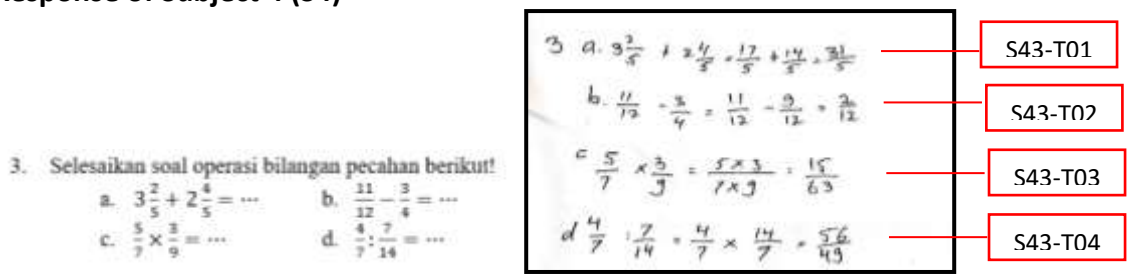
Based on the analysis of these aspects, it can be concluded that S5's understanding is at the extended abstract level in the SOLO taxonomy. This is evident when the subject seeks the appropriate fractional values; S5 uses the concept of the integer number line. However, facing difficulties, S5 re-reads the problem. It utilizes the interpretation of the image by drawing a rectangular shape, partitioning it into six equal parts, and considering the entire section as a unified whole. This indicates that S5 can use the information obtained to plan the problem-solving process based on the given problem.

To reinforce the answer, S5 can provide another solution to the given problem by dividing each value on the number line by six and obtaining the same result. Moreover, S5 can establish a connection between the two methods by stating that similar problems can be solved by determining the value occupying the one-unit section. This shows that S5 can solve the given problem well and can relate both problem-solving processes so that the acquired information can yield the correct answer. This is supported by Ekawati et al. (2013), stating that at the extended abstract level, students can use data or information applied to concepts, connecting interim results to draw conceptual conclusions and make generalizations. The factors influencing students' understanding in sorting fractional numbers are their ability to comprehend the concepts explained by the teacher holistically regarding the taught material, serving as a basic foundation for interpreting information, thus allowing the obtained information to be connected and leading to accurate conclusions.

Analysis of Students' Understanding of Solving Fractional Number Arithmetic Operations
Response of Subject 4 (S4)



(a) (b)

Figure 5. (a) Problem about Solving Fractional Number Arithmetic Operations, (b) Answer from Subject 4 (S4)

The written test results of the subject indicate that the subject is able to perform fractional operations well. S4 answered all fraction operation questions correctly. In part a, S4 was able to convert mixed numbers into proper fractions before performing addition operations on fractions. S4 also followed the correct procedures for adding fractions. For part b, before performing subtraction operations, S4 first made the denominators of the two fractions the same. After that, S4 correctly completed the subtraction operation on the fractions. For part c, S4 was able to perform multiplication operations on fractions correctly by multiplying the denominators with denominators and numerators with numerators in the fractions. In part d, S4 could correctly solve the division operation. The subject changed the position of the numerator to the denominator and the denominator to the numerator in the fraction that became the divisor, then changed the division operation to multiplication. To reveal the student's understanding and identify the influencing factors, the following excerpts from the interview are provided.

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Interview Transcript 4

P3-W01	:	*This question is in part a, what's it called in fractions?*
S43-W01	:	*Mixed fraction.*
P3-W02	:	*How do you solve it?*
S43-W02	:	*First, change the mixed fraction into a proper fraction. Three times five plus two equals seventeen, so it becomes the fraction seventeen over five. Here, two times five plus four equals fourteen, so it becomes the fraction fourteen over five. Then, add the numerators, which are seventeen plus fourteen, resulting in thirty-one. So, the answer is the fraction thirty-one over five.*
P3-W03	:	*Why did you choose the denominator as five?*
S43-W03	:	*Because in addition, I remember to match the denominators, just like in subtraction. But here, the denominators are already the same, so there's no need to look for it.*
P3-W04	:	*How do you solve part b?*
S43-W04	:	*For part b, since the denominator is twelve, I multiply this one (pointing to the number four) by three, which becomes four times three equals twelve. The numerator above is also three times three, which equals nine. After that, subtract eleven minus nine, which equals two. Then, take the denominator twelve, so the answer is the fraction two over twelve.*
P3-W08	:	*How about part c? How do you solve it?*
S43-W08	:	*Just multiply five by three, which equals fifteen, then seven times nine equals sixty-three.*
P3-W11	:	*How about part d, how do you solve it?*
S43-W11	:	*For part d, here, I reverse and change it to multiplication. Four times fourteen equals fifty-six, then seven times seven equals forty-nine.*
P3-W14	:	*Do you know another way to solve division problems like this with fractions?*
S43-W14	:	*For adding mixed fractions, you can work separately with whole numbers and fractions.*
P3-W15	:	*How is that?*
S43-W15	:	*For this part, three plus two equals five, so the result has a whole number of five. Then, the fraction part, two-fifths plus four-fifths, results in six-fifths. This can be understood as a mixed fraction, so one and one-fifth. Then, add five plus one and one-fifth, which equals six and one-fifth.*
P3-W17	:	*According to you, do the two methods relate to each other?*
S43-W17	:	*The answers are the same, but the methods are different.*
P3-W19	:	*So, what's the conclusion for adding fractions?*
S43-W19	:	*I don't know, what's the conclusion?*
P3-W20	:	*How about other operations?*
S43-W20	:	*That's all I know. Never been taught another way*
P3-W22	:	*Why?*
S43-W22	:	*Because I thought that was the only way. If not, the answer would be wrong.*

Based on the test results and interviews, the analysis of the fulfillment aspects of S4's understanding in solving fractional arithmetic operations is presented below based on the taxonomy level of SOLO understanding.

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Table 6. Analysis of S4's Understanding in Solving Fractional Arithmetic Operations

Aspects of Understanding	Data	Description
Understanding the purpose of the problem	**S43-W01**	Able to understand the problem
Finding information in the given problem	**S43-W01**	Able to find information on the problem
Connecting the found information	**S43-W02, S43-W03**	Able to connect information
Designing a problem-solving solution	**S43-W02, S43-W04, S43-W11**	Able to design a problem-solving solution
Solving the problem with one solution	**S43-T01, S43-T02, S43-T03, S43-T04, S43-W02, S43-W04, S43-W08, S43-W11**	Able to solve the problem with one solution
Solving the problem with several solutions	**S43-W14, S43-W15, S43-W20**	Able to solve other problems but not for all parts
Generalizing from several given solutions	-	-

Based on the results of the analysis of these aspects, it can be concluded that the understanding of S4 is at the relational level in the SOLO taxonomy. This is evident when S4 can explain how to convert mixed fractions into proper fractions by multiplying the whole number and the denominator and then adding it to the numerator. After converting the fraction, S4 adds the two numerators of the fraction. S4 can explain the requirements for performing addition and subtraction operations of fractions. Namely, both denominators must be the same. This indicates that S4 can use the information provided in the problem and apply the correct steps in the solution process.

S4 is able to solve multiplication problems involving fractions by multiplying the denominators and numerators of the fractions. In part d, S4 changes the position of the numerator and denominator in the divisor fraction, then changes the division operation into multiplication. S4 uses this method because it is the one taught since the beginning. However, S4 can solve addition problems of fraction numbers in another way by working on whole numbers and fractions separately. S4 knows that the results obtained from these two different methods are the same but cannot yet explain the relationship between the two solution methods. This is consistent with the research conducted by Hidayah et al. (2021), stating that students at the relational level can understand the problem, devise a solution plan, connect the information in the problem to obtain the correct answer, and provide several alternative solutions but are not yet able to generalize their understanding. This happens because students believe that the only acceptable method is the one taught by the teacher and fear that their answer will be considered wrong if they use a different solution method, making them feel content with the taught solution.

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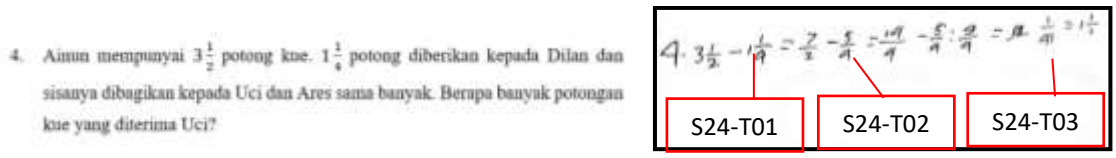
Response of Subject 2 (S2)



(a) (b)

Figure 5. (a) Problem about Solving Contextual Problems on Fraction Material, (b) Answer from Subject 2 (S2)

Based on the results of the written test, it is evident that the subject did not write down the known and asked parts of the problem. The subject is seen subtracting the number of cakes owned by Ainun from the cakes given to Dilan. S2 used the subtraction operation on mixed fractions. In the above image, the subject is seen converting mixed fractions into proper fractions. Then, S2 aligns the denominators of the two fractions to 4, subtracts the numerators of the fractions with the same denominator, and obtains the result of $\frac{9}{4}$. After that, S2 converts the obtained result into a mixed fraction and obtains $2\frac{1}{4}$. However, S2 seems to simplify the result obtained incorrectly by dividing the whole number and the denominator but getting a less accurate result, which is $1\frac{1}{1}$. S2 did not use all the information provided in the problem. To reveal the student's understanding and identify the contributing factors, the following excerpt from the interview is presented:

Interview Transcript 5

P4-W01	:	*Do you understand the meaning of this question?*
S24-W01	:	*Not really*
P4-W02	:	*What do you know from this question?*
S24-W02	:	*Ainun's cake is three halves, and Dilan's cake is one-fourth*
P4-W03	:	*What is being asked?*
S24-W03	:	*How many pieces of cake did Uci receive*
P4-W04	:	*What operation do you use to solve this problem?*
S24-W04	:	*Subtraction of fractions.*
P4-W05	:	*How do you solve it?*
S24-W05	:	*This is Ainun's cake minus Dilan's cake, so three halves minus one-fourth. First, change it to proper fractions. Two times three plus one equals seven, so the result is seven halves. Then, four times one plus one equals five, so the result is five-fourths. Next, match the denominators first, making it four. Four divided by two times seven equals fourteen, so fourteen-fourths. The fraction of five-fourths remains the same. Then, subtract fourteen-fourths minus five-fourths, which equals nine-fourths.*
P4-W06	:	*Why did you choose the denominator four?*
S24-W06	:	*Because four is larger than two.*
P4-W07	:	*Is there another way to make the denominators the same?*
S24-W07	:	*There is, but I can't remember. If explained, I know, but when I work alone, I don't know.*
P4-W08	:	*So, how have you been learning all this time?*
S24-W08	:	*Ask my smart friends to explain it again.*
P4-W09	:	*Like that? Then why is the final answer one over one?*

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S24-W09 : *This (pointing to the fraction nine over four) is first changed to a mixed fraction, then simplified and divided by two, making it one over one.*

Based on the results of the test and interview, the following presents the analysis of the fulfillment aspects of S2's understanding in solving contextual problems about fractions based on the level of understanding of the SOLO taxonomy.

Table 7. Analysis of S2's Understanding in Solving Contextual Problems About Fractions

Aspects of Understanding	Data	Description
Understanding the purpose of the problem	**S24-W01**	Has not understood the problem yet
Finding information in the given problem	**S24-W02, S24-W03**	Only partially finds information in the problem
Connecting the found information	**S24-W04, S24-W06**	Is able to link information but not accurately
Designing a problem-solving solution	**S24-W04, S24-W05**	Unable to design a problem-solving strategy accurately
Solving the problem with one solution	**S24-T01, S24-T02, S24-T03, S24-W05, S24-W09**	Unable to solve the problem accurately with one solution
Solving the problem with several solutions	-	-
Generalizing from several given solutions	-	-

Based on the analysis of these aspects, the understanding of S2 is at the unistructural level in the SOLO taxonomy. This is evident as S2 can explain how to convert mixed numbers into proper fractions, equate the denominators of fractions, and then perform subtraction operations correctly. However, S2 aligns the denominators of fractions by looking at the larger denominator and admits forgetting the method taught by the teacher. The answer obtained by the subject is then converted back into mixed number form, and the answer is simplified by dividing by 2, resulting in $1\frac{1}{1}$. S2 draws an incorrect conclusion from the answer, stating that Uci received $1\frac{1}{1}$. pieces of cake. This indicates that S2 has not been able to solve contextual problems related to fractions accurately. This is consistent with the research findings of Ekawati et al. (2013), stating that at the unistructural level, students can understand the problem and plan the problem-solving process but lack accuracy in the process. Factors affecting students' understanding include difficulty in understanding the taught material, a lack of variation in the provided exercise problems, and leading students to rely too heavily on given examples. As a result, when presented with different problems, students may become confused and lack precision in their' calculation operations.

4. CONCLUSION

Based on the research results and discussions, the following conclusions can be drawn:

1) Students' understanding of the fraction material based on the SOLO taxonomy is as follows:
   a. Students' understanding of the concept of fractions is divided into three levels in the SOLO taxonomy: prestructural, unistructural, and extended abstract.

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b. Students' understanding of determining the order of fractional numbers is divided into four levels in the SOLO taxonomy: prestructural, unistructural, multi structural, and extended abstract.
c. Students' understanding of solving arithmetic problems involving fractional numbers is divided into four levels in the SOLO taxonomy: prestructural, unistructural, multi structural, and relational.
d. Students' understanding of solving contextual problems related to fractions is divided into three levels in the SOLO taxonomy: prestructural, unistructural, and multi structural.

2) Factors influencing students' understanding of the fraction material are as follows: Limitations of students in following school lessons; Low interest and learning motivation of students; Students' misconceptions in understanding the taught material concepts; Students' lack of precision in performing calculation operations; Lack of variation in the exercise problems given by the teacher; and students can understand the concept of the taught material but have not been able to generalize their knowledge.

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