

# The analysis of students' mistakes in solving word problems on fractions based on polya problem-solving: a study case of 4<sup>th</sup> grade elementary school students



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## ABSTRACT

The needs to understand mistakes made by students in solving fraction problems in mathematics and the prevalent views that mathematics is a difficult and unfavored subject serve as the main background for this research. The purpose of this research is to describe the students' mistakes when solving mathematics problems analyzed through Polya's problem-solving framework. This study follows a quantitative research tradition with a descriptive method. The participants of this study are the 4th-grade students and all of the 4th-grade teachers in two schools: Padaringan State Elementary School 1 and: Padaringan State Elementary School 2. The sample applied in this research consists of 56 students selected through the purposive sampling method. The data were collected using written tests and interviews. Next, the collected data were analyzed using a quantitative approach in the form of percentages for each mistake category. The result of this research shows that the mistake percentage in the step of understanding the problem is 23.37%. This form of mistake is considered the lowest mistake category compared to the other form of mistakes. The mistake percentage in the step of plan designing is 26.53%, while the mistake percentage in the step of plan initiating is 24.36%. In addition to that, the mistake percentage in the step of answer reviewing is 25.74%

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## 1. Introduction

Education is one of the primary needs which every Indonesian has to fulfill. Up to this point, mathematics subject is still viewed by many students as a difficult and uninteresting subject. In fact, there are few students who still consider mathematics a scary subject that needs to be avoided (Intisari, 2017; Siregar, 2017). One of these factors is the "book factor," which is defined as the inability of the teacher to answer a difficult question from the student (Asdarina et al., 2019). Those views will affect the students on their understanding of mathematics. The students' difficulty in learning mathematics can be seen through a few mistakes in their understanding of math symbols, object values, measurements, and bad writing (Cipta, 2014). Thus, the initiation of a fun learning process on math subjects is needed to improve the students' understanding of math problems. Mathematics is a universal study that has become the base of modern technology development (Suci et al., 2014). Mathematics held an important aspect in many different applied science studies and the development of human ways of thinking (Siagian, 2016). Mathematics can develop the human way of thinking in their daily routines to challenge the development of science and technology. That is why mathematics needs to be taught to students, starting from the elementary level to the college level (Arifin, 2017).

One of the basic topics in math, fraction, has to be taught to students from their early days (Tonra, 2017). The first sub-chapter of the fraction, which needs to be taught, consists of the learning of number equations in fraction and its way of solving the problem related to it. The sub-chapters of fractions usually taught to the 4th-grade students are fraction simplification, fraction addition, fraction multiplication, fraction subtraction, and fraction transformation to decimal numbers and vice versa. A problem in mathematics is defined by Hudojo as a question or a statement that needs to be solved (Hudojo, 2003). There are two types of problems in math: problems to be solved and problems to be proved. To-be-solved problems are usually theoretical and concrete. Variables that appeared in the problem need to be defined, and the types of objects which can be applied need to be tried. Meanwhile, to-be-proved problems usually ask how to show that the statements that occurred in the problems are whether right or wrong. To solve these kinds of problems, we need to work on hypotheses and conclusions based on proven theorems. Word problems are prevalent in mathematics (Apriasari & Rejeki, 2020). One of the purposes of this method is to improve students' literacy skills. The word problems in mathematics are usually stated or written in the form of mathematical symbols and relations. This type of problem is also very beneficial in the development of students' critical thinking process or HOTS (High Order Thinking Skill). In solving word problems, students need understanding and reasoning skills to find the appropriate steps for problem solving (Khumairah, 2020).

Making mistakes while solving mathematics problems is a part of the learning process. However, the mistake may also result in a decrease in students' confidence which will decrease the students learning ability (Triningtyas, 2016). Mistakes can be viewed through a few different aspects, which are a decrease in concentration, a hasty thinking pattern, and the wrong interpretation during the learning process (Tsai & Lee, 2018). In solving mathematical word problems, students often perform calculation errors, apply wrong concepts or theorems, and write unrelated answers (Susanti & Taufik, 2019). One of the steps to observe the students' mistakes in solving the word problem is through the step of problem solving by Polya. Jonassen (Jonassen, 2000) and Ifenthaler (Ifenthaler, 2012) quoted that there are four steps that can be applied in problem solving, which are understanding the problem, planning the problem solving process, initiating the plan, and reviewing the answer. This research focuses on the fraction topic, especially word problems on fractions. We chose 4th-grade students in Padaringan elementary school 1 and Padaringan elementary school 2 as our participants. Our reason was that students in those schools experienced difficulties in the word problems for the fraction chapter. Furthermore, the percentage of the mistakes made by the students to solve word problems on fractions is still unidentified. Thus, this research aims to describe the level of the mistake percentage made by the student to solve word problems related to fractions analyzed by using the framework of the Polya steps of problem solving.

## 2. Method

This study is quantitative research with a descriptive method. This research was conducted during the 2020/2021 academic year, in September 2020, with a population of 56 students. The objective of this research is to describe and analyze the mistakes made by the 4th-grade students in Padaringan elementary school 1 and Padaringan elementary school 2 in solving the word problems in the fraction chapter. The type of design applied in this research is a study case. The first step applied in this research is the collection and analysis of the quantitative data, which is defined as the mistakes percentage made by the students, and the collection of the qualitative data is defined as the description of the mistake made by the student. The technique of analysis applied in this research is quantitative data description and interview. The problem given to the student is in the form of word problems in the fraction chapter. Arikunto mentioned that a test or problem is defined as a collection of questions applied to measure the ability, knowledge, and talent of the student (Arikunto, 2010). The problem or test carried out in this research is a test given after the learning process is finished (Post Test). The validity and the reliability of the word problems applied for this research are already tested to meet the condition made by Sugiyono who mentioned that a certain instrument is defined as valid if only this instrument can be applied to measure what should be measured (Sugiyono, 2012). This research applied the Polya problem solving analysis method by observing four categories of mistakes made by the students, which are problem understanding, problem solving planning, planning initiation, and answer reviewing. This analysis is done by reviewing the answer to each problem which already been worked on by the student.

**Table 1.** Data result of Mistakes made by students

Number of Question	Mistakes occurred during steps of								Number of mistakes per question
	Understanding		Planning		Executing		Reviewing		
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	
1	44	25.58	43	25.00	44	25.58	41	23.84	172
2	41	24.26	45	26.63	39	23.08	44	26.04	169
3	33	20.12	46	28.05	40	24.39	45	27.44	164
<b>Number of mistakes per step</b>	118	23.37	134	26.53	123	24.36	130	25.74	505

### 3. Results and Discussion

After the test using three questions already worked by 56 students, there are four types of mistakes made by the students in solving the fraction word problems. The result of the type of mistakes made by the students is illustrated in Table 1. These four types of mistakes are defined with the description as follows:

- Mistakes in the step of understanding the problem; the step which needs to be done in understanding the problem is to start by understanding the term and language in the problem and the formulation of the variables from the problem. Then, reviewing all of the variables known from the problem needs to be done to determine the purpose of the problem itself. In Table 1, the percentage result of mistakes made in the step of understanding the problem is 23.37%. This type of mistake is considered in the low category of mistakes compared to the other three types of mistakes mentioned before. In the analysis of the answer made by the students, the most errors made in the step of understanding the problem are the writing incompleteness of all of the variables from the problem, the writing incompleteness of what is being asked, and the incompleteness of the answer written by the student. The next mistake made by the student is the error in writing the variables mentioned in the problem, which impacted the error of the data illustration. This effect will then affect the error in the step of solving the problem. The factor causing the mistake in the step of understanding the problem is the lack of ability to understand and read the language presented in the problem. Runtukahu and Kandou stated that "Children who lack the language and reading ability tend to be confused by the terms used in math, such as addition, subtraction, borrowing, and object value, especially in the study case type of problem." (Runtukahu & Kandou, 2014)
- Mistakes in the step of planning the problem solving process; students are able to make a plan to solve a certain problem when they understand the meaning of the problem itself or at least understand which equation needs to be applied to solve the question presented in the problem. The main achievement in problem solving process is to plan the problem solving process itself. If the students lacking in knowledge of all of the subjects presented in the problem, they will have difficulty creating the right plan for problem solving. In this step, students are expected to have the ability to write and mention all of the equations which can be applied to the given problem and to substitute all of the data which already known from the problem. The data analysis result shows that the percentage of mistakes made during the planning process is 26.53%. The mistakes made in this step are considered a very high category of mistakes. This means that the frequency of mistakes made in this step is quite high compared to the mistakes made in the previous step. From the answer analysis, many students made an error in writing and mentioning the equation which needs to be applied to solve the given problem. Moreover, there are also many students who did not even write the equation, which affects their inability to determine which further step needs to apply. One of the factors causing the mistake in the step of planning the problem solving process is the hastiness and lack of thoroughness in the problem reading process. Moreover, the factor of the lack of knowledge and ability to construct the data presented in the problem and the output which needs to be answered from the problem also becomes the main reason for the mistakes made in this step (Rofi'ah et al., 2019; Saputri,

2019). Runtukahu and Kandou stated that “If the precondition ability is not understood or mastered, the learning of mathematics given to the student is useless (Runtukahu & Kandou, 2014). Mathematics is a very structured subject where one type of understanding is becoming the precondition for the next one”.

- Mistakes in the step of executing the plan; after the students are able to finish the step of problem solving planning, they need to be able to initiate the operation of calculation or concept which is suitable to the question given in the problem. To initiate and apply the plan which already been made before, students also have to be able to substitute all of the data presented from the question into the equation which already acquired from the previous step. The data analysis result shows that the percentage of the mistakes made during initiating and working on the plan is 24.36%. The mistakes made in this step are considered a very high category of mistakes compared to the previous step. The common mistake made by the student in this step is the error that occurred during the calculation caused by a lack of concentration and the ability to do an addition or subtraction operation. This type of mistake also can occur cause of the error made in the previous step. In solving word problems, especially written ones, students are expected to have the ability to write and thoroughly explain the process of solving the given problem, identify the relevant concept, generalize and formulate the problem solving plan, and organize the ability which previously already acquired. Meanwhile, in this research, many students did not thoroughly write and explain the problem-solving process as intended by the researcher (Katon & Arigiyati, 2018). Students also still not be able to determine the relevant concept from the given problem, which impacted the many mistakes made in this step. The mistakes made by the student in this step are also mainly caused by the lack of students' ability in basic mathematics. Runtukahu and Kandou (Runtukahu & Kandou, 2014), stated that the basic mathematics ability of the student, which is arithmetic operations such as addition, subtraction, multiplication, and division, should have already been acquired from an early stage because this ability holds an important role to execute the problem solving plan.
- Mistakes in the step of reviewing the answer; the step of reviewing the acquired result is the last step to solving the study case type of problem in mathematics. In this step, students are expected to recheck and review the acquired answer and all of the previous steps which already been made thoroughly. Polya in Nilasari (2014) & Widyastuti (2019) stated that there are many benefits that can be acquired from reviewing the obtained answer, such as avoiding the occurred mistakes. The analysis process resulted in the percentage of mistakes made during reviewing the answer, which is 25.74%. The mistakes made in this step also can be considered as a very high category of mistakes compared to the other previous steps. The mistakes made in this step are mainly caused by the student's confidence in concluding the answer without thoroughly reviewing all of the processes previously made and the student's hastiness in continuing to answer the next question and finishing the test.

#### 4. Conclusion

Based on this research, it can be concluded that the mistakes included as the lowest category of mistakes is in the step of understanding the problem with a percentage of 23.37%. While the highest category of mistakes is acquired from the step of problem solving. Planning with a percentage of 26.53%. The mistakes made by the student are caused by certain factors, such as the lack of ability to read the mathematics terms and languages, the lack of ability in an arithmetic operation, and the hastiness of the student in completing the study case type of problem without reviewing and rechecking the answer or the previous steps first.

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