Students' Performance in Solving Problems Involving Fractions

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Abstract

The concept of fraction is a fundamental mathematics subject that is repeatedly reported to be difficult for students to learn and for teachers to teach. Various articles on strategies to teach fractions have been presented, but students' proficiency in dealing with fractions has not improved in general. This article describes a qualitative study conducted to assess students' performance in solving a set of problems involving addition and subtraction of fractions. The students' performances were analyzed according to the standard competence as inscribed in the Indonesian Curriculum Version Year 2013 for fifth grade students which was: capable of solving problems involving addition and subtraction of fractions with different denominators. A set of test was administered to twenty fifth-grade students at a primary school in Aceh, Indonesia. Result showed that the students' understanding of addition and subtraction of fractions was poor: majority of the students knew the rule of addition and subtraction of fractions but only 45% executed the computation correctly, 25% students appeared to be struggling in finding the least common denominator when executing operations with fractions, none of the students reduced their fractions to lowest terms, and understanding word problems also proved to be a challenge to many of the students. This finding necessitates the importance of meaningful learning. Students need to experience fractions in a familiar context in order to be able to grasp conceptual and procedural understanding of fractions.

Keywords: student performance, addition and subtraction of fractions.

Introduction

The concept of fractions is a fundamental subject in mathematics. Successfulness in understanding fractions greatly influences students' understanding of other closely-linked concepts such as decimals, ratios, and percentage (Ndalichako, 2013). The application of fractional concept is in fact present in our daily life. For instances, fractions are used in conversations about distances, ages, and measurements of length, weight, and volume. In Indonesian education, the concept of fractions is taught to students since the second grade of primary school. In other countries such as Tanzania, the topic of fractions is introduced in as early as grade one. Unfortunately, the teaching and learning of fractions are repeatedly reported to be challenging. This is a global problem. Numerous studies showed that students' achievement in fractions in many countries was low (Amato, 2005; Idris & Narayanan, 2011; Ndalichako, 2013; Sadi, 2007; Wu, 2014). Several problems have been reported to be the cause for students' low achievement. First of all, the rules of

fractional computations are more complex than those of integers (Wu, 2014). Teachers' practice is also a major factor that influences students' achievement (Charalambous et al., 2010; Johar, Patahuddin & Widjaja, 2017). Moss and Case (as cited in Ndalichako, 2013) argued that teachers spent more time on the computation procedures of fractions rather than their conceptual meaning. Focusing on rote memorization of the computation rules without understanding can contribute to students' failure (Idris & Narayanan, 2011). As Siebert and Gaskin (2006) suggested that students would struggle in dealing with fractions unless they had conceptual understanding of fractions.

There have been several studies conducted to assess students' fractional knowledge worldwide, but there is limited number of studies published in Indonesia on the topic, especially in Aceh Province. This article reports a study conducted to assess students' performance in solving problems involving fractions at a state primary school in Aceh - Indonesia, whose students' performance in mathematics was quite low. The teachers reported that reviews of annual examination results indicated that the topic of computation of fractions was the most difficult topic for the students.

This study looked into the fifth grade students' performance in solving addition and subtraction of fractions with different denominators. It is hoped that the findings of this study can give insight into the difficulties that students experience in learning fractions and therefore teachers can use this information to improve their teaching practice.

Literature Review

Indonesian curricula have been experiencing quite a few adjustments over the years but the concept of fractions has always been considered an important topic in the teaching and learning of mathematics. In the revised version of the Indonesian Curriculum Year 2013, which was effective as of 2016, the teaching and learning of mathematics subject in primary school has been allotted an exclusive amount of time as opposed to be taught in integration with other subjects, which was the case in the older version of Curriculum 2013. The concept of fractions is introduced in grade two, beginning with identifying simple fractions: ½, 1/3 and ¼. In grade three, addition and subtraction of like fractions (fractions with the same denominators) are introduced. In grade four, students start to learn equivalent fractions. In grade five, students learn addition and subtraction of fractions with unlike denominators, multiplication, and division of fractions. In grade six, students learn to solve problems involving mixed operations of fractions and decimals.

As stated previously in the beginning of this article, the teaching and learning of fractions in primary school plays an important role in students' successfulness in mathematics. But the fact that the concept and computation of fractions are more complex than those of natural numbers makes it more difficult to teach and to learn. An effective approach to teach fractions is to link the concept and symbols of fractions with students' everyday lives (Huinker, 2010). Piaget (1968) has reminded us that children come to school with their head full of pre-existing knowledge which they constantly assimilate with new experience to make sense of it. In short, students' previous experience greatly influences how they perceive a new concept (Wong & Evans, 2011). A comprehensive understanding of a basic concept helps a student understand another concept. Vice versa, one misconception can lead to another misconception (Amato, 2005; Idris & Narayanan, 2011). Therefore the teaching of fractions needs to focus on meaningful learning at every stage progressively.

Previous studies showed that in dealing with fractions, most students' experienced difficulties in understanding the concept of equivalent fractions and the four basic

computations of fractions (Idris & Narayanan, 2011; Sadi, 2007; Wong & Evans, 2011). In fact, Ni (2001) claimed that students' incomplete understanding of equivalent fractions led to their difficulties in understanding computations of fractions. Sembiring, Hadi, and Dolk (2008) reported that students relied on rote memorization of procedures in solving equivalent fractions and computation of fractions. In dealing with fractions where students could no longer rely on their fingers, which students usually used as a "natural reference point for whole numbers" (Wu, 2014, p. 4), students tended to resort to meaningless memorization just enough to get to the correct answer without truly understanding the process. It is highly important for teachers to be aware of these difficulties in order to help their students construct good understanding of fractions.

Research Method

This qualitative study was carried out at a primary school in Banda Aceh – Indonesia. Twenty fifth-grade students participated in this study. This study was conducted as a follow-up following a preliminary observation that the fifth grade students who participated in this study were having difficulties in dealing with fractions. Their achievement in addition and subtraction of fractions, particularly, was very low. This study sought to reveal the difficulties that the students had in dealing with the addition and subtraction of fractions. Test and interview were employed to assess the students' performance in solving problems involving addition and subtraction of fractions. For the interview, eight students were asked to participate. These students were chosen for interview because of their poor performance in the test.

The test instrument was designed to assess students' fractional knowledge based on the standard competence as inscribed in the Indonesian Curriculum Year 2013 for fifth grade students which was: capable of solving problems involving addition and subtraction of fractions with different denominators. The test consisted of 8 questions based on the types of fractional problems adapted from Idris and Narayanan (2011). Modifications were made to fit the topics that had been taught to the students who participated in this study. The types of the questions covered addition and subtraction of proper fractions with related and unrelated denominators. Among the questions, 4 questions were presented in mathematical notations and 4 questions were presented in word problems. The following table shows the description of the problems used in the test:

Table 1. Description of test items

No	Description	Test Item
1	Addition of proper fractions with related denominators.	$\frac{1}{5}+\frac{7}{15}=\cdots$
2	Addition of proper fractions with unrelated denominators.	$\frac{5}{6}+\frac{1}{8}=\cdots$
3	Subtraction of proper fractions with related denominators.	$\frac{2}{3}-\frac{2}{6}=\cdots$
4	Subtraction of proper fractions with unrelated denominators.	$\frac{3}{4}-\frac{1}{6}=\cdots$
5	Addition of proper fractions with unrelated denominators (word problem).	Ina and Ani were asked by the teacher to finish a task together. Ina has done 2/5 of the task, and Ani has done 1/3. How many parts of the task have they done altogether?
	Addition of proper fractions (word problem).	Andi and his family are going to a city by car at a constant speed. In 2 hours they reach 1/3 of the distance.

6		If they start at 8 AM, a. how far will they be at 12 noon? b. what time will they arrive at the city?
7	Subtraction of proper fractions with the same denominator (word problem).	Bobi has a cake and he cuts it into 12 equal parts. He gives 2 parts for his brother, 1 part for his sister, and 3 parts for his mother. How many is left?
8	Subtraction of proper fractions with related denominators (word problem).	There are two fractions with the same numerator, which is 2, but different denominators. The first fraction's denominator is 3 and the second one's denominator is twice the value of the first one. What is the difference between the two fractions?

Students' performance was analyzed based on the standard competence mentioned above which was broken down into the following criteria: 1) comprehension of the mathematical procedures involved in addition and subtraction of fractions, 2) the ability to find least common denominator, 3) the ability to reduce a fraction to lowest terms, and 4) understanding a problem statement.

Results and Discussion

The following table displays students' performance in solving problems involving addition and subtraction of fractions.

Table 2. Distribution of students' performance in solving addition and subtraction of fractions

Performances	Number of Students	Percentage
Comprehension of the mathematical procedures involved in solving the problems:		
1. Executing the rules correctly.	12	60%
2. Executing the computation correctly.	9	45%
The ability to find least common denominator	15	75%
The ability to reduce a fraction to lowest terms:		
1. Knowing the rules involved.	11	55%
2. Executing the rules.	0	0%
Understanding of word problems:		
Question no.5	10	50%
Question no.6	3	15%
Question no.7	14	70%
Question no.8	10	50%

The table shows the number of students who demonstrated capabilities in four aspects that were assessed in dealing with addition and subtraction of fractions. Firstly, 60% of the students exhibited comprehension of the rules involved in the computation, and 40% of the students admitted that they did not remember the procedures of adding and subtracting fractions. Out of 60% of the students who

knew the rules involved in the computation, only 45% could execute the calculation correctly.

Majority of the students (75%) exhibited the ability to find least common denominator. Unfortunately, during interview it was revealed that only 10% who really understood why it was important to find least common denominator in adding and subtracting fractions. The rest of the students could not associate the concept of equivalent fractions with the procedure of finding least common denominator in adding and subtracting fractions. The other 25% students did not seem to master the ability to find least common denominators.

As for the ability to reduce a fraction to lowest terms, none of the students who participated in the study reduced their fractions. All of them left their final answer as it was. Reducing a fraction to its lowest terms means presenting a fraction in its simplest form. We questioned all of the students to clarify this matter and it was revealed that 55% of the students actually knew how to reduce a fraction to lowest terms. They said they have learned it but only performed it when asked to do so because they did not know the meaning and they did not think it was important to do as long as they could add and subtract fractions. The other 45% students confessed they did not know how to reduce a fraction to its lowest terms.

Understanding the questions that were presented in word problems was also proved to be quite challenging for some of the students. There were 4 word problems in the test. A straightforward statement such as question number 5 was relatively easier to understand by the students compared to more complex statement such as question number 6. Question number 5 was understood by 50% of the students while question number 6 was understood only by 15% of the students. The eight students who were chosen to participate in the interview could not answer these questions. They confessed that they were not used to solving word problems. They admitted that it was difficult to pick information provided in the problems and they got confused whether to add or subtract the numbers in the word problems. When asked to reread the questions a few times and were encouraged to try to understand the questions, a small number of the students slowly began to understand the word problems. It was apparent that they lacked confidence at first but once they got the meaning they seemed to be satisfied that they actually might be able to solve the problems.

There were three students who did not provide correct answers for any of the problems. Figure 1 shows the three students' answers to question number 1.

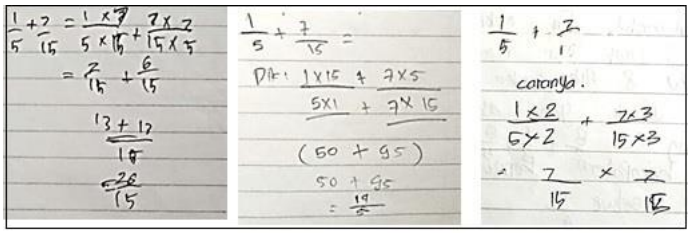

Figure 1. Sample of Students' Answer

During interview they confessed that they did not understand fractions. They said it was very difficult to grasp the concept. When they were asked to reread the questions, they said they could not understand what the questions were asking. The following is a part of an interview with one of the three students. The letter 'I' represents the Interviewer and 'S' represents the student.

I : How do you solve question number 1?
S : [silent].
I : Look at the denominators. Are they the same?
S : No.
I : How do you find the common denominator?
S : I don't remember.
I : Do you know why you have to find the common denominator first?
S : I don't know. I am not good at mathematics.

It was upsetting to hear that these three students always said they were just not good at mathematics. This negative attitude could hinder their successfulness in learning mathematics.

The findings of the study were in line with previous studies that showed students faced difficulties in dealing with fractions (Ndalichako, 2013; Sembiring, Hadi & Dolk, 2008; Wu, 2014). The complexity of the rules involved in addition and subtraction of fractions seemed to scare the students away from trying to understand them and instead they turned to rote memorization in order to arrive at the correct answer (Sembiring, Hadi & Dolk, 2008). This practice could be hazardous for students' long term achievement in mathematics. Rote memorization did not last long (Idris & Narayanan, 2011) and certainly did not help students' knowledge construction (Major & Mangope, 2012).

The study also found that equivalent fraction was the most problematic concept. Very few percentage of the students in this study exhibited understanding of the concept. Ni (2001) and Lamon (2005) argued that understanding of equivalent fraction was crucial in learning fractions. Lack of understanding of the concept greatly influenced students' performance in computations of fractions as was proven in this study. It was apparent that the students who participated in this study experienced difficulties in understanding why it was important to find the least common denominators when adding and subtracting two fractions. The students merely memorize the procedures without truly understanding them. This was as Amato (2005) found that students relied on procedural knowledge in dealing with equivalent fractions. The fact that none of the students reduced their fractions to lowest terms further confirmed the finding that their understanding of equivalent fractions was very limited.

Utilizing contextual problem is an essential approach to provide an opportunity for students to experience fractions in context so they can see fractions as numbers, not just meaningless symbols (Huinker, 2010). Unfortunately, the students in this study were not used to solving word problems. They could answer the questions in number format better than the word problems. This finding was in line with a study conducted by Jan & Rodriques (2012) who found that students faced difficulties in understanding word problem statements. Indonesian students' overall performance in solving mathematics word problems has been repeatedly reported to be very low. This was revealed by PISA (Programme for International Student Assessment) scores. In 2015, Indonesia ranked 63 out of 69 participating countries which was a slight improvement from the previous PISA score in 2012 where Indonesia was in 64^{th} place out of 65 countries (OECD, 2016).

The findings mentioned above raise implications for mathematics teachers. Wu (2014) stated that students used their fingers to help with counting natural numbers, but since this strategy could not work for fractions, teachers employed geometric figures such as circles and rectangles. But apparently this strategy could lead to misconception on students' part that fractions were not numbers which in turn could inhibit their knowledge construction of fractions (Amato, 2005; Johar,

Patahuddin & Widjaja, 2017). Therefore, it is of utmost importance that teachers consistently assess students' understanding by asking the students to elaborate their thinking during classroom activities (Idris & Narayanan, 2011; Siegler et al., 2010). Various presentations of fractions and varied tasks could also help students to gain deep understanding of the concept and long lasting skills to deal with computations of fractions (Huinker, 2010; Wong & Evans, 2011).

Conclusions

Students' performance in dealing with the addition and subtraction of fractions was unsatisfactory. The students somewhat knew the procedures involved in the computations but they experienced difficulties in executing the calculation correctly. The students did not have comprehensive understanding of the concept of equivalent fractions, and they also had difficulties in understanding word problem statements. These results emphasized the importance of meaningful learning. It is hoped that these findings encourage teachers to reassess their practices and formulate better teaching plans.

The study was conducted in a small scope in terms of the participants involved and the assessment of students' fractional knowledge. It is suggested for future research to expand the evaluation of students' performances to include multiplication and division of fractions in larger scale, especially in Aceh Province, Indonesia, in order to dig deeper into students' difficulties in dealing with fractions.

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