

The Enhancement of Problem Solving Ability Through Realistic Mathematics Education Approach

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Abstract

The aim of this study is to study and to analyze the achievement and enhancement of Mathematical Problem Solving Ability (MPSA) of students in elementary school. The method used is quasi experiment in two elementary schools in Banda Aceh City with total sample are 96 students. Generally, it can be reported that mean score of achievement in experiment group by using Realistic Mathematics Education (RME) approach is 25.45, whereas mean score in control group by using conventional learning is 15.17. This shows that MPSA achievement of students who learn mathematics by using RME approach is better than conventional learning. Mean score of enhancement in experiment group with RME approach is 0.3423, whereas mean score in control group with conventional learning is 0.0975. This shows that MPSA enhancement of students by using RME approach is better than students by using conventional learning.

Keywords: RME, problem solving, elementary school, fractions

1. Introduction

Mathematics will always exist in human activity. Human activity phenomena which involve mathematics is frequently not used in mathematics learning activity. Mathematics education which adopt human activity phenomena will become a meaningful learning process, because there is relation between mathematics and life activity. Certainly, the problem faced by students expect the solution. In process of learning mathematics including the topic of fractions, they always encounter the abstract things. The abstractness of topic of fractions can become barrier and difficulty for 4th grade students of elementary school to understand it. The inability of students to understand the fraction has lead to students error in learning algebra. Laursen (Brown & Quinn, 2007:8) suggested that: 'The inability to perform basic operations on common fractions has led to error pattern that

emerge in learning algebra. Problems can arise when students attempt to apply misunderstood shortcuts, learning with fractions, to situations involving algebra'.

Therefore, before student learn algebra, student ability is required in understanding the concept of fractions. Morge (2011:282) reported that "The topic of fractions can be intimidating and difficult for children, even into middle grades". Similarly Capraco (2004:193) said that: "Fractions are often difficult for students to fully comprehend. Teachers must find a variety of strategies to use in classroom for teaching fractions."

The concrete operation in fractions can be done by using concrete object so they can observe and represent their understanding with aid of manipulated concrete object. The use of concrete object in learning process can be done by RME learning which move from concrete to abstract. In accord with type of thinking in learning mathematics delivered by Darhim, there are four types of thinking, namely: (1) concrete thinking; (2) semi concrete thinking; (3) semi abstract thinking; and (4) abstract thinking. Jitendra et al (Schunk, 2012: 596) 'conducted the study on 3rd grade students and found that specific strategy teaching is effective to enhance problem solving ability compared with teaching in general strategy, even though these two kinds of teaching can enhance counting ability possessed by students.'

Soedjadi said (1999/2007:7) that: "the abstractness of objects existed in mathematics need to be attempted in order to be embodied in more concrete, so it can help students to understand it more easily. This is the important key which should be known by mathematics teachers, and it is expected that it can encourage them to be more creative in planning the learning." Concerning with student understanding in concrete level, Dahar (1988:107) said: "someone who has achieved the concept in concrete level if he/she recognize an object which had been confronted before." By involving concrete object in learning process, students will become more active physically and mentally.

4th grade students of elementary school/MI in Indonesia aged around 10 or 11 years old. Based on Piaget theory, the level of intellectual development of the children aged around 7-11 years old are in concrete operational period. This level is the beginning of rational thinking. It means that children have logical operations which can be applied on concrete problems (Dahar, 1988). It is reasonable that learning process with RME approach is applied on 4th grade students which is began with concrete operational involving concrete object as its representation form.

Mathematics learning process which concern to contextual problem is RME approach. The context chosen suited with the things used to experienced or seen by students in their daily life as their learning experience both formal and informal. Students learning experience in meaning of word "equal" can be directed/used to understand the concept of half fractions for each part after divided by equally two. By utilizing their knowledge and learning experience informally, it can make them easier to understand the problem posed.

A teacher need to know "well" what ability which is needed by students to enter learning process which will be implemented. Many errors done by students in fractions problem because they lack of mathematical initial ability (MIA). Understanding the problem, fractions concept, KPK, and mathematical basic operation are initial abilities which are important to be possessed by students in solving fractions problem in elementary school. Polya (1985) in his book revealed that there are four stages related to problem solving process, namely 1) understanding the problem, 2) devising a plan, 3) carrying out the plan, 4) looking back.

2. Formulation of Problem

The gaps mentioned in problem background above arise the problem which is related to students' problem solving ability which is expected can be enhanced through RME learning. In detail, the problem above is outlined in research questions as follow:

- 1) Are achievement and enhancement of MPSA of students who learn with RME approach better than students who learn with conventional learning (CL)?
- 2) How does the form of errors contained in instruments sheet of students' MIA and MPSA?

3. Aim of Study

Related to problem formulation which can be mentioned, there are some aims which become the focus in this study. In detail, the aims of this study are:

- 1) to study the achievement and enhancement of students' MPSA after implementation process of learning fractions with realistic mathematics education approach in elementary school.
- 2) to study the errors done by students who learn with RME and CL in solving MPSA problems.

4. The Benefit of Study

It is expected that the result of study is beneficial for researcher and another people, particularly the topic of fractions in elementary school. Below are some benefits which are expected in this study:

- 1) As the effort to enhance mathematical problem solving ability particularly the topic of fractions in elementary school level.
- 2) As reference material for teachers who are teaching the topic of fractions in elementary school.
- 3) It can become autonomous learning material for students of elementary school who are learning fractions.

5. The Definition of Term

The definition of term from variables included in this study need to be asserted operationally so it omit or reduce the possibility to invoke different meaning between one term to another term.

- 1) MPSA is students' ability to understand the problem through the known and questioned elements and the adequacy of element needed in arranging the solution symbolically or pictorially.
- 2) RME Approach is learning which use contextual problem and concrete object which can be used to understand concept, problem and represent the fractions based on the context chosen and with consideration based on environment and initial understanding possessed by students.
- 3) CL is learning implemented by teacher in teaching the fractions as used to be implemented without intervention, supplementation, and assistance from others.

6. Research Method

The method used in this study is quasi experiment with pretest-posttest control group design. The total of sample are 96 students consist of 42 students of SDN 2 Banda Aceh and 50 students of SD IT Nurul Ishlah Banda Aceh in 2015/2016. Sample are divided into two groups, namely: experiment group and control group with total of 51 and 45 students.

Experiment group (X) is given the treatment with RME learning and control group with CL. Before learning process activity is implemented, MSPA pretest activity is done first. After learning process, MSPA posttest is done. Pretest and posttest problems posed have similar item and numbers. Gain score for pretest and posttest is used to see the enhancement of students ability. To see the accomplishment, posttest data is used. The variables in this study are learning model as independent variable and problem solving ability as dependent variable.

Learning in experiment class is done based on learning design which is arranged after validation process from experts. Besides validation done by experts, the design is trialed on same age non subject is done (5th grade). This is done in order that the language used can be understood by subject of study as expected by researcher.

6.1 Subject of Study

The selection of two schools as site of study is done with consideration, both from the aspect of the number of class or suggestion from mathematics teachers. The two classes selected as experiment class and control class in SDN 2 Banda Aceh and SD IT Nurul Ishlah can be seen in Table 1. The data used in statistic test is data from students who follow all test and non test activity with total of 96 students, as explained in Table 1 below.

Table 1
Sample of Study

No	Name of School	Numbers of Sample	
		Experiment	Control
1	SD Negeri 2 Banda Aceh	24 (4A)	22 (4D)
2	SD IT Nurul Ishlah Banda Aceh	27 (4B)	23 (4A)
Total		51	45

After the selection of two elementary schools as site of study, the meeting is held with mathematics teachers who were doing the process of fractions learning as a step to anticipate the things which need to be done during learning process and delivering a set of learning.

6.2 Instrument of Study

This study use test and non test instrument to obtain data. Test instrument consist of : MIA and MPSA, and non test is students response toward learning process, a set of learning design, and teacher observation guide. As for stages of study done are: observation, MIA test, MPSA pretest, learning process, MPSA posttest, students response and unstructured interview.

Initial observation is done by visiting some elementary schools existed in Banda Aceh. Observation is focused on mathematics teachers who are teaching in 4th grade of elementary school and the number of class existed in location of study. To obtain the broader and more complete description of school existence, the interview with School Principal is done. The next observation done when learning process occurred in class. Observation toward learning process consist of 20 statement items with each item consist of three choices, namely: yes/clear, not clear and not done.

Before learning process is done, students' MIA test is done to place the subjects in three category of abilities: high, medium and low. MIA test is chosen from the topics which had been learned before and arranged in the form of essay with total of 9 items. The score of achievement is obtained from gain score of posttest with MPSA pretest. The instrument used had been validated by 2 lecturers and doctoral program students and had been trialed and some notes are obtained as follow:

- 1) There is a student who does not understand the meaning of $\frac{1}{4}$ which had been taken/given to another students, so he does not understand when being asked how much the rest of this part. The problem posed is completed by picture and its size as illustration of word problem. In another case, a student in high level even had forgot to mention or write the steps which should be done to add two fractions $\frac{1}{2} + \frac{1}{3}$.
- 2) Some students do error in giving/writing their answers even though the steps they taken close to right answer.
- 3) Students forget the concept of fractions addition.
- 4) Students are lack in understanding the meaning of problem.

MPSA test is administered before and after learning process. The procedure done in arranging that MPSA test is: to arrange syllabus, the indicator which will be measured, aspect and content and readability adjustment by 4th grade students of elementary school. The indicator which will be measured in MPSA test is a) understand the problem through identification of known elements and adequacy of data/element needed; b) arrange the solution problem and represent it (symbol, picture, graphic, table and diagram); c) choose and apply solution strategy to obtain solution and; d) check the correctness of solution which had been arranged.

To obtain the response of students toward learning process, the questionnaire is given to them in the end of learning process. The learning process designed consist of some sub topics and limitation as follow: the meaning of fractions, simplicity, addition, subtraction and fractions problem solving. The exercise problem used as homework and exercise. The learning process use concrete object/media which are made from board, cartoon paper, and mortar (made from clay). Related to the use of concrete object as media in learning process, Minister of Education and Culture (2013: 6) said that: "The skill is obtained through activity, by observing ,asking, trying, reasoning, presenting, and creating"..... To force students ability to produce contextual project, both individual or group then it is suggested to use learning approach which produce the project based learning."

6.2.1 The Board With Rectangle Shape.


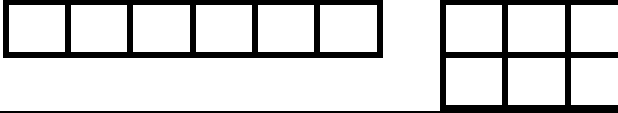
It is divided into 24 parts with equal size and resemble the chocolate.



Figure 1 Chocolate

Each small piece is made to be congruent in order that paperboard provided can cover the parts of fractions board in two directions (length or wide direction). The use of fractions rectangle is completed by paperboard with eight forms/sizes.

Table 2
The Shape and Representation of Fraction Value

Fraction Value	The Size of Paper as Representation	The Shape of Paper
$\frac{1}{6}$	1x4	
$\frac{1}{4}$	1x6 and 2x3	

The example of fraction board which represent $\frac{1}{2}$ as the following figure.



Figure 2 Fraction Board

Each group is facilitated by two sets of fraction boards, so it can be used to perform fractions addition operation.

6.2.2 “Cobek” or Mortar

Mortar is a name of object which is made from clay and used as plate to grind chilly, union and the others manually/traditionally in Aceh, as seen in the figure below:



Figure 3. Mortar and Its Fractions

The fractions of mortar are used by each group to represent the meaning of fraction so students understand the concept of fractions, particularly fractions representation as part of a whole.

6.3 The Scope of Study

This study is conducted in topic of fractions for 4th grade students of elementary school in even semester, 2015/2016 academic year. The definition of fraction is focused on “part of a whole”. Part of a whole can be shown through discrete and continuous object.

6.4 Data Analysis

There are two kind of data which is analyzed in this study namely quantitative and qualitative data. Quantitative data is used to find out the enhancement of students' MPSA test result after the process of learning fractions is finished. Qualitative data is used to describe error and strategy done by students who learn by using RME and CL in solving MPSA problems. The processing of study data based on its variables is done by descriptive statistic analysis, t-test and two-way ANOVA test.

7. Discussion

Entirely, it can be reported that students' gain mean based on total score achieved by each category also varied. The mean score of achievement and enhancement for each group of MIA category is presented in Table 3 as follow. The highest mean is obtained by group of students from high MIA category and the lowest mean is obtained by group of students from low MIA category. Entirely, for MPSA data, mean score obtained by experiment group is higher than control group with difference of 10. 2737.

Table: 3
Mean Score of
Enhancement and Posttest of All Categories

Group	Category of MIA	Mean Score of Enhancement (N-Gain)	Mean Score of Post-test
		MPSA	
Experiment	High	0,5046	33,61111
	Medium	0,2163	24,00000
	Low	0,2781	19,05000
	Total	0,3423	25,45098
Control	High	0,0545	17,15385
	Medium	0,0841	15,00000
	Low	0,1336	14,00000
	Total	0,0975	15,17778
Total		0,2276	20,63542

In process of learning which is facilitated by concrete object, students can find or sum two fractions which have different numerator with their own way. Generally, there is enhancement of students understanding in process of summing two fractions with different numerator. In pretest, students do addition with incorrect way $\left(\frac{6}{24} + \frac{1}{4} = \frac{7}{24}\right)$. After learning process, students had did it correctly, become $\left(\frac{6}{24} + \frac{6}{24} = \frac{12}{24}\right)$.



Figure 4

Discussion to Determine Two Fractions with Equal Value by Using Media

Generally, students still lack in understanding the picture which represent the magnitude of a fraction. Students are trapped by the size given without seeing the width of part from each shaded area which do not has equal “width”, so students are trapped by the data given, that is, a circle is divided into three parts based on its diameter which is divided into three with equal length.

But on the other side, students also not chose the bolded area in equilateral triangle which is $\frac{1}{3}$ part of a whole (an equilateral triangle) in which the direction is not given. In another problem (item no.9) , “there are some students who present the answer correctly without doing standardized division or subtraction operation.

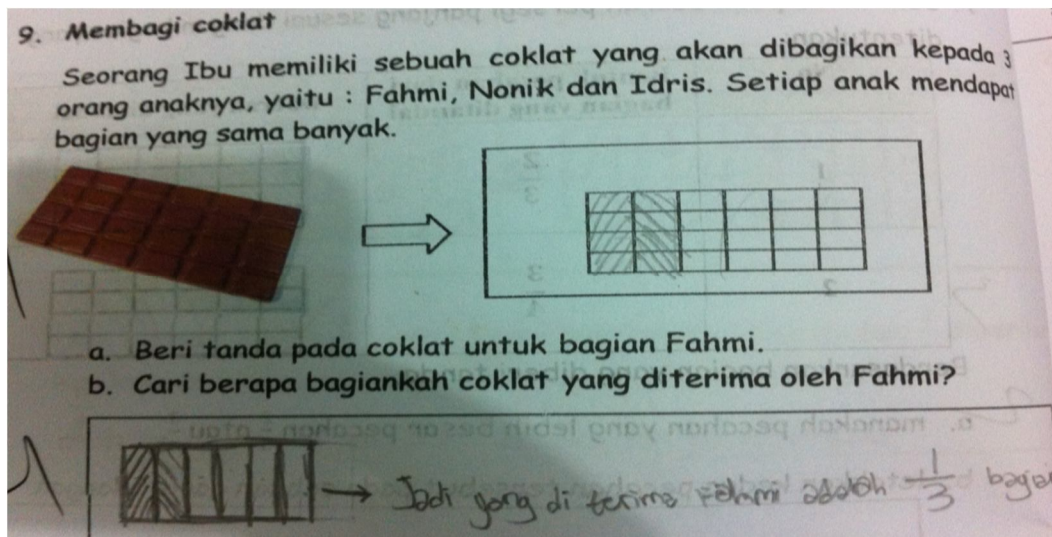


Figure 5

The Excerpt of Student Answer

There is error made by students related to the meaning of word “how many the part?” (question b). In this case, we can see the type of error done by students which contain the word “how many the part” as seen from the excerpt of students answer as follow.

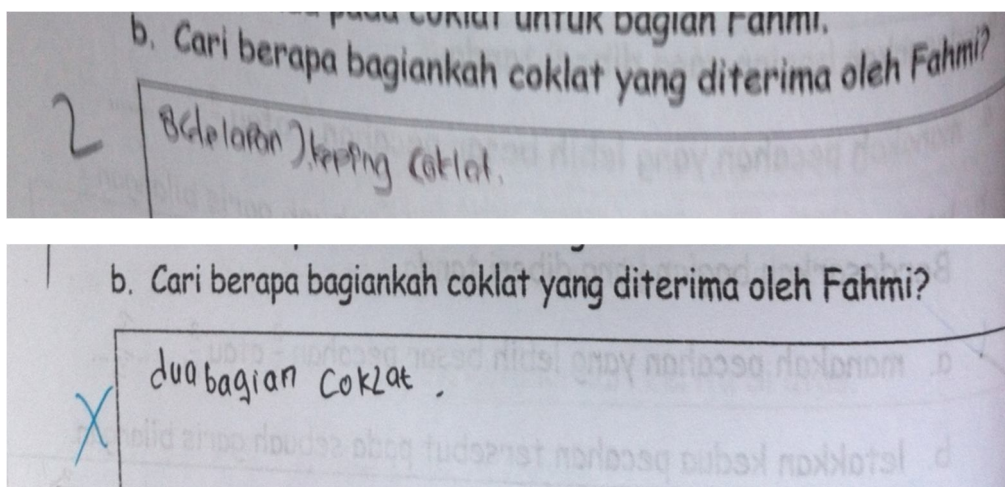


Figure: 6

The Excerpt of Student Answer

In pretest, students do error by adding the denominator of two fractions $\frac{1}{7} + \frac{2}{7} = \frac{3}{14}$. But in posttest, more than half of students who are in high category had been able to answer it correctly, both the picture and symbol of fractions by adding two fractions with same denominator, or directly.

8. Conclusion and Recommendation

- 1) The achievement of MPSA entirely or based on MIA (high, medium, low) with RME approach is better than conventional learning.
- 2) The enhancement of MPSA entirely or based on MIA (high and low) with RME approach is better than conventional learning.
- 3) The enhancement of MPSA for students of medium MIA group between mathematics learning and RME approach is not different with Conventional Learning.
- 4) The implementation of fractions learning with fractions board combination and with concrete object shows good result toward achievement and enhancement of MPSA. Similarly with the use of mortar to find the fraction which is actually suited with students initial understanding toward the fractions. Therefore, in a process of learning fractions in 4th grade of elementary school, it is expected that teachers use mortar and such kind of object which can be divided to find/understand the actual meaning/ concept of fraction as representation of simple fraction value.
- 5) In fractions board, the value of a fraction from certain part in a certain width unit, as numerator is the sum of a certain part of area, and the sum of whole of a part (n) is made to become its denominator, then all part in one unit had been divided into n of "equal" part. As suggested by Liu that the fraction is a number which has numerator and denominator. As a number concept, the fraction show proportional association between the part called as numerator and a whole which is called as denominator (Liu et al, 2012).
- 6) Based on test result, there are some students who do not chose the bolded area which is triangle from a shape of triangle which is given. On the other side, there are some students who chose a shape of circle which is divided into three (based on the size of its diameter, so there are two parts with equal size and one shaded part in the centre which bigger/wider). Probably, this error occurred because to represent the fractions, the picture of rectangle or circle is given routinely. Therefore, in the future it need to be corrected by giving emphasis on definition of fractions which is represented by various shapes other than rectangle.

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