

Students Problem Solving Ability Based on Realistic Mathematics with Ethnomathematics

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Abstract. *The aim of the research is to describe the profile of problem solving ability of secondary student with high mathematical ability in learning based on realistic mathematics supported by ethnomathematics. The study is a descriptive qualitative research. The subject is a 7th grade student in a public secondary school at Semarang regency, Central Java. The data was collected by test and interview. The student's problem solving ability was analyzed by using Polya Steps. The results showed that the profile of student's problem solving ability with high mathematical ability was very good. In the beginning, the student started by understanding the problem completely. Then, they was making good planning to solve the problem, applying the correct process, and producing the right answer. In addition, they could look back the process but incomplete yet. This finding, hopefully, helped teachers in choosing the appropriate strategies or instructional approaches in order to improve the students problem solving ability.*

Keywords: *problem solving ability, realistic mathematics education, ethnomatematics*

Introduction

There are several competencies that should be mastered by students, i.e. problem solving, critical thinking, and creative thinking ability. The most important thing in solving problem is understanding, reasoning, and methodology up to producing the right solution. This statement is aligned with the consensus among mathematics education scholars, "problem solving is fundamental not only to doing mathematics but also to teaching and learning mathematics" (Lester & Charles, 2003; National Council of Teachers of Mathematics [NCTM], 1980, 1989, 2000; Schoen, 2003). In learning mathematics, students should be able to solve the problem of the topic on the subject-matter before studying the next one. They also, hopefully, give positive contribution to the society, be able to apply their cognitive ability to solve every problem not only in their field but also in the other one. That is why, it is important to know the profile of students' problem solving ability in their learning mathematics.

Learning mathematics should make priority to students' ability in problem solving. NCTM (2000: 182) stated, "problem solving is the cornerstone of school mathematics, without the ability to solve problems, the usefulness and power of mathematical ideas, knowledge, and skills are severely limited". Students can find the new rule in higher level that can not verbalize by solving the problem (Nasution, 2010). In line with Nasution argue, Wilson, Fernandez, and Hadaway (1993: 66) expressed a widespread belief when they said, "the art of problem solving is the heart of mathematics". Problem posing and problem solving activities can encourage the students to improve their performance. This statement in line with Suroto's (2011: 170) argument that if there is problem posing in

the class, it will encourage students' understanding of problem and their performance as well.

Donaldson (2011) stated that teaching through problem solving is a particularly effective way to help students gain understanding of mathematical concepts. Likewise, teaching through problem solving has some advantages, for instance: 1) increase students' interest in and enjoyment of mathematics (Kahan & Wyberg, 2003; Lambdin, 2003), 2) help students to develop mathematical habits of mind (Levasseur & Cuoco, 2003), and 3) demonstrate the usefulness of mathematics for solving a wide range of problems (NCTM, 2000). Furthermore, there are four indicators to determine problem solving ability according to Polya (1973) namely: 1) understanding the problem, 2) devising a plan; 3) carrying out the plan; and 4) looking back. In addition, the solution of the problems were scored based on Schoen and Oehmke framework (in Fauziah, 2010: 40).

There are some approaches that can be used in learning mathematics. One of them is Realistic mathematics education. In Indonesia, it called Pendidikan Matematika Realistik Indonesia (PMRI). On this approach, students learn mathematics, in the beginning, from real things or real life to the abstract mathematics. PMRI make the process of learning mathematics meaningful and enjoyable and can increase the understanding of the concepts (Nursyahidah, 2013). Realistic mathematics can be combined with Ethnomathematics as stated by D'Ambrosio (1985) that mathematics appeared as the result of the human activity in environment where it is affected by the culture of the society. So, mathematics is become a part of the students daily life. This condition help them to understand the problem and solve the mathematics problems well.

Some scholars have studied on teaching and learning of the mathematical problem solving. Those studies explained how the teachers used standards-based mathematics curricula, how they understood about problem solving shape, and how they taught and supported their students to develop problem solving skills (e.g., Grouws, 1985; Lester, 1994; McCaffrey, Hamilton, Stecher, Klein, Bugliari, & Robyn, 2001; Reid, 2002; Silver, 1985). The National Council of Supervisors of Mathematics (NCSM) offers a representative and generally accepted definition of problem solving:

“Problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations ... problem solving strategies involve posing questions, analyzing situations, translating results, illustrating results, drawing diagrams, and using trial and error” (NCSM, 1989: 471).

Furthermore, Polya (1945) stated that problem solving should be a legitimate topic in teaching and learning school mathematics. In addition, NCTM also stated that problem solving should become "the focus of school mathematics" (NCTM, 1980:1). "Problem solving is central to inquiry and application and should be interwoven throughout the mathematics curriculum to provide a context for learning and applying mathematical ideas" (NCTM, 2000: 256). Polya (1973) identified four indicators to measure the students problem solving ability: 1) understanding the problem, 2) devising a plan; 3) carrying out the plan; and 4) looking back.

Realistic Mathematics Education is based on Freudenthal's statement that “mathematics is a form of human activity” (Wijaya, 2012). This statement implies that mathematical learning is always associated with human activity, but not all human activity reflects math. Therefore, it is necessary to select the activities that are in accordance with

mathematical concepts. Those concepts are meaningful if relevant and useful for humans.

Chor in Wijaya (2012) stated that knowledge would be meaningful if it introduced with a context or realistic problems in the learning process. Realistic problem is the prior knowledge having the students. If the realistic problems is related to problem solving, then the problem will be modeled mathematically. It is also known as *model of* and *model for* in realistic mathematics education. These models are a bridge to understand the mathematical concepts from the problem learned. There are five characteristics of the realistic mathematics education: 1) context, 2) models for progressive mathematization, 3) students' own construction, 4) interactivity, and 5) intertwinment (Gravemeijer, 1994; Treffers, 1991). Lange (1995) divided two kinds of mathematization process these are vertical, formalization process of mathematics, and horizontal, generalization process of mathematization. The object of mathematization is the mathematical model itself

Ethnomathematics is a mathematics that grows and develops in a particular culture which is perceived as a lens to view and understand mathematics as a cultural product. The culture refers to the language of society, place, tradition, way of organizing, interpreting, conceptualizing, and giving meaning to the physical and social world (Ascher, 1991). Furthermore, as quoted D'Ambrosio (1985), mathematics in schools is known as academic mathematics. While ethnomathematics is a mathematics which is applied to identify cultural groups such as tribal society, labor groups, children of certain age groups, and professional class. So, ethnomathematics is a mathematics that arise from human activities in the environment that is influenced by culture.

The study of Ethnomathematics in mathematics learning has been widely practiced. For instance, the game Wasakwakwalwa puzzle in Hausa culture in Northern Nigeria, South African carpenter method in determining the center of the rectangular box cover, Bali woven crafts, Sero (SET NET) community culture Kokas Fakfak West Papua, woven Rajapolah, and so on (Puspawati, 2014; Ubayanti, 2016; Prabawati, 2016). In this research, Ethnomathematics will be studied in Javanese culture point of view.

The objective of the research is to determine and describe students ideas to solve problem in learning based on realistic mathematics related to Ethnomathematics in secondary school. Therefore, the teacher, hopefully, be able to choose the appropriate context to teach and the learning approach to improve students' problem solving ability. The close daily life problems with the students will help them to imagine and improve their creativity to acquire new ideas in solving the problem. Thus, the students with different level of mathematics ability will be enthusiast in solving the problem.

Research Methods

The research was conducted in one of public secondary schools in Semarang regency, central java province, Indonesia. The data was collected by using test and interview. In this research, Mathematics Ability Test (MAT) was used to classify the level of the students' problem solving ability in a class with 35 students. Furthermore, a student with high mathematics problem solving ability was interviewed to investigate his profile of the problem solving ability in learning based on realistic mathematics related to Ethnomathematics. The inductive approach was used to analyze the data of the research.

Results and Discussion

Mathematics Ability Test (MAT) is a test that aimed to measure the level of students understanding in mathematics which is classified into three level, i.e. high, average and low. The test results would be scored by using Fauziah's guidelines (2010)

and classified by applying Redhana's criteria (2013). The MAT problems are presented in appendix. The student with MAT score more than 80 was classified as the student with high mathematics ability. The percentage of each level of the students' problem solving ability was presented in Table 1.

Table 1.
The Percentage of the Students Mathematical Ability

Grade VIIIA	Mathematical Ability			Total of Students
	High	Moderate	Low	
Number of students	3	10	22	35
Percentage	8,57%	28,57%	62,85%	100%

Based on the first Table, it can be seen that only three students (8,57%) met the criteria of the high mathematical ability. Most of them (62,8%) gained low score in MAT, so they had the low mathematical ability criteria. Furthermore, the subject is determined by asked the teacher consideration in order to find the appropriate research subjects. one of the consideration were their communication skills. Therefore, based on those considerations, researcher took a student with high mathematics ability as the subject. In this research, the interview was used to investigate the profile of problem solving ability of the secondary school student with high mathematics ability in learning based on realistic mathematics related to Ethnomathematics.

The interview between researcher (R) and the student (S) about his process in solving the problem 1.a (Appendix A) is presented in the following

- R : *"What do you know about the problem?"*
 S : *"Hmm, finding the number of "wakul" on the picture"*
 R : *"How do you know the problem?"*
 S : *"By reading the question and look at the given picture"*
 R : *"How many times do you read the question to get understanding the problem?"*
 S : *"only once"*
 R : *"Ok, then, what is asked in the question?"*
 S : *"How do Dimas pay?"*
 R : *"So, what is your plan to solve that problem?"*
 S : *"Hmm... (the subject looks think a moment)... by using the elimination method"*
 R : *"How to get solution of that problem? Please explain"*
 S : *"By using pure elimination method, then find the value of x and y. Firstly, I multiply the first equation by 1 and multiply the second equation by 3, then I got the value of y = 40.000. Then I multiply the multiply the first equation by 4 and multiply the second equation by 3, Then I got the value of x = 35.000"*
 R : *"How do you convince that your process to solve the problem is correct?"*
 S : *"Yes, I convince that my process is true, because I did process based on what I have learned before"*
 R : *"How did you do the given question?"*
 S : *"I read the question first, then think the way to solve the problem or make the planning by writing the given information, then calculate it using the appropriate strategy to solve the problem."*
 R : *"Did you check your answer after finishing the process?"*
 S : *"Yes, I did, but just a moment"*

The student's written answer of the problem 1.a is presented in the following figure

Misal: x = Ceting
 y = Kukusan

$$\begin{cases} 6x + 3y = 330.000 & \times 1 \\ 2x + 4y = 230.000 & \times 2 \end{cases} \Rightarrow \begin{cases} 6x + 3y = 330.000 \\ 4x + 8y = 460.000 \end{cases}$$

$$\begin{array}{r} 6x + 3y = 330.000 \\ -4x - 8y = 460.000 \\ \hline -2x - 5y = 890.000 \\ 4x + 8y = 460.000 \\ \hline -4x - 13y = 1.350.000 \\ \hline 4y = 990.000 \\ y = 247.500 \end{array}$$

$$\begin{cases} 6x + 3y = 330.000 & \times 4 \\ 2x + 4y = 230.000 & \times 3 \end{cases} \Rightarrow \begin{cases} 24x + 12y = 1.320.000 \\ 6x + 12y = 690.000 \end{cases}$$

$$\begin{array}{r} 24x + 12y = 1.320.000 \\ -6x - 12y = 690.000 \\ \hline 18x = 630.000 \\ x = 35.000 \end{array}$$

Figure 1. The student answer of problem 1(a)

Based on the student's written answer dan interview, it can be found that the student had understood the problem completely by writing what they already known and simbolized it with x and y variable. Then, they made planning that suitable with procedure and got the correct solution by multiplying both of equations with certain number such that the linear equation system can be solved easily. In addition, he also able to calculate correctly by using elimination method to determine the value of x and y , but the final result still uncorrect. It was happened because he did not finished in reviewing or checking his answer. Therefore, the student already solved the problem but his answer is not correct yet.

In problem 1.b (Apendix A), the student could explain the seller ways to give back the money to the buyer by adding the price to the back. So, he got the correct answer, $340.000 + 10.000 + 50.000 = 400.000$. The following figure is the student's written answer in solving problem 1(b).

Rp. 400.000 - (1414)

$$1414 = 140.000 + 200.000 = 340.000$$

$$Rp. 400.000 - 340.000 = Rp. 60.000$$

Cara penjual mengash uang kembalian

340.000

- > Rp. 10.000 → Rp. 350.000
- > Rp. 50.000 → Rp. 400.000

Figure 2. The student answer of problem 1(b)

Furthermore, the interview regarding the secondth problem (Apendix B) as the triangulation for validating the data is presented in the following

- R : "What do you know about the problem?"
 S : "The number of "dumbeg" and "bugisan"
 R : "What is asked in that problem?"
 S : "How much rice flour is needed?"
 R : "What is your plan to solve that problem?"
 S : "By using mix method, elimination and substitution method"
 R : "How do you solve the problem? Please explained"
 S : "By using elimination and substitution, then I found the result"

- R : "Are you sure that your answer is correct?"
 S : "Yes, I'm sure"
 R : "Why?"
 S : "Because I calculate it twice and I got the same answer"
 R : "Did you check the process and the result of your answer?"
 S : "Yes, I checked it"

The following figure is the student's written answer in solving problem 2.a.

Misal: 10 dumbeg
 3 bugisan

$$\begin{array}{l} 12x + 8y = 1.200 \\ 8x + 10y = 1.150 \end{array} \quad \begin{array}{l} \times 2 \\ \times 3 \end{array} \quad \begin{array}{l} 24x + 16y = 2.400 \\ 24x + 30y = 3.450 \\ \hline -14y = -1050 \\ y = \frac{-1050}{-14} \\ y = 75 \end{array} \quad \begin{array}{l} \times 5 \\ \times 4 \end{array} \quad \begin{array}{l} 60x + 40y = 6.000 \\ 32x + 40y = 4.600 \\ \hline 28x = 1.400 \\ x = \frac{1.400}{28} = 50 \\ x = 50 \end{array}$$

Jawab: {50, 75}

Figure 3. The student answer of problem 2(a)

Based on the result of the student's written answer and interview, it can be found that the student had understood the problem well. He not only could changed the contextual problem to mathematics model by using variables (x and y), but also wrote the linear equation systems of two variables from the given problem. He also made a good planning to solve the problem. Furthermore, he has done the appropriate procedure to solve the problem such that the answer is correct. The student had already reviewed his solution but incomplete. Therefore, the answer was incomplete, he only calculate the solution and produce the correct answer. The student's written answer are presented in Figure 4.

$$\begin{array}{l} x = 75 \times 10 = 750 \text{ gram} \\ y = 50 \times 3 = 150 \text{ gram} \\ \hline 900 \text{ gram} \end{array}$$

Jadi jika ibu mempunyai 900 gram bisa membuat 10 dumbeg dan 3 bugisan.

Figure 4. The student answer of problem 2(b)

Figure 4 showed that the student wrote only one way of the solution, combination of 10 "dumbeg" and 3 "bugisan". He did not explored the another ways to solve the problem. Based on the research results, it can be concluded that the study is suitable with Putra's research (2015) which was stated that the students with high mathematical ability has mathematical problem solving ability such as able to demonstrate a good

understanding in analyzing the given problems. They were also looking back every step of the solution until sure that the answer is correct. In addition, this study also suitable with the study conducted by Fauziah (2010) about the problem solving ability of the students with high mathematical ability. In her study, she conclude that the students with high mathematical ability able to understand the problem completely, make planning which is suitable with the procedure, carry out the appropriate process, and look back the process of problem solving.

Conclusion

The profile of problem solving ability of the student with high mathematics ability in learning based on realistic mathematics related to Ethnomathematics is including very good category. The student able to elaborate his understanding of the problem completely, planning with the suitable procedure, and doing correct process so that he get the correct solution. In addition, the student can review or look back his solution process but incomplete yet. Sometimes, he answer the pobleem mathematically without change into contextual form.

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Appendix A

Mathematics Ability Test 1

Topics : SPLDV
Class/Semester : VIII/I
Duration : 20 minutes

1. Look at the picture below.
 - a. How much does Dimas have to pay if he buys goods as shown in the third picture? Explain your answer

The image displays three boxes, each containing a different set of goods. Each box is divided into two sections: the left section shows woven baskets and the right section shows woven hats. The first box contains 6 baskets and 3 hats, with a price tag of Rp 330.000,00. The second box contains 2 baskets and 4 hats, with a price tag of Rp 230.000,00. The third box contains 4 baskets and 5 hats, with a price tag of Rp ?

- b. If Dimas pays with four pieces of a hundred thousand, how much refund will Dimas get? How does the seller usually calculate the amount of the refund? Explain your answer.



Appendix B

Mathematics Ability Test 2

Topics : SPLDV
Class/Semester : VIII/I
Duration : 20 minutes



At the harvest time, people in pantura (north java) area often hold a tradition called as sea alms for fishermen or alms for farmers. At the event they usually make a traditional foods or snacks such as "dumbeg" and "bugisan". The shape of those foods are similar with cone and wrapped by the coconut or banana leaf. To make 12 dumbeg and 8 bugis is required 1200 grams of rice flour, while to make 8 dumbeg and 10 bugisan is required 1150 gram of rice flour.

- a. How much rice flour is needed to make 15 dumbeg and 15 bugs? Explain your answer

- b. If the mother has 900 grams of rice flour, determine the possibilities of the number of dumbeg and / or bugisan that can be made. Explain your answer