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## Proceedings

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# Categorizing Students' Mathematical Problem Posing: A Case on Counting

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**Keywords:** Category, Mathematical Problem Posing, Counting Operation.

**Abstract:** This research aims to categorize mathematical problems proposed by students based on the concept of counting operations. The counting operations which are used in this research are addition, subtraction, multiplication, and division. This research intends to a descriptive study. Data were collected from the 7<sup>th</sup> grade students of Islamic Junior High School in Malang, Indonesia. The topic given to the students was Social Arithmetic. Students were asked to pose problems based on the given situation without giving the solution. The analysis of the results shows that there are four categories of students' problem posing, they are respectively the problems that involving one counting operation (the first category), two counting operations (the second category), three counting operations (the third category), and four counting operations (the fourth category). Even though the students did not solve the problem, but some of them had predicted the solution of the problem. When posing mathematical problems, the students associated the given situation to their mathematical abilities. Also, some students added some new quantitative information and develop the mathematical problems.

## 1 INTRODUCTION

Learning in school has encouraged a lot of students to pose and solve mathematical problems (Cai and Hwang, 2002; Crespo and Sinclair, 2008; Silver, 1997, 1994; Singer et al., 2013; Xia et al., 2008). The students are asked to find the solutions for the given situation and information. This result was a very great weapon for students to think convergently. The students must be trained to think divergently so that their mathematical abilities can be developed. One of the ways for students to come up with ideas and develop their mathematical abilities is by assigning tasks to pose some mathematical problems.

Many researchers associate the task of problem posing with creativity (Haylock, 1997; Kontorovich et al., 2011; Leung and Silver, 1997; Marhayati and Sa'dijah, 2018; Pehkonen, 1997; Shuk-kwan, 1997; Silver, 1997; Siswono, 2010; Van Harpen and Sriraman, 2013). In mathematical problems, the students are trained to think out of the box. Students do not only solve the problems given by the teacher but also formulate the problems. In formulating

problems, students use their mathematical abilities. Using mathematical abilities, creative questions are needed so they can formulate various questions.

A semi-structured problem posing situations can be used to train students' mathematical abilities. According to Stoyanova and Ellerton (Stoyanova and Ellerton, 1996), semi-structured problem posing situations are the submission of problems based on open-ended situations. The students are asked to explore open-ended situations using knowledge, skills, concepts, and relationships from their previous mathematical experiences. Thus, from the questions posed, students can show into their knowledge, skills, concepts, and mathematical experiences.

One of mathematical abilities that is needed in the submission of mathematical problems is the ability in counting operations. Basic counting operations consist of addition, subtraction, multiplication, and division. Counting operations are the foundation in learning mathematics. If students have controlled the concept of counting operations, it will be very helpful to pose or solve the mathematical problems. In addition, the mathematical experience that the students have been

experienced also supports the activity of posing questions to provide varied results.

The mathematical experiences that are closely related to everyday life such as shopping, discounts, shopping trucks, price lists, and others will be more meaningful in relating mathematics and everyday life (Bonotto, 2011). Social arithmetic is closely related to everyday life. Silver and Cai (Silver and Cai, 1996) conducted study on the posing of arithmetic problems. Social arithmetic learns about the use of algebraic concepts to solve simple economic problems. Social arithmetic material discusses about profit, loss, discounts, interest rate, percentage, buying price, and selling price. It is often encountered by students in everyday life.

In this study, students were given the task of posing math problems. The purpose of the study was to categorize the mathematical problems proposed by students in the terms of counting operations. Teachers can use the result of the study for developing students' creativity related to counting operations.

## 2 METHODS

The type of this study is descriptive research. Data were collected from the 7<sup>th</sup> grade students of MTs Surya Buana in Malang, Indonesia. The material that has been used was Social Arithmetic. The task of posing mathematical problems given to students is the submission of problems without completion. Students are asked to pose as many as possible problems based on the information provided.

The information provided in the problem posing is a word problem accompanied by an illustration. The provision of illustration is intended to clarify the given short story and to attract students' attention and to give the students the freedom to choose the questions from the story provided or from the images provided. The story in the situation/information provided is in the form of an open situation. From the given situation, it is expected that students can issue their creative ideas in asking questions and developing them outside the given situation. Students are given the freedom to change or to add information to the given situation. Information provided to students is presented in Figure 1.

The research procedures carried out are as follows: giving assignment to the 7th grade students. Then, analyzing the results of the problem submission. The problems raised by students were selected in the form of mathematical problems that could be solved. Although in this study students

were not asked to complete it. Furthermore, the categorization of questions submitted by students is carried out. Question categories are presented in Table I.

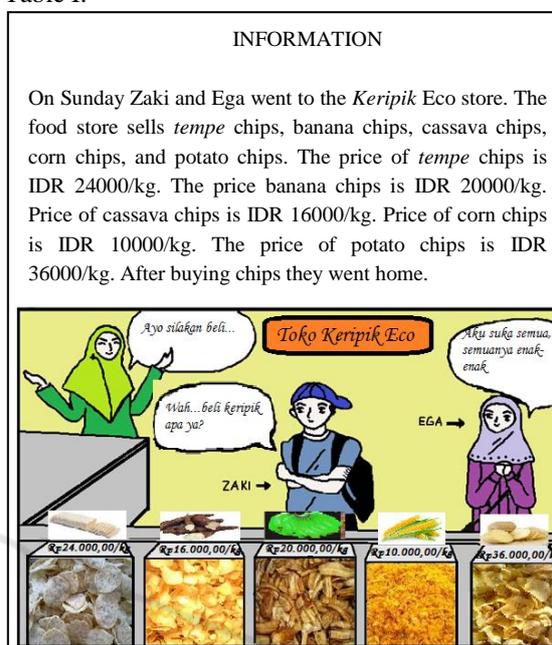


Figure 1: Information given to the students in posing mathematical problems.

Table I: Categories of questions raised by students.

Problem Category	Description
One counting operation	The resulting problem involves only one count operation, which is it can be addition or subtraction or multiplication or division
Two counting operations	The resulting problem involves two counting operations
Three counting operations	The resulting problem involved three counting operations
Four counting operations	The resulting problem involves four counting operations

## 3 RESULTS AND DISCUSSION

### Category of One Counting Operation

The problem that fall into the category one counting operation are presented in Figure 2.

The price of 1 kg of corn chips is IDR 10000 and the price of 1 kg of *tempe* chips is IDR 24000. Determine the difference!

Figure 2: Problems containing one counting operation.

Figure 2 shows that it is known that the problem posed by students contain one counting operation. If the problem posed by the student is gained, the solution will involve only one counting operation, that is subtraction. The price difference between corn chips and *tempe* chips is determined by reducing the price of *tempe* chips with corn chips (the price difference =  $24000 - 10000 = 14000$ ). The students used quantitative information in a given situation without adding some new quantitative information.

Problem that was posed by students involve addition or subtraction or multiplication or division. This shows that in making problems, the students only focus on the information provided and try to ask questions with a low level of difficulty.

#### Category of Two Counting Operations

The problem that meets the category of two counting operations are presented in Figure 3.

Zaki bought 2 kg of banana chips, 1 kg *tempe* chips, and 3 kg of corn chips. How much Zaki should pay?

Figure 3: Problems containing two counting operations.

Figure 3 shows that the problem posed by students contains two counting operations. They are multiplication and addition. There are three stages in finding the solution. The first is determining the purchase price of 2 kg of *tempe* chips, by multiplying 2 kg with 24000 so the result is 48000. The second is determining the purchase price of 3 kg of corn chips, by multiplying 3 kg with 10000 so the result is 30000. The third, finding the total money to be paid, that is  $48000 + 30000 = 70000$ . The problems submitted contain new quantitative information, namely 2 and 3. This shows that in formulating problem, the students are not only focus on the information provided, but also, they associated with their experiences. When the problem in Figure 5 is compared with the problem that fall into the category of one counting operation, the problem in this category is more complex.

#### Category of Three Counting Operations

The questions that fall into category of three counting operations are presented in Figure 4.

Ega bought 2 kg of potato chips and apparently got a 10% discount. How much money must be paid?

Figure 4: Problems containing three counting operations.

Figure 4 shows that the problems posed by students contain three counting operations, they are multiplication, division, and subtraction. There are three stages in solving the problems in Figure 4. First, the price of 2 kg of potato chips is calculated as  $2 \times 36000 = 72000$ . Second, the amount of the discount is calculated, which is  $72000 \times 10\% = 7200$ . Third, the amount of money that must be paid after the discount is  $72000 - 7200 = 64800$ . At the time of determining the discount, there are two counting operations involved namely multiplication and division. There is new quantitative information added which is 2 kg and 10% discount. This shows that students think they are developing, not just focusing on the information provided. The questions raised are also more complex than the questions that fall into the category of one and two counting operations.

#### Category of Four Counting Operations

The questions that fall into the category of four counting operations are presented in Figure 5.

Ega bought 4 kg *tempe* chips, 3 kg corn chips, 2 kg potato chips, 1 kg cassava chips. Because Ega buy a lot of things, finally Ega get a 25% discount. Hence, how much Ega should pay?

Figure 5: Problems containing four counting operations.

Figure 5 shows that the problem posed by students contains four counting operations, namely multiplication, addition, division, and subtraction. There are seven stages of problem solving. First, the price of 4 kg of *tempe* chips is calculated which is  $4 \times 24000 = 96000$ . Second, the price of 3 kg of corn chips is calculated, namely  $3 \times 10000 = 30000$ . Third, calculated the price of 2 kg of potato chips, namely  $2 \times 36000 = 72000$ , Fourth, calculating 1 kg of corn chips which is 16000. Fifth, the total price of chips purchased is  $96000 + 30000 + 72000 + 16000 = 214000$ . Sixth, calculated a discount of 25% that is  $214000 \times 25\% = 53000$ . Seventh, the amount of money that must be paid after applying the discount is  $214000 - 53000 = 160500$ . New quantitative information added are 4 kg, 3 kg, 2 kg, 1 kg, and 25% discount. New quantitative information added more when compared to questions included in categories one, two, and three counting operations. This shows that students develop the form of problems and not only focus on the information

provided. The problem posed is more complex than the three other problems.

## 4 CONCLUSIONS

There are four categories of problems posed by students, which contain one counting operation, two counting operations, three counting operations, and four counting operations. The characteristics of problems that fall into category one are involving one count operation, the absence of new quantitative information and the low complexity of the question. This shows that the source of ideas in posing problems comes from the situation/information provided. The characteristics of the problems included in the second category involved two counting operations, new quantitative information and at least two steps in solving the problem. The characteristics of the problems included in the third category contain three counting operations, new quantitative information and at least 3 steps to solve the problem. The number of quantitative information in the problem of third category is greater than the categories in the second categories shows that the students begin to develop out of the given situation. The characteristics of the problems in the fourth category involve four counting operations, the presence of new quantitative information, at least 4 steps to solve the problem, and the development of the form of the problem that was posed out of the given situation. The development of the posed problems in the fourth category can be seen with more new quantitative information added and the problems posed are more complex than the first, second, and third categories.

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