Students’ Creativity: Problem Posing in Structured Situation

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Abstract. This is a qualitative research concerning on students’ creativity on problem posing task. The study aimed at describing the students’ creative thinking ability to pose the mathematics problem in structured situations with varied condition of given problems. In order to find out the students’ creative thinking ability, an analysis of mathematics problem posing test based on fluency, novelty, and flexibility and interview was applied for categorizing students’ responses on that task. The data analysis used the quality of problem posing and categorized in 4 level of creativity. The results revealed from 29 secondary students grade 8, a student in CTL (Creative Thinking Level) 1 met the fluency. A student in CTL 2 met the novelty, while a student in CTL 3 met both fluency and novelty and no one in CTL 4. These results are affected by students’ mathematical experience. The findings of this study highlight that student’s problem posing creativity are depend on their experience in mathematics learning and from the point of view of which students start to pose problem.

1. Introduction
Creativity is the important component for nation advancement. Nation advancement is influenced by education, one of them is mathematics. Then creative thinking is important for mathematics [1, 2]. Creativity is processed to create new ideas that are appear which is the process or the result and involve originality [3].

Problem posing task is very important because it can improve students’ abilities to pose questions, and one that is considered important in Indonesian curriculum. However, based on observation, students abilities in posing questions were considered as poor, so problem posing task is needed. Problem posing is defined as tasks designed by teachers that require students to create one or more questions [1, 4]. Most students in Canada are only given an amount of task to solve mathematical problems posed by a teacher or those that appear in the book [5]. Therefore, students are only capable to solve mathematical problems without posing them. The students' mathematical experience is incomplete if it has never had given a chance to solve a problem made by themselves [7]. By using the problem posing, students are exposed to complex situations that make them feel responsible [7]. In addition, posing a problem gives students a sense of belonging to math. Education in America, China, and Italy emphasize the problem posing as necessity in a learning process of mathematics [8, 9, 10].

There are three situations of problem posing such as free, semi-structured, and structured situations [11]. In free situation students pose problems without limitation, semi-structured situation students are given an open situation and invited to explore the structures in the situation and facilitate them using the knowledge, skills, concepts, and relationships of their previous mathematical experiences, while in
structured situation students pose problem by varying the existing situation therefore requires high creativity. Problem posing plays a role in determining student creativity. Creativity is understood as the cognitive ability to create and discover. While problem posing refers to generate something new or revealing something new from a set of data that requires creativity [2]. The ability to pose a problem is a sign of creativity therefore there is a close relationship between problem posing and creativity [2, 3, 12]. Hence, problem posing can be in the form of testing a creative thinking.

The structured situation is a problem posing situation that is rarely analyzed [7]. Researchers analyzed teachers’ mathematical problem posing in a structured situation and their difficulties [7]. However, they just analyzed in ratio and proportion topics. Another study about assesses students’ creativity in mathematics [13]. In this study, students posed mathematical problems than assessed based on fluency, flexibility, and novelty. The situation used is semi-structured problem posing. However, this study directly analyzes using three components without analyzing the quality of students’ problem posing. Study about structured situation on students of grade 8 and 9 to modify it conducted by Stoyanova & Ellerton [11]. However, they just wrote about the framework.

Therefore, this study aimed to investigate and describe students’ creativity in problem posing. The situation used is structured situation. Problems posed by students analyzed based on quality of problem posing [9, 14]. Then they analyzed based on fluency, flexibility, and novelty. This qualitative research used the test of problem posing and interview.

2. Method
This qualitative study was conducted on 29 junior high school students in Surabaya Indonesia, in which 3 students with different creative thinking level at level 1, 2, and 3 are taken. The data used in this study were collected from February to March 2016. The instrument used is the test of problem posing that used to analyze creative thinking level. Data collection used tests and interviews. Test done during 60 minutes with a situation and students posed at least 3 problems. Each student was interviewed during 20 minutes. The aim of this interview is to know deeply about the student consistency in that level by using questions which concern to fluency, flexibility, and novelty.

Problems posed by students analyzed based on mathematics problem, non-mathematical problem, irrelevant mathematical problem; plausible or implausible mathematical problem; problem with sufficient or insufficient information [9, 14]. Then they analyzed based on fluency, flexibility, and novelty [12] and grouped in CTL. The indicators of CTL that is used in this study explain in Table 1.

| Level          | Characteristic of Creative Thinking Level                                                                 |
|----------------|----------------------------------------------------------------------------------------------------------|
| Level 4 (Very Creative) | Students satisfied all components of creative thinking or only flexibility and novelty in posing problems. |
| Level 3 (Creative) | Students were fluent and then they were flexible or demonstrate novelty.                                 |
| Level 2 (Quite Creative) | Students were able to show flexibility or novelty in posing problems without fluency.                     |
| Level 1 (Almost Not Creative) | Students were able to show fluency without novelty and flexibility in posing problems.                   |
| Level 0 (Not Creative)  | Students were not able to show any components of creativity.                                              |

Adapted from reference [15]

3. Results
Students posed at least 3 problems. The results obtained by all the mathematical problems posed are plausible questions of the 69 mathematics problems posed. Students posed 64 plausible mathematical problems with sufficient information of a total of 69 plausible mathematical problems. Of the 64
problems posed by students are analyzed based on fluency, novelty, and flexibility then grouped based on CTL. The results were no student in CTL 4, there were 2 students in CTL 3, a student in CTL 2, there were 14 students in CTL 1, and 12 students in CTL 0. Because there is no student was on CTL 4, so the researcher only took a student from each of CTL 1, 2, and 3. Here are the problems, answers, and interviews of selected students.

Two sailors travel from Jakarta to America. They carry 2 ships, the first ship contains 250kg of meat, 600kg of flour, and 1200kg of potatoes. In the second ship, the number of potatoes is increased which is 300kg from the first ship, while the amount of meat and flour equal to the first ship. Due to the long sailing time, the total decaying potatoes on both ships are 245kg. Pose mathematics problems by varying the given situation and define the solutions. Varying the problem can be done by adding information or modifying a given situation.

**Figure 1. Structured Situation Used in Research**

3.1. **Student in CTL 3**

A Student in CTL 3 posed three problems and solution shows in Figure 2.

The student posed the first problem of the given situation about the total potatoes if the rotten potatoes is removed. It is about addition and subtraction. There were 2 ways but the same ways, just differ in the order of working step. The researcher interviewed the student to make the answer in another way, but she did actually the same way by applying the concept of integer operations which is \((1200 \times 2) + 300 – 245\). Therefore, student did not meet flexibility.
The second problem posed by the student was unclear information in the problem, based on interview results obtained that the problem number 1 happened is like a given situation but the rotten potatoes are thrown away. After the potatoes are removed, the number 2 ship gets lost and the food is taken by the crew, after being taken, the remainder is brought to America.

The student posed problems by adding information from the given situation. The answer was the correct answer. The concept used was different concept from problem number 1. The concept on problem number 1 is the concept of integer operation while the concept used in problem number 2 included the concept of fractions. The context is a different context because of the addition of different information included. So student met the novelty. A student could not solve in different ways. Student only solved 1 correct answer. So she did not meet the flexibility.

The third problem required an explanation through interviews. Based on the interview results from problem number 3, she can explain it as follow:

Researcher: What do you mean by what is the total price of potatoes, do you mean that the potatoes at the beginning?
Student: After being eaten by the crew, what is the total price of potatoes when the price of potato in America is Rp 100,000,00 / kg?

After explained through the interview, the question posed had the correct answer. The same concept used is the integer operation but the context used is different, by adding information. So, the student met the novelty.

Of three questions posed by the student have correct answers and based on interview therefore she met fluency. So it can be concluded the student met fluency and novelty so she is in CTL 3.

3.2. Student in CTL 2

Student in CTL 2 posed three problems and solution shows in Figure 3.

Figure 3. Problems and Solutions Posed by Student in CTL 2

Student poses the first problem with the wrong answer so it is not included in the analysis to determine the creativity. The second problem needs to be clarified through interviews. Based on the interview, the second problem means:

Researcher: Can you explain more about your problem?
Student: The second ship is almost drowned by the halfway travel time. Sailors managed to save 150kg of meat, 400kg of flour, and 500kg of potatoes. What is the amount of food (in kg) on the ship if all the potatoes are decomposed on the first ship?

In the middle of the journey, the second ship almost disappear. The sailor is success to save 150kg meats, 400kg flours, and 500kg potatoes. What is the number of food if all the rotten potatoes in the first ship?

In the America, All of food is taxed a dollar every 5kg. What is the tax must be paid?
Potatoes are decaying 245kg on first ship. It is the continue of story number 1 so the second ship was only 150kg of meat, 400kg flour, and 500kg of potatoes. The second question is a problem with addition of information from the given situation and correct answer.

The third problem is a different context from the first and second problems that have been posed. It is about tax, when arriving in America, all food is taxed. Per 5 kg is 1 dollar. How much tax is charged?. On the third problem, the student posed the problem with the correct answer with the addition of information. Problem number 3 is the continuation of the problem number 2 therefore the tax is the remaining items in question number 2. This showed that the student could clarify the information in question number 3.

Based on the information above, the student posed 2 problems of different context with the correct answer. Then it can be concluded that the student met the novelty. But the student only posed 2 questions with the correct answers, the student could not answer in different ways he did not meet the flexibility and fluency thereof. So it can be concluded the student is in CTL 2.

3.3. Student in CTL 1

Student in CTL 1 posed problem and solution shows in Figure 4

![Figure 4. Problem and Solution Posed by Student in CTL 1](image)

The student posed three problems with the same concept about the addition of integers. The context used is also the same context. The answers of three problems are the correct answer but the student could not solve in a different way. Based on the information above, the student posed 3 different problems that have the same concept and context. Then it can be concluded that the student met the fluency. So, it can be concluded the student is in CTL 1.

Based on the interview, students in CTL 1, 2, and 3 use the previous mathematical experience. It can be seen in this interview

A Student in CTL 1: My teacher has taught me the problems like these.
A Student in CTL 2: I pose them based on the books which I have read before.
A Student in CTL 3: I have read some questions in magazine about mathematics quiz so I use that experience

Students also pose the problem by think through the answers first. It can be seen one of student’s interview script

A Student in CTL 3: I think the answer first because I am afraid if I pose the problem first then there is no answer that satisfy this problem

4. Discussion

Based on the result of this research, no student met the flexibility component because students solve the problem in one way or in two ways but by using the same ways. Therefore, no students satisfied CTL 4 (very creative). The characteristic of CTL 4 is students satisfied all components of creative thinking or only flexibility and novelty in posing problems [15]. So flexibility is emphasized on CTL 4. Students did not satisfy flexibility because they are unusual to use more than one way to solve a problem or they did not have experience about that. This result is the same as the result of the research that no students in CTL 4 because did not have the experience to solve in more than a way [16]. It shows that mathematical experiences are important in posing problems [11].

The highest level that reached by the student is in CTL 3, she met the novelty and fluency. She posed 3 plausible mathematical problems with sufficient information and correct answers. The concept used
in one problem is different from another. There is additional information on the problem so it has a different context with the previous problem. It is a little bit different with one of the research result. The result is students pose similar problems, but in this result of research student pose problems from the given situation with additional information [7]. This shows that she met fluency and novelty. It appropriate with the theory that students in CTL 3 were fluent and then they were flexible or demonstrate novelty [15].

Student in CTL 2 posed 2 problems, both of these have additional information so the context used is different. So he met novelty, in accordance with the theory if the students satisfy the novelty or flexibility component then the student in CTL 2 (quite creative) [15]. Student who met fluency is in CTL 1 [15]. The concept used in the three problems is the same concept given. The context used is the same context as the given situation without any additional information.

The way for posing the problem is by thinking through the answers first and using the previous mathematical experience. That result same as the research result that student uses the previous mathematical experience for posed problems but there are some different points which are students posed problems by thinking outside of the box, start with mathematical concepts and relate to real life, and come up with relevant concepts and connect them [17].

5. Conclusion
Based on the results of the study, we conclude that the creativity of students in posing the problem depends on the experience of students in learning mathematics. The more students experience in learning mathematics the more creative the students are also in posing the problem. Beside the learning experience, the students’ creativity in posing the problem also depends on the students’ way in posing the problem. Some are guided by the answer first, and also directly pose the problem by looking at different points of view from a known problem.

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