Students’ creative thinking ability in learning mathematics through learning model of Logan Avenue Problem Solving (LAPS) – Heuristic

U Husna, C M Zubainur and B I Ansari
Syiah Kuala University, Jl. Teuku Nyak Arief Darussalam, Banda Aceh 23111, Indonesia
Email: cutmorinazubainur@unsyiah.ac.id

Abstract. Students’ mathematical creative thinking ability has not met the expectation. One of the efforts to develop creative thinking ability is implementing the learning model of LAPS-Heuristic. This paper focuses on the development of students’ mathematical creative thinking ability through the LAPS-Heuristic model. The learning instruments used in the LAPS-Heuristic model have been developed through the ADDIE development model. The data were students’ achievement on mathematical creative thinking ability obtained from the pilot test. This test is part of the implementation stages of the ADDIE model. The participants were 30 students in grade 8 of a junior high school in Banda Aceh, Indonesia. The results show that the development of students’ mathematical creative thinking abilities during the learning with the LAPS-Heuristic model varied. The indicator of fluency and flexibility decreased in the second meeting but was followed by an increasing result in the subsequent meetings. The indicator of originality had an increasing result at the third meeting and remained the same for the following meeting. Meanwhile, the elaboration indicator showed an increasing result in each meeting. Overall, the development of students’ mathematical creative thinking abilities could be developed by maximizing the heuristic questions posed to students.

1. Introduction
Mathematical creative thinking is an ability that students should develop through mathematics learning. This ability is a part of high order thinking skill which should be acquired by students to solve mathematical problems. This mathematical skill is necessary to develop the ability to think and to reason [1].

The ability to think creatively includes the aspects of fluency, flexibility, originality, and elaboration [2]. Fluency is the ability to spark different ideas, answers, ways or suggestions for solving a problem or answering a question. Flexibility is the ability to generate various ideas, alternative solutions or questions to see a problem from different perspectives, and to change the way of thinking. Originality is the ability to create a new and unique response. The originality aspect relates to the ability to construct and make an unusual combination of mathematical procedures. Elaboration is the ability to develop ideas or products. It is also concerned with the ability to find out the details of an object, idea or situation to be something more interesting to explore. Those all abilities can be developed through problem-solving activities. The activities can stimulate students to find multiple solutions or ideas [3].
Generally, students’ mathematical creative thinking abilities have not met the expectation. This is because the creativity aspect still gets less attention compared to other aspects of learning mathematics. The problems presented in the class are not challenging enough and do not give the students the opportunity to use a variety of strategies. The problems given generally have a single way of completion so that students are not used to doing creative thinking. [2].

It is necessary to develop the ability of students' mathematical creative thinking through learning that can generate students’ creative thinking abilities to solve mathematical problems [4]. One of the efforts that can be done is implementing the learning through the model of Logan Avenue Problem Solving (LAPS)-Heuristic. Learning with the LAPS-Heuristic model can create a sense of curiosity and motivation that makes students more creative [5]. The learning with the LAPS-Heuristic model consists of understanding the problem, planning the solution, solving the problem, and reviewing the solutions [6].

The researchers have developed learning instruments with the LAPS-Heuristic model as an effort to help foster students' mathematical creative thinking abilities. The purpose of this paper is to discuss the development of students' mathematical creative thinking abilities during the learning with the LAPS-Heuristic model using the learning instruments that have been developed.

2. Method
The learning instruments with the LAPS-Heuristic model to foster students' mathematical creative thinking abilities have been developed using the ADDIE development model [7]. The learning instruments developed have fulfilled the validity and practicality criteria based on the recommendations from experts, practitioners, and pilot test. This paper describes the development of students' mathematical creative thinking ability through the LAPS-Heuristic model. This model was implemented in five meetings of the class session on proportion topic. Students were taught the concept of proportion in the first meeting and the concept of ratio in the second meeting. Then, the students learned direct proportion in the third meeting, and inverse proportion in the fourth and fifth meetings.

Data on the development of students' mathematical creative thinking ability was obtained through a test of mathematical creative thinking ability given at the end of each class session. This study involved 30 students in grade 8 of a junior high school in Banda Aceh, Indonesia. The data was analyzed by examining student’s strategies using a rubric of mathematical creative thinking ability.

3. Result and discussion
The results show that students’ creative thinking ability during learning with Logan Avenue Problem Solving (LAPS) –Heuristic model developed variously. Indicators used to measure creative thinking ability include fluency, flexibility, originality, and elaboration [2]. Students meet the fluency indicator if they can provide more than one solution with the same concept. Flexibility indicator is achieved if students can provide multiple solutions involved different concepts. Students meet the originality indicator if the solution given is novel and different from the solution of the majority of students. Students attend the elaboration indicator if their solution is explained in detail.

The percentage of the number of students met the fluency indicator for mathematical creative thinking ability reached 70% in the first meeting, 60% in the second meeting, 73.3% in the third meeting, 66.66% in fourth meeting and 83.33% in the fifth meeting. This finding shows an improvement on the fluency indicator at the first, third and fifth meetings. The students could understand the concept of proportion so that the solutions given were varied and involved the same concept. On the other hand, at the second and fourth meetings, the number of students who met the indicator of fluency decreased from the previous session. The questions for the fluency indicator given at the second meeting were more difficult than the questions presented at the first meeting. Besides, in the first meeting, the students discovered the concept of direct proportion using manipulatives so that the concept they had is more profound than the concept they got in the second meeting. At the fourth
meeting, the students made mistakes in solving inverse proportion problems; they used the concept of direct proportion to solve those problems.

An example of the student's answer regarding the fluency indicator at the first meeting is shown in Figure 1. On the problem, the student was asked to determine some forms of direct proportion from the statement: “The number of Honda motorcycle is three times more than the number of Yamaha motorcycle with the ratio of 3:1.”

![Figure 1. A student's answer that met the fluency indicator.](image)

Moreover, the percentage of the number of students who met the flexibility indicator at the first meeting was 53.33%, at the second meeting was 50%, at the third meeting was 70%, at the fourth meeting was 73.33% and at the fifth meeting was 80%. The students' creative thinking ability for the flexibility indicator had improved. However, it decreased by 3.3% at the second meeting compared to the percentage in the first meeting. This happened because the students were not used to solving problems in different ways. To deal with this situation, teachers should sharpen the heuristic questions further in the next meeting to train students to solve problems in various ways.

Heuristic questions posed by teachers allowed students to be more explorative and creative in solving the problems. Examples of the heuristic questions are “What information do you obtain from the problem given?”, “Please write the information you get with your own words,” “Is the information provided has been already complete?”, “How do you solve the problem?”, and “Is there any other ways to solve the problem?”.  

![Figure 2. The problem for the flexibility indicator in the third meeting.](image)
Figure 3. Example of a student’s answer that met the flexibility indicator in the third meeting.

Figure 3 shows an example of a student's answer regarding the flexibility indicator. In that problem (see Figure 2), the students were required to provide more than one solution with different concepts. Based on the student’s answers, the student could provide more than one solution with different representations, i.e., equations, table, and graph.

Furthermore, the students who met the originality indicator reached 13.33% in the first meeting, 10% in the second meeting, 16.66% in the third meeting, 10% in the fourth and fifth meetings. The students’ creative thinking ability improved only in the third meeting. The students who met the originality indicator used various and novel ways of solving problems while the other students generally gave the same solution. The problem with the originality indicator is shown in Figure 4, and an example of a student’s answer that met the originality indicator is presented in Figure 5.

Andi wants to travel by car. He spends IDR 135,000 for the gas to drive a distance of 50 km. If Andi has IDR540,000 for gas, how many km Andi could travel? Solve the problem using a novel strategy.

Figure 4. The problem for the originality indicator in the third meeting.

Andi wants to travel by car. He spends IDR 135,000 for the gas to drive a distance of 50 km. If Andi has IDR540,000 for gas, how many km Andi could travel? Solve the problem using a novel strategy.

Figure 5. Example of a student's answer that met the originality indicator in the third meeting.
Generally, the students solved the problem (see Figure 4) using the form of logic, proportionality, and summation. Figure 5 is a student's answer that used summation.

Furthermore, the finding shows that the percentage of the number of students who met the elaboration indicator was 40% in the first meeting, 60% in the second meeting, 73.33% in the third meeting, 74.07% in the fourth meeting and 83.33% in the fifth meeting. This percentage shows that the students' creative thinking ability on the elaboration indicator kept increasing in every meeting. The heuristic questions helped them solve the problem in detail. The problem for the elaboration indicator in the fifth meeting is provided in Figure 6, and an example of student's answer is shown in Figure 7. The answers given by the students shows that the students were able to elaborate on their answer began with understanding the problem, planning a solution, solving the problem, and drawing a conclusion.

Mr. Lukman is a chicken farmer. At the beginning of a month, Mr. Lukman has 480 chickens. The chickens could finish 80 kg of chicken feed within a week. Mr. Lukman buys 8 bags of the chicken feed (1 bag contains 120 kg) in one time. After he sells his chickens, there are 160 chickens left on his farm. Mr. Lukman needs your help to find how many months he could feed the 160 chickens with the amount of the feed left.

Figure 6. The problem for the elaboration indicator in the fifth meeting.

Figure 7. Example of a student's answer that met the elaboration indicator in the fifth meeting.

Overall, the development of students' creative thinking ability varied. At the beginning of the meetings, the students’ ability on indicators of fluency, flexibility, and originality had not improved yet because the students were less interested in solving problem-based tasks. Teachers tried to motivate the students to explore multiple strategies to solve problems by asking heuristic questions. Heuristic questions helped students to develop their thinking process to reveal new relationships, see new things and form new combinations of two or more concepts that had been learned before. In this way, the teachers could help develop students' creative thinking abilities [8].

However, some students still did not follow the steps of problem-solving as required. The students preferred to complete the problems quickly without thinking of other possible strategies. The students needed more time to get used to solving the problems that require multiple strategies. This is because the students were familiar with routine problems that only have a single correct answer. This condition needs to be changed to help the students develop their mathematical abilities [9,10].
Improving mathematics learning could be done by conditioning the students not only as listeners but also as active students that eager to search for information useful to solve problems. The students also need to learn the most crucial aspect in solving mathematical problems; that is, the process of finding the right solution involving the higher order thinking process [11] through problem-based tasks. The problem-based tasks allow the students to generate curiosity and motivation, to develop creativity, to analyze problems, to evaluate the results obtained, to get new solutions, to found and use various strategies, and to integrate new and prior knowledge.

4. Conclusion
Based on the results of this study, it can be concluded that the creative thinking ability of junior high school students through Logan Avenue Problem Solving (LAPS) -Heuristic model varied for each indicator. The development of students' creative thinking ability during learning through the LAPS-Heuristic model for the indicator of proficiency decreased by 10% in the second meeting, but it showed a progress in the next meeting. For the indicator of flexibility, there was a decrease of 3.3% in the second meeting while in the next meeting, the students experienced an improvement. For the indicator of originality, there was an improvement in the third meeting. The improvement also occurred in each meeting for the elaboration indicator. The development of creative thinking ability in solving problems is also supported by the heuristic questions. Therefore, it can be concluded that the LAPS-Heuristic model can be used to improve students’ creative thinking abilities.

References
[1] Kwon O N, Park J S and Park J H 2006 Cultivating divergent thinking in mathematics through an open-ended approach Asia Pacific Education Review 751
[2] Munandar U 2004 Pegembangan Kreativitas Anak Berbakat (Jakarta : Rineka cipta)
[3] Silver E A 1997 Fostering creativity through instruction rich in mathematical problem solving and thinking in problem posing ZDM 2 1615
[4] Coelho A and Cabrita I 2015 A creative approach to isometries integrating geogebra and italic with ‘paper and pencil’ environments Journal of the European Teacher Education Network 10 71
[5] Anggrianto and Desi N 2016 Improving critical thinking skills using learning model Logan Avenue Problem Solving (LAPS)-Heuristic Journal of Education and Practice 7 67
[6] Shoimin A 2014 68 Model Pembelajaran Inovatif Dalam Kurikulum 2013 (Yogyakarta: Ar Ruzz Media)
[7] Branch R M 2009 Instructional Design: The ADDIE Approach (USA: Springer. Science Business Media)
[8] Siswono T Y E 2010 Leveling students’ creative thinking in solving and posing mathematical problem IndoMS. J.M.E 1 17
[9] Polya G 1985 How to solve it : A new aspect to mathematical method (Princeton: Princeton University Press)
[10] Švecová V, Rumanová L and Pavlovičová G 2014 Support of pupil's creative thinking in mathematical education Procedia-Social and Behavioral Sciences 116 1715
[11] Bey A 2014 Developing skills resolution mathematical primary school students International Journal of Education and Research 2 601