Creative thinking process of female elementary school student with visual learning style in mathematical problem solving

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Abstract. In solving mathematical problems, the creative thinking process is basically assessed based on two indicators: creative processes and products. The creative process is the stage of creative thinking that includes generating ideas, planning problem solving, and producing problem solving. The process generates creative products should meet the aspects of fluency, flexibility, and novelty. The present study aims at describing the creative thinking process of elementary school students in solving mathematical problems. It involved female student who practiced visual learning style as the subject with the consideration the subject could generate a flexible product, but not an extraordinary product that meets the aspects of fluency and novelty.

Data was collected through test and in-depth interview. The validity was done with data triangulation technique. The collected data were analyzed with transcription, categorization, reduction, interpretation and conclusion. The findings indicate that the creative thinking process of elementary school students in mathematical problem solving is realized through generating ideas (reading and examining images in the question) to identify information that is already known, to employ different approaches for planning problem solving, and to produce creative products that meet the aspect of flexibility. Nevertheless, the products have not fulfilled the aspects of fluency and novelty.

1. Introduction

Thinking is a primary mental activity manifested in the form of behaviors. Likewise, [1] claimed that thinking is a mental process that is not exactly noticeable, yet it is indicated from one’s behavior. [2] argued that creative thinking is a behavior to find new relationships in accordance with a topic from different perspectives, and to create new combinations of concepts in one’s mind. Meanwhile, [3] explicated that creative thinking is the ability to expose new relationships, see concepts from different perspectives, and generate new combinations from two or more disparate concepts.

Furthermore, [4] suggested creative thinking is the ability to think differently or called divergent thinking. It is the capacity to generate new ideas that meet aspects of fluency, flexibility and novelty. The creative thinking process consists of three stages: generating ideas, planning solutions, and producing problem solving. Similarly, Krathwohl and Anderson in [5] explained cognitive processes in terms of creativity, which include generating, planning, and producing. Generating ideas involves divergent thought process that suggests possibilities for problem solving. Generating ideas is a divergent process that suggests possibilities for problem solving. It implies that problem solving entails the phase of investigating, finding or asking. In addition, it can also be done by exploring information based on...
former experiences and/or on-going learning process. Essentially, the process will lead to planning and subsequently, producing solution that meets the aspects of fluency, flexibility and novelty.

Furthermore, [6] asserted that mathematical creative thinking skills can be defined as an orientation or disposition toward mathematical instruction, including discovery and problem solving tasks. Such activities potentially bring students to develop creative approaches in mathematics. A study on creative thinking in solving mathematical problems [7] found the necessity of stimulus for students with relatively low skills to solve problems creatively. Moreover, students with verbal skills relatively have higher ability to solve problems in terms of fluency. Similarly, Evans in [8] claimed that creativity as the ability to find new relationships, conceive subject matter in a new perspective, and generate new combinations of concepts that already exist in one's mind.

Learning style is a key in the development of individual performance at work or school environment, as well as in interpersonal situations. In fact, the level of skills to learn, understand and absorb subject matter is diverse. Some students are excellent, while others are moderate or slow. So far, there is a specific learning style focused on leaning by seeing called the 'visual learning style'. Through this style, visual learners will prefer using colors, images and so forth. In addition, [9] affirmed that visual learners have a propensity to focus more on the sharpness of their sights.

In addition to learning style, gender becomes a factor in the level of skills. In the present study, gender refers to male and female. Previously, [10] claimed that men are superior to women in mathematical and mechanical skills, accuracy, precision and thinking ability. Meanwhile, women are inclined to excel in verbal abilities, yet less capable of abstract reasoning and logical thinking. The American Psychological Association (Science Daily, 6 January 2010) in [11] reported that according to a new analysis of international research, girls around the world are not worse at math than boys. Furthermore, although men are more confident in their math abilities, and women from countries where gender equity is more prevalent are more likely to perform better on mathematics assessment tests. In physical activities and motor skills, boys are temperamentally more active than girls thus they tend to have difficulties to sitting calmly for a certain time, being less enthusiast in reading, and often having tantrums in class.

The present study aims at describing the creative thinking process of elementary school students in solving mathematical problems. Creativity or creative thinking is included in the 21st century skills that have been identified as being required for students to face a more complex life than today. Early age stimulation is important to optimally foster students’ creative skills. Ayan in [8] explicatd that 90% of originality is generated at the age of 0-5 while 20% is generated at elementary school ages. Only 2% is generated in adulthood. Buzan in [8] also declared that 70–90% of creative groups are in kindergarten ages, 50–70% of them are in elementary school ages, and the rest is in secondary school ages. The phenomenon triggers the importance to carry out a study on the creativity of elementary school students.

2. Methods
The present study is a qualitative research. It involved the 5th grade female students of a private elementary school in Ambon City, Maluku, Indonesia, as the subjects. These students practiced visual learning style with the mathematical skills score of 83. The decision to prefer female students who implemented visual learning styles was made with considerations: 1). They sufficiently mastered knowledge and experiences in basic mathematics, i.e., natural numbers, whole numbers, integers, rational numbers, and geometry, especially flat planes; 2). The given materials stimulate the emergence of creative thinking processes as the foundation of the next levels.

The instruments of data collections included the assessment of student learning style, problem solving test, interview guidelines, and audio video recorder. The instrument of student learning style assessment was the modification of the Swinburne University of Technology VAK Learning Styles Self-Assessment Questionnaire translated by the Language Center of Universitas Negeri Surabaya. It was validated by experts and a counseling teacher. Meanwhile, the problem-solving test was developed in the present study. The problem is presented below.
**Problem:**

Pak Hendra has an area in the shape of a right-angled trapezoid as illustrated in Figure 1 below, in which AD = 60 m, AB = 45 m, and BC = 20 m. He will divide this area equally for his two children to inherit.

a. How Pak Hendra divides it so his children will obtain equal size, precisely? (Make a sketch).

b. Determine several ways to divide it!

![Figure 1. A right-angled trapezoid.](image)

The collected data were analyzed by initially carrying out transcription of data obtained from observation and interviews. Validation was done by comparing the data of test and interviews. Data analysis included data categorization, data reduction, data interpretation, and conclusion.

3. **Results and Discussion**

The collected data were the results of written test and in-depth interviews. Data collection was done twice. First, it was carried out on 31 March 2017 until 7 April 2017 in the 5th grade class. Second, it was conducted on 14 to 21 April 2017 at the same room but on extra hours and supervised directly by the homeroom teacher.

Based on data analysis, the creative thinking processes of the subjects in solving mathematical problems include generating ideas, planning the problem solving and producing problem solving. These processes are elucidated as follows.

3.1. **Generating Ideas**

The results of observation and in-depth interviews indicated that during the test, the subjects read the question twice and examined the right-angled trapezoid meticulously. These activities generate ideas of identifying the information that is already known and the point of the question, correctly and completely. It is in accordance with the excerpts of in-depth interview with a subject as follows:

*Researcher*  
Take the test, please. (Researcher distributed the test and worksheet to the subjects).  
(Read the question and examined the Figureure).

*Subject*  
Well. Explain the information given on the question and what is the problem?

*Researcher*  
Yes, Pak. The area possessed by Pak Hendra is in the shape of right-angled trapezoid in which AD = 60 m, AB = 45 m, and BC = 20 m. He will divide it into two areas with the same size and give it to his two children. The problem is..(The subject read the question once more).

3.2. **Planning Problem Solving**

Based on the observation and in-depth interview with a subject, the result is clarified as follows:

*Researcher*  
What is your plan to solve this problem?
Initially, I will draw a right-angled trapezoid and convert it into a rectangle by dividing the right-angled trapezoid into two rectangles. Subsequently, I will calculate and determine the width of each area using the precise formula.

Based on the interview, there were several steps carried out by the subject. Firstly, the subject would draw a right-angled trapezoid and divide it into two equal rectangles (A and B). Subsequently, the subject would divide the B area into two since a part of this area should be owned by another child. The next step was to calculate and determine the area using the precise formula.

Furthermore, the subject also planned the second plan as an alternative to solve the problem, which was different from the previous one, yet the method was similar. In the second plan, the subject would begin by drawing a right-angled trapezoid. The Shape would be divided into two equal rectangles: A for the first and B for the second child. Subsequently, the subject would divide B area into two right triangles with the same size. The area would be calculated and determined using the precise formula.

As the third plan, the subject would divide the right-angled trapezoid into three areas of A, B and C. Subsequently, the subject would calculate and determine the width of each part by using the precise formula. The subject clarified the plans during the interview.

Researcher: Is there another different plan from the previous one to divide this right-angled trapezoid into two areas with equal size?

Subject: (The subject was thinking considerately for a while) Yes, Pak. Initially, I will divide AD = 60 meter into six, 10 m for each. Next, I will divide AB = 45 m into three, 15 m for each, and draw it.

3.3. Producing problem solving

Based on the first plan, the subject solved the problem by initially drawing a right-angled trapezoid and dividing it into two equal areas of A and B. Area A was intended for the first child in the form of rectangle with a length of 20 m and a width of 45 m. Thus, A is \( L_1 = p \times l = 20 \text{ m} \times 45 \text{ m} = 900 \text{ m}^2 \). Meanwhile, area B for the second child is a rectangle with area of \( L_2 = \frac{1}{2} (p \times l) = \frac{1}{2} (40 \text{ m} \times 45 \text{ m}) = 900 \text{ m}^2 \). The solution resulted from the first plan produces equal areas for the first and second child. The excerpt of the interview is presented below.

Researcher: Well, based on your first plan, how do you solve this problem of land distribution?

Subject: Here, Pak! (The subject started by drawing a right-angled trapezoid and continued with a rectangle (Figure 2).)

Figure 2. Problem solving of the second

Subsequently, the subject solved the problem in accordance with the second plan, namely by dividing the right-angled trapezoid into three areas. The first area was intended for the first child in the shape of rectangle A in which \( L_1 = 900 \text{ m}^2 \). Meanwhile, the other areas were intended for the second child in the

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Subsequently, the subject solved the problem in accordance with the second plan, namely by dividing the right-angled trapezoid into three areas. The first area was intended for the first child in the shape of rectangle A in which \( L_1 = 900 \text{ m}^2 \). Meanwhile, the other areas were intended for the second child in the
shape of right triangles of B and C (Figure 2), in which 

\[ L_2 = \frac{1}{2} (a \times t) + \frac{1}{2} (a \times t) = \frac{1}{2} (45 \text{ m} \times 20 \text{ m}) + \frac{1}{2} (40 \text{ m} \times 22.5 \text{ m}) = 450 \text{ m}^2 + 450 \text{ m}^2 = 900 \text{ m}^2. \]

Therefore, the solution provided by the second plan produced the same area for the first child and the second child. Nevertheless, the solution resembles the problem solving of the first plan.

\[ \text{Area of the first child was } L_1 = \text{Area } A + \text{Area } B = 750 \text{ m}^2 + 300 \text{ m}^2 = 1050 \text{ m}^2. \]

\[ \text{Area of the second child was } L_2 = \frac{1}{2} (45 + 15) 20 = 600 \text{ m}^2. \]

Basically, the solution in the third plan generated different area between the first and second child. The subject clarified the problem solving as follows:

Researcher: How do you divide the land owned by Pak Hendra equally for his two children?

Subject: First, I would divide AD = 60 m into six areas, or 10 m for each. Subsequently, I would divide AB = 45 m into three areas, or 15 m for each and draw it (Figure 4).

Subsequently, the subject solved the problem in accordance with the third plan, namely by dividing the right-angled trapezoid into several areas, namely regions A, B and C (Figure 3). The subject also calculated and determined the width of each area by using a formula. The area of the first child was 

\[ L_1 = \text{Area } A + \text{Area } B = 750 \text{ m}^2 + 300 \text{ m}^2 = 1050 \text{ m}^2. \]

Based on the results of producing stage, the products generated by student’s creative thinking process in solving mathematical problems is explicated as follows.

### 3.3.1. Fluency

The indicator of fluency is indicated by the ability in solving a mathematical problem in which the student is able to propose more than one plan with correct answer. In accordance with this indicator, at the first plan, the subject solved the mathematical problem correctly and systematically by initially drawing a right-angled trapezoid, dividing it into two areas: Rectangle A for the first child and Rectangle B for the second child. Based on the results of the first plan, the first and second child gained equal area.
At the second plan, the subject initiated by drawing a right-angled trapezoid and dividing it into three: Rectangle A and Right triangles B and C. The area of B and C is equal to the area of Rectangle B generated from the first plan. Briefly, this second plan yielded similar result with that of the first plan.

Subsequently, at the third plan, the subject divided Pak Hendra’s land in the shape of a right-angled trapezoid into three areas: A, B and C. The subject calculated and determined each area precisely by using the formula. The results of this third plan of problem solving did not generated correct result, as indicated by the area of the first child is not similar to that gained by the second child.

Based on the analysis of fluency indicator, it can be identified that the subject who practices visual learning style does not entirely fulfill the fluency aspect.

3.3.2. Flexibility
The indicator of flexibility in solving mathematical problems is indicated by the ability of student in using various approaches correctly. Based on the analysis of the plans proposed by the subjects, it can be examined that the subject used three different approaches to solving the problem, correctly and completely, yet the subject was not fully accurate in the process hence there was a mistake in the product. In overall, student who practices visual learning style fulfills the aspect of flexibility.

3.3.3. Novelty
The indicator of novelty is indicated by the ability of student in solving a mathematical problem correctly, and there is one plan that is different, correct and irregularly performed or completed by the student at the level of development or knowledge. Based on the analysis of the generated problem solving, the subject successfully generated ideas in solving the problem, but due to the lack of not accuracy and precision, the final result was incorrect hence the subject failed in fulfilling the aspect of novelty. The process of problem solving is presented in Figure 5 below.

![Figure 5. The final result of problem solving.](image)

Based on the results displayed in problem solving and in-depth interview, it can be identified that student who practices visual learning style does not succeed to meet the aspect of novelty in solving mathematical problem.
Furthermore, the process and products of creative thinking of student (female, visual learning style) in solving mathematical problems are presented in a brief description as follows.

**Table 1. Summary of Creative Thinking Process and Products in Solving Mathematical Problems**

| Phase                      | Description of Creative Thinking Process                                                                 |
|---------------------------|----------------------------------------------------------------------------------------------------------|
| Generating Ideas          | Student reads the question and examines the image in the question to identify information that is already known and to understand what is asked in the question correctly. These activities lead to generating ideas. |
| Planning Problem Solving  | Student makes three plans with different approaches. The first plan is almost similar to the second plan, which is by dividing the right-angled trapezoid into two areas. The difference is at the second plan, the student divides the trapezoid into three areas. The first and second plans have similarities in calculating the area of the first and second child. Meanwhile, at the third plan, the student divides the right-angled trapezoid into three areas that are dissimilar from the first and second plan. Subsequently, the student calculates and determines the area of the first and second child. |
| Producing Problem Solving | Fluency: The student has not generated products that fulfill the aspect of fluency.                      |
|                           | Flexibility: The subject has fulfilled the aspect of flexibility based on the final products.            |
|                           | Novelty: The subject has not generated products that fulfill the aspect of novelty.                      |

The creative thinking process in solving mathematical problems is basically associated with two indicators, namely those that lead to creative processes and those that lead to creative products. Based on the findings of the present study, it can be claimed that the process in creative thinking is initiated by “generating ideas”. At this phase, it is identified by the student’s activities of reading the question twice and examining the image attached in the question. From these activities, the student will be able to identify the given information and later, understand what the problem of the question is. Subsequently, the student will devise a plan for problem solving (the phase of Planning Problem Solving) by using different approaches. Nevertheless, not all of the plans successfully generate correct product in the next stage of Producing Problem Solving, but at least, the student has experienced a process or stage in creative thinking. It confirms Krathwohl and Anderson in [5], in which the process in creative thinking consists of three phases or processes, namely generating, planning, and producing.

Siswono [12] argued that “to create” means to put elements together into a interrelated and functional product or to rearranges elements into a new pattern. It is associated with three cognitive processes of generating, planning and producing. These three processes are identical to the process of creative thinking. The three cognitive processes are identical to the process of creative thinking. Furthermore, [8] provides an example of the creative thinking process at the stage of generating ideas, namely when a person reads a book. In such activity, the reader will receive information from various stages ranging from sensory processes to memories. The collected information will be transformed to produce new information and it will be a new knowledge for the reader. Furthermore, [13] explicated that the creative thinking process developed by Wallas is one of the most common theories to find out the creativity process. It includes four stages, namely preparation stage, incubation stage, illumination stage, and verification stage. The “preparation” stage has similarities with the phase of "generating ideas" in which students will learn to think, seek for answers, ask other people, and similar activities.

Creative products are essentially associated with the creative process, particularly in the phase of producing problem solving. Based on the results of mathematical problem solving, it can be claimed that female student who practices visual learning styles generates creative products that meet the flexibility aspect. The student is able to employ various approaches by drawing several images, which
also indicates the ability to think flexibly, namely thinking in a number of different categories or approaches, with the basis of current knowledge and inspiration [14]. It is also indicated by the results of the problem solving in which the student uses different and correct approaches in the process. Nevertheless, the student may be less accurate and systematic thus some approaches result in mistake. This inaccuracy leads to the fail in fulfilling the fluency and novelty aspects. Creative thinking is the ability to think divergently which includes fluency in thinking with lots of ideas, flexibility in thinking with diverse categories or approaches, novelty in thinking with extraordinary ideas, and elaboration by applying ideas into a clear evidence [4].

4 Conclusions
Based on the findings of the present study, it can be concluded that female student who practices visual learning style is able to fulfill the creative process indicators, namely: a) generating ideas through reading and examining images on the questions meticulously in order to generate ideas for identifying information that is already known and for understanding the problem completely and correctly; b) planning problem solving by initially drawing an image, modifying it into several parts, and calculating and determining the area; and c) producing problem solving. The products of the creative thinking process have met the aspects of flexibility, but not the aspects of fluency and novelty.

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