

INTOVERTED PRIMARY SCHOOL STUDENTS' CREATIVITY IN MATHEMATICS PROBLEM SOLVING BASED ON GENDER DIFFERENCES

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Abstract

Creativity has been excessively studied in various area of knowledge. In mathematics, creativity is considered one of ability that is required especially in problem solving. It is because mathematics problems are continuously changing in term of complexity and novelty. On the other hand, creativity is interrelated with individual sources. This study explores introverted primary school students' creativity in mathematics problem solving based on gender differences. Data were collected by utilizing one mathematics problem and interview. There were two 5th grade primary school students (one male and one female) that participated in this research. There are three creativity criteria that is assessed namely fluency, flexibility, and novelty. Finding showed that introverted male student fulfilled three of creativity criteria meanwhile introverted female student fulfilled two criteria of creativity namely fluency and flexibility. In process of problem solving, both subjects utilized external condition, intellectual knowledge and intuition. The flexibility of subjects is different in some way. Introverted male student tended to use as much as strategies. Introverted female student tend to modify the strategy to produce other solutions. Moreover, the difference was also found in the way how they used intuition in solving the given problem.

Key words: Introverted Primary School Student, Creativity, Mathematics Problem Solving, Gender Differences.

INTRODUCTION

Background

Creativity has been excessively studied in mathematics area especially in problem solving (Elia, Heuvel-Pahnhuizen, & Kolovou, 2009; Laprocina, 2002; Sheffield, 2013; Silver, 1997). Problem solving is considered as the most significant human activity that utilize creativit thinking. it is because problems that are encountered are varied in term of complexity and novelty. This situation also happens in school. Students faced problems that continously changed in term complexity and novelty. As stated by Stanic and Kilpatrick (Elia et al., 2009) that students face new situations and problems continuously. As a result, creative thinking will be essential for students in order to successfully answer mathematics problems. Another crucial reason why creativity is important in problem solving is that creative thinking provides opportunity to think many possible ways, to think an unusual method, to think adaptively in using methods that have been learned, and to choose the most appropriate way in problem solving.

In mathematics, creative thinking is defined as combination of logical thinking and divergent thinking which is on intuition but has a conscious aim (Pehkonen in Siswono, 2010). When creative thinking is applied in solving mathematics problems, the logical thinking

provides rational reasons to classify and to prove an acceptable conclusion. Meanwhile, divergent thinking allows the students to think about many possible ideas in solving the problems. The focus of divergent thinking in mathematics problem solving is fluency, flexibility, and novelty (Haylock; Krutetskii; Haylock; and Silver in Siswono, 2010). Fluency is defined as student ability to obtain at least two correct answers in problem solving. Flexibility is defined as the ability to use at least two strategies and to decide the best appropriate way in solving the encountered novel problem setting. Novelty is defined as idea or strategy that problem solver used is considerably “new” to him/herself. An idea or strategy considered as a new is when the individual use idea or strategy that is not commonly used by other individual (student) in the same level of knowledge; or the idea or strategy that is used are in higher level of concept compared to the concept that is commonly mastered by the students in the same level.

On the other hand, result of interviewing primary school teacher indicates that there are some differences between passive female students and passive male students. The differences occur because the level of creativity is influenced by the individual difference. According to the investment theory (Sternberg, 2006), creativity is influenced by several interrelated individual sources. One of the sources is gender. There are numerous studies that conducted in observing the role of gender in creativity. However, it is still difficult to be conclusive since the result of the study still various in some ways. Several researches provide information that there is no significant difference between male and female creativity (Chan, 2005; Goldsmith & Matherly, 1988). According to Kaufman (2006), “the available evidence suggests that women and girls tend to score higher on creativity tests than men and boys. Stoltzfus, Nibbelink, Vredenburg, and Hyrum (2011) found that male participants’ performance on creativity measures perform better than females. Moreover, Laprocina (2002) found that boys invented more strategies in solving mathematics problem solving than girls. On the contrary, it is also found that girls were more likely than boys to use manipulative to solve mathematics problems.

Moreover, Laprocina (2002) found that fifth grade student showed the ability to invent and use the invented strategies in mathematics problem solving. This finding provides the assumption that primary school students can perform a level of creativity in mathematics problem solving. Another study that was conducted by Elia et al. (2009) showed that students performed a degree of flexibility in using the heuristic strategy on non-routine mathematics problem solving.

Research Questions

The research question in this study are:

1. How is the creativity of an introverted male primary school student in mathematics problem solving?
2. How is the creativity of an introverted female primary school student in mathematics problem solving?

Research Objectives

The research objective are

1. To describe the creativity of an introverted male primary school student in mathematics problem solving.
2. To describe the creativity of an introverted female primary school student in mathematics problem solving.

Method

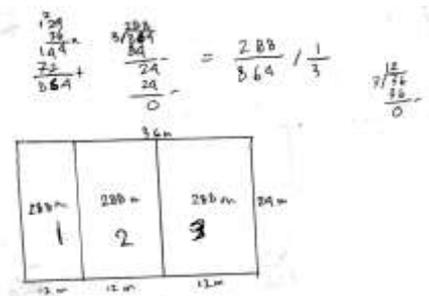
In our study, we conducted a qualitative research. There are two participant on male and one female as research subjects. Research data is collected from problem solving test and interview. The instruments are personality test, problem solving test, and interview protocol.

The personality test consist of ten questions that categorized the participants into introverted and extroverted personality. The problem solving test consists of one open problem which has many correct solutions and has many possible ways that can be used in obtaining a correct solution. Interview is conducted while research subject answering the given problem. The data is validated by using time triangulation where the data is gathered from two different times. The valid data is obtained if and only if both of collected data shows a coherency and consistency. Data analysis involves data reduction, data display and drawing conclusion.

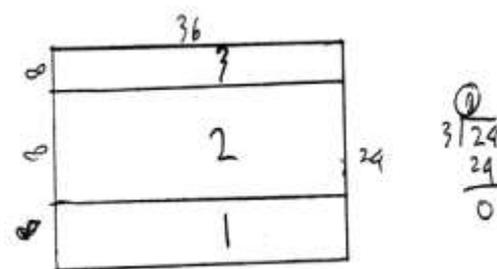
RESULT

A. Introverted Male student creativity

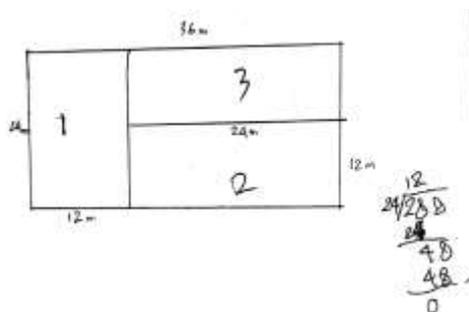
The data about that collected from introverted male subject indicate that the subject understood the question. He knew about what is known such as shape of land, length, width, and what is needed to be done to the land. He knew that the land will be distributed into three people. He also knew about what was the question required which was drawing a figure and determining measurement of parameters of new shape. There are five different correct answers that were produced. The answers are presented as follows:



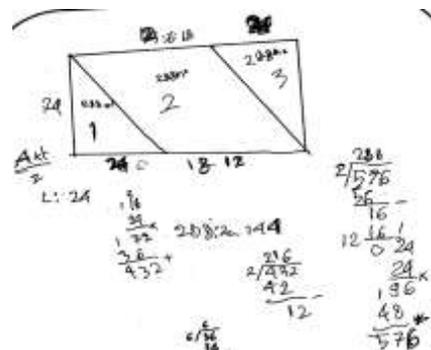
Picture. A.1



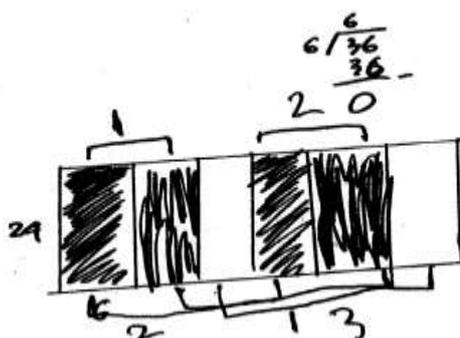
Picture. A.2



Picture. A.3



Picture. A.4



Picture. A.5

Based on the answers and student interview response, introverted male student creativity in mathematics problem solving can be described as follows:

1. Fluency

The subject ability to produce five different correct answers shows that introverted male subject is fluent in mathematics problem solving. In producing different correct answers, he required several time to think about the possible answer. He began drawing a divided rectangle and determining the measurement of each part. The process of planning the possible answer is happened in the subject mind since in every student activities to produce an answer he only required a few minute of time. He drew an answer when he is confident that the idea will lead him to a correct answer.

2. Flexibility

Flexibility in mathematic problem solving in this research is categorized in two aspects. The aspects are the way he produced a picture of divided land and the way he determined parameters of each part of dividing rectangle. In producing the figure of a divided rectangle, he used four different ways (Picture A.1, Picture A.3, Picture A.4, and Picture A.5). In determining parameters of each divided land, there are three different ways that is used by the subject. First, he divided value of parameter of main rectangle by three equally that is used in the first answer, the second answer and fifth answer. Second, he divided area of each part of rectangle by known parameters that are performed in determining parameters of each part of rectangle in third answer and fourth answer. Third, when he determined length of one part of main rectangle length, he subtracted length of main parameter with known length of its part. Moreover, He also utilized his intuition based on the analysis of the previous answer in determining the measurement of each part. it is happen in the process of obtaining the fourth answer.

3. Novelty

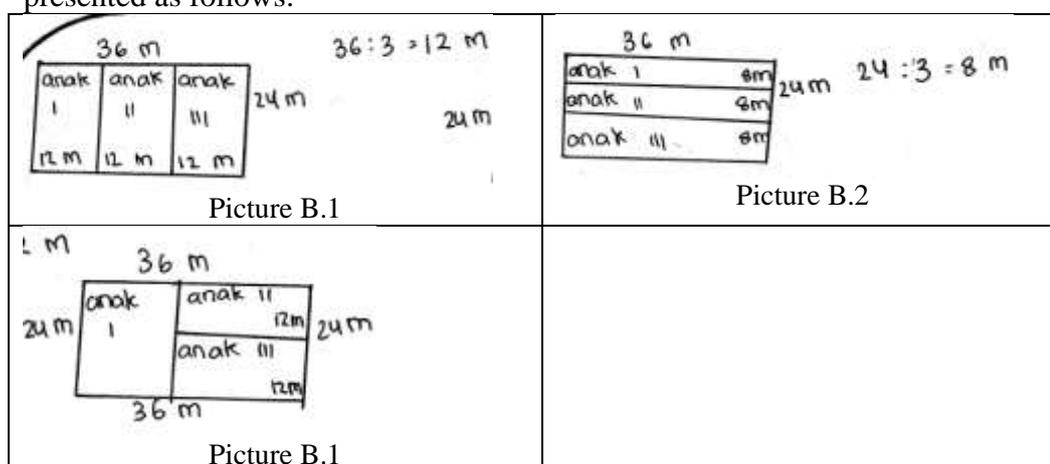
IMS fourth and fifth answers are considered as a new product. In the fourth answer, IMS produced a divided rectangle that was formed two shapes of plane figures namely triangle and parallelogram. In determining parameters of rectangle, he modified area of rectangle formula. He divided the area of rectangle which is area of one third of rectangle by one of known parameter. It requires higher thinking in determining the parameters since has not been practiced in class. Meanwhile in fifth answer, IMS broadened the idea that

distributed a land into three people does not mean that the land should be divided into three parts. It can be divided into six parts where one person got two parts and the parts could be distributed separately.

B. Introverted Female Creativity

1. Fluency

The data about that collected from introverted female subject indicates that the subject understood the question. She knew about what is known such as shape of land, length, width, and what is needed to be done to the land. She knew that the land will be distributed into three people. She also knew about what was the question required which was drawing a figure and determining measurement of parameters of new shape. There are two different correct answers that were produced. She also produced one different picture of divided rectangle. However, she could not determine the parameters correctly. The answers are presented as follows:



The subject ability to produce two different correct answers and one other different picture of divided rectangle shows that introverted female subject is fluent in mathematics problem solving. In producing different correct answers, she required several time to think about the possible answer. She began drawing a divided rectangle and determining the measurement of each part. The process of planning the possible answer is happened in the subject mind since in every student activities to produce an answer she only required a few minute of time. She drew an answer when she is confident that the idea will lead her to a correct answer. However, the third answer is produced based her intuition and feeling. She felt that the rectangle can be divided as in Picture B.1 but she cannot determine the parameters correctly.

2. Flexibility

In producing the figure of the land, introverted female subject used two different ways (Picture B.1 and Picture B.2). In determining measurement of each new shape of divided land, she only used on way which is dividing the parameter of the main rectangle by three equally that is used in the first answer, and the second answer

3. Novelty

In term of novelty, introverted female subject do not produce an answer that is considered as a new product. Therefore, in this matter, IFS do not fulfill the novelty criteria yet.

DISCUSSION

A. **Intoverved Male Student (IMS) Creativity**

Based on result of research, introverted male student is fulfilled the three of the creativity indicators namely fluency, flexibility and novelty. In term of fluency, he can produce five different pictures and determine its measurement correctly. He also used different ways both in producing different pictures and determining measurement of each part of rectangle. It means that he is categorized to be flexible in mathematics problem solving. Moreover, the subject also produces answers that are considered as new product since it required higher order thinking and broadened the idea to produce it.

In producing a new picture, way to divide the land and way to determine measurement of each parameter for each part of rectangle, the subject processes all in formation in his mind. He used his knowledge and more focus in what he has in his mind. Although he did not divide the rectangle into three parts equally, he believed that each part of rectangle has equal area. Moreover, he also used his intuition in obtaining a correct solution. It can be inferred from student response in confirming the correct measurement of parameters in fourth answer. He gusted a number as value of one parameter of one part of rectangle after he verified that first value is incorrect. Therefore, it can be concluded that the introverted male subject uses his intellectual knowledge and intuition in producing the idea of answering given problem. In other word, result of this research supports the statement that is stated by Martindale (1989, cited in Martindale, 2007) which is the introverted people creativity is developed because of their tendency to be subjective; to involve their intellectual knowledge and feeling; and to focus in using their intuition.

In addition, the fact that introverted male student can produced five different correct answers which are involve four different ways in dividing the land and three different ways in determining the parameter of each part of the rectangle provides the proof that introverted male subject invented more strategies than the introverted female subject. This result confirms the result of the research that is conducted by Laprocina (2002) that boys invented more strategies than girl in problem solving.

B. **Intoverved female Student (IFS) Creativity**

Result of research shows that introverted female student is fulfilled two indicators of creativity namely fluency and flexibility in mathematics problem solving. She can produce three different picture of divided rectangle which means she already fulfilled fluency criteria in problem solving test 1 and produce four different pictures in problem solving test 2 where fourth picture is the modification of third picture. In fulfilling the flexibility criteria, even though she only used one way in determining the measurement of each parameter which is divided the value of divided side of rectangle by three, she used two different ways in dividing a rectangle.

In the process of producing solutions, she required sometime to imagine possible answer. She drew a new rectangle, divided into three and wrote the measurement of each part of rectangle when she got the idea. In other word, she already processes all the information in her mind in producing an answer. She used her knowledge and focus in her mind to process given information and to produce a new possible answer. Moreover, she shows intense focus in using her feeling and intuition. Even though, she cannot determine the parameter of each part in verifying the equal area of each part of the rectangle, she believes that area of each part of rectangle is equal since in her mind the rectangle is divided into three equally. She could provide a reasonable answer intuitively in explaining why the length side of the rectangle is not divided into two equally since if she did it, one part of the rectangle is equal to a half of the whole area.

Based on the fact, it is clear that the intellectual, feeling and intuition are considered as major factors that develop the introverted people creativity as what Martindale (1989, cited in Martindale, 2007) stated. Meanwhile, introverted female student fourth answer in the test 2 shows that she manipulated the strategies in drawing the picture in the third answer. As the result, this finding is similar with what was found by Laprocina (2002) that girls are creative in manipulating the strategies in problem solving.

C. The creativity comparison between Introverted male student and introverted female student

Based on the data analysis, it can be concluded that introverted male student fulfilled all of three creativity criteria namely fluency, flexibility and novelty. On the other hand, introverted female student fulfilled two criteria of creativity namely fluency and flexibility. If the number of fulfilled creativity criteria is the indicators of creativity level, it is clear that IMS is more creative than IFS. This result supports Stoltzfus et al. (2011) studied that male tends to be creative than female.

Regarding the process of producing the different correct answers, both of IMS and IFS process most of the information in their mind. They tend to plan the possible answer by using their intellectual knowledge and implement it when they think the idea is sophisticated to answer the question. Related to their personality types, it can be concluded that both IMS and IFS show the use of intuition in producing an answer. However, in using the intuition, the data indicate that IMS and IFS use it differently. The IMS used his intuition when predicting the correct measurement of the parameters based on his calculation and available data. It involves thinking processes in predicting it. On the other hand, IFS tends to use her feeling in answering the question intuitively. She produced a new picture based on her feeling. She believed that a rectangle can be divided into three parts equally by using the way. However, she did not ignore her reasonable thinking in explaining the reason why she felt that the rectangle can be divided into three as can be seen in the picture 4.11. She explained that if the length of the rectangle is divided into two parts equally, the first part area will be a half of the main rectangle area. As the conclusion, in using intuition, IFS used her feeling and thinking.

In terms of flexibility, there are some differences that IMS and IFS have. IMS shows that he can use and produce more strategies than IFS. It can be proven by looking at the fact that IMS used four different ways in dividing the rectangle into three parts and used three different ways in determining the parameters of each part correctly. Meanwhile, IFS only used two different ways to divide the rectangle into three parts and used only one way to determine the parameters of each part correctly. Interestingly, in producing different pictures of divided rectangles, IMS used more strategies than IFS. He tried to invent a different way. On the other hand, IFS tends to modify the way that she already used. She modifies the way that she used in drawing the third picture to obtain the fourth picture in problem solving test 2. This difference provides a new proof that male invented more strategies than female and female tends to modify the strategy as stated in Laprocina (2002).

CONCLUSION

Based on research results and discussion it can be concluded that introverted male student fulfilled three of creativity criteria meanwhile introverted female student fulfilled two criteria of creativity namely fluency and flexibility. In the process of problem solving, both subjects utilized external conditions, intellectual knowledge and intuition. The flexibility of subjects is

different in some way. Introverted male student tended to use as much as strategies. Introverted female student tend to modify the strategy to produce other solutions. Moreover, the difference was also found in the way how they used intuition in solving the given problem.

SUGGESTION

1. In enhancing the student creativity, teacher can use problem solving by giving a challenging open problem and providing the representation of the real situation such that both introverted and extroverted student are facilitated to develop their creativity.
2. Since the area of personality is widely open, there are several possible opportunities to conduct the research in area of personality types, gender differences and creativity.

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