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CREATIVITY THROUGH MATHEMATIZATION IN SOLVING NON-ROUTINE PROBLEMS

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Abstract

This study aimed to describe and compare the students' fluency, flexibility, and originality in solving non-routine problems in Palembang context. They were depicted from the student's fluency, flexibility and originality in solving the horizontal and vertical mathematization forms. It is a qualitative study. The subjects were the ninth grade high school students in Palembang. The instruments used were tests, observations, and interviews. The tests were carried out to see the written horizontal and vertical mathematizations form. The observations were to find out the process of getting mathematical ideas during the test. The interviews were to explore the ideas from the students with lacked detail answers. Then, the data from the test results, interviews, and observations were reduced and grouped based on the indicators of creativity. The reduced data were presented in a descriptive form for drawing conclusions. The results of the data analysis showed that the high-ability students were more fluent and flexible in solving the problems, but the provided solutions were categorized as less original and tended to use formal mathematics in the form of formulas, symbols and mathematical operations. Meanwhile, the moderate-ability students tended to start by simplifying problems and presenting them in the form of visual images. Their answer sheets revealed their originality of thinking, flexibility, and fluency in understanding the problems and the solutions. Different results were obtained from the low-ability students. They tended to have difficulty in understanding the problems, so there were many errors in solving the problems showing their inability to write the known data and relate them to other facts that they already learned. As a result, the aspects of fluency, flexibility, and originality could not be seen in their answers.

Keywords: Mathematization, Creativity, Problem Solving, Non-routine

Abstrak

Penelitian ini bertujuan untuk menggambarkan dan membandingkan kelancaran, fleksibilitas dan orisinalitas dalam menyelesaikan masalah non rutin berkonteks "Palembang". Hal ini tergambar dari kelancaran, fleksibilitas dan orisinalitas siswa dalam membuat matematisasi horizontal dan matematisasi vertikal. Penelitian ini merupakan penelitian kualitatif. Subjek penelitian ini adalah siswa kelas IX SMP di kota Palembang. Instrumen yang digunakan adalah tes, observasi, dan wawancara. Tes dilakukan untuk melihat bentuk matematisasi horizontal dan vertikal secara tertulis. Observasi dilakukan untuk melihat proses penuangan ide matematis selama tes berlangsung. Wawancara dilakukan untuk menggali ide dari siswa yang jawabannya kurang detail. Data hasil tes, wawancara, dan observasi selanjutnya direduksi dan dikelompokkan sesuai indikator kreativitas. Data hasil reduksi tersebut disajikan dalam bentuk deskriptif untuk selanjutnya digunakan dalam pengambilan kesimpulan. Berdasarkan hasil analisis data diperoleh bahwa siswa berkemampuan tinggi lebih lancar dan fleksibel dalam menyelesaikan masalah tetapi penyelesaian yang diberikan dikategorikan kurang original dan cenderung menggunakan matematika formal berupa rumus, simbol dan operasi matematika. Sedangkan siswa berkemampuan sedang cenderung memulai pekerjaan dengan menyederhanakan masalah dan menampilkannya dalam bentuk gambar visual. Dari lembar jawaban tampak originalitas berpikir, fleksibelitas dan kelancaran siswa baik dalam memahami persoalan maupun penyelesaiannya. Hasil yang berbeda diperoleh dari siswa berkemampuan rendah. Mereka cenderung mengalami kesulitan dalam memahami permasalahan sehingga banyak terjadi kesalahan-kesalahan di dalam menyelesaikan soal yang tampak dari ketidakmampuan siswa dalam menuliskan data-data yang diketahui dan mengaitkannya dengan fakta lain yang sudah mereka pelajari sehingga aspek kelancaran, fleksebilitas, dan originalitas tidak muncul di dalam jawaban mereka.

Kata kunci: Matematisasi, Kreativitas, Pemecahan Masalah, Non-Rutin

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Problem-solving skill is very fundamental in this changing world (Malik, 2018; Nufus & Bahrun, 2018; Marchetti, 2018), and creativity is also an important skill (Puccio, 2017). It is one of the reasons why these two competences become the focus of mathematics curriculum in Indonesia, especially those related to non-routine, open, and real word problems (Depdikbud, 2013; Cai & Ding, 2015; Maulana & Yuniawati, 2018; Chong, Shahrill, Putri, & Zulkardi, 2018; Minarni, Napitupulu, & Husein, 2016).

The problem-solving ability is related to solving non-routine problems (Celebioglu, Yazgan, & Ezentas, 2010). Non-routine problems are those that challenge and encourage students to use different heuristic approaches in their solution (Dendane, 2009). Therefore, the solution process needs mental and intellectual processes in finding solutions based on accurate data and information and drawing precise and accurate conclusion (Heffernan & Teufel 2018; Sudia & Lambertus, 2017). These complex situations often cause difficulties for students in solving non-rourine problems (Murdiyani, 2018; Hartono, 2014).

Problem solving has six principles, namely (1) success in solving problems can be achieved if the idea of the problem is known (Carson, 2007); (2) solving problems use existing data/information (Csapó & Funke, 2017); (3) the starting point of problem solving is to look for possible solutions (Fischer, Greiff, & Funke, 2012); (4) being aware of the contents of the problem comes before trying to solve the problem; (5) ideas that are creating new ideas (innovative) should be separated from the process of evaluating ideas because the evaluation process will inhibit the creation of ideas (Madzík, 2019); and (6) selected situations should be turned into a problem situation and it sometimes needs to be changed to a choice situation.

When facing a difficult or complex problem, the first step to start is to analyze the problem and describe the problem in a simpler form so that it is more easily solved (Miller & Ranum, 2013). Furthermore, the problem-solving process is continued by looking for some possibilities that might become a way out to finally find a solution that is considered the best, most appropriate, and easiest (Fischer, Greiff, & Funke, 2012), and during the process of solving the problem the students freely use ideas or creating new ideas without being bound or associated with old ideas (AlMutairi, 2015).

There are four factors that influence problem-solving, namely motivation, beliefs, habits, and emotions (Ozturk & Guven, 2016). Therefore, the ability to solve problems is not only measured by the ability of students to find solutions, but also seen from the problem-solving process. Students who can solve problems will understand what they will solve and why the solution is chosen. The ability to solve problems is measured and focused not only on the truth of the substantial mathematical solutions and procedures performed, but also on the coherence and wrinkling of ideas or mathematical procedures that support these solutions. Related to this, problem-solving is a process of communicating ideas or mathematical thoughts coherently and clearly.

Chamberlin (2010) points out that one of the keys to success in solving problems is to represent the problem correctly. For example, by representing all mathematical ideas related to the problem in a concise and simple manner can make it easier to process, operate, and find the solutions. The representation can be in the forms of models, schemes, and symbols. In a realistic mathematical view, the process of conveying ideas in the form of models, schemes, and symbolizations is called the process of mathematization.

Mathematization is divided into two, namely horizontal mathematization and vertical mathematization. There are several activities included in the horizontal mathematization, such as (1) identifying specific mathematics in general contexts; (2) scheming; (3) formulating and visualizing of problems in different ways; (4) finding relationships; (5) finding regularity; (6) introducing the isomorphic aspects in different problems; (7) turning everyday problems into mathematical problems; and (8) turning everyday problems into a known mathematical model. Meanwhile, there are several activities classified as vertical mathematization, such as (1) expressing a relationship in a formula; (2) proving regularity, (3) improving and adjusting the model, (4) using different models, (5) combining and integrating the models, (6) formulating a new mathematical concept; and (7) generalizing (Menon, 2013; Loc & Hao, 2016).

The most important aspect to be considered in problem-solving ability needs not only the mastery of factual and procedural knowledge relevant to the problem but also high creativity by looking at the problem from various points of view (Cropley & Cropley, 2009). Creativity will emerge if someone is able to know the relationship between the elements that already exist, and he/she is able to provide new ideas to create something new (Diyanni, 2016).

Creativity, on the other hand, is defined as the ability to provide new ideas and apply them in problem-solving (Siswono, 2010). It can also be defined as the ability to combine, solve, or answer problems, and reflect the operational abilities of creative children reflected in the emergence of various possible answers or problem-solving based on the information provided, including triggering many ideas about a problem (DeHaan, 2009). Creative thinking and creativity come from sharp thinking with intuition, moving the imagination, uncovering all amazing and inspiring possibilities and new ideas (Barnard & Herbst, 2018). In addition, the creativity usually arises because of habits such as curiosity, enjoying asking questions, and always looking for new experiences (Diyanni, 2016).

Siswono (2010) explains that creativity is reflected in fluency, flexibility, and originality. The fluency in thinking is reflected from generating many relevant ideas/answers. Therefore, the fluency of thinking is more emphasized on quantity not quality. The fluency is defined as the ability in producing several ideas and various answers or questions, seeing a problem from different points of view, looking for alternatives or different directions, and being able to use a variety of approaches or ways of thinking. The flexibility in thinking is reflected from the results of ideas that tend to be different and of being able to quickly change the way or approach in problem-solving. The originality is usually reflected from the presence of answers or unusual solutions and the tendency to differ from the answers of other students. One who has creativity and ability to think in high divergence does not have much difficulty in solving the problems s/he faces.

Creativity as defined by experts is always related to the ability to think and behave (Starko, 2013). Therefore, for students to develop their creativity, they need both internal and external impulses. One form of encouragement from the outside is the existence of tasks and teaching materials that can facilitate students to develop their creativity. One of the teaching materials that can develop creativity is the one containing problem-solving questions that have situations or phenomena related to daily life (Novita & Putra, 2016).

Non-routine tasks and problems that are not well structured are activities that potentially develop student's creativity (Novita & Putra, 2016). Consequently, the creativity in solving mathematical problems can be defined as the ability of students to formulate mathematical problems freely, inventively, and currently (Saragih & Habeahan, 2014). The raised ideas are the result of information association and tendency to produce divergent answers in line with the concepts of flexibility and fluency that exist in creativity (Benedek, Könen, & Neubauer, 2012). Creativity always involves imagination, intuition, and invention by developing divergent, original, curious thoughts, by making predictions and guesses and by tending to use trial and error strategies (Gilhooly, 2016). Many studies in mathematics education (Celebioglu, Yazgan, & Ezentas, 2010; Mabilangan, Limjap, & Belecina, 2011; Villareal, 2014; Yazgan, 2015) show that non-routine problems are most effective for improving mathematical problem-solving skills.

Pitta-Pantazi and Christou (2009) believe that the use of non-routine problems is most effective to improve students' mathematical creativity. Yazgan (2015) analyzes the role of strategy in solving non-routine problems and finds that students' success in solving problems is different between high and low ability students. The analysis of the solutions given by the students when solving problems shows that when they are given the freedom to solve problems at will; seven of the eight problem-solving strategies they use to solve one problem are non-routine (Mabilangan, Limjap, & Belecina; 2011).

Research related to creative thinking shows that non-routine problems produce a positive influence on students' mathematical creativity. The use of non-routine contextual problems has a potential effect on improving students' thinking skills in real life situations, so this study used the contextual non-routine problems. Based on the description above, it is assumed that the use of non-routine problems with the context of Palembang will bring up many strategies and representations in the solution to produce positive effects on students' mathematical creativity. Therefore, this study aimed to describe and compare the fluency, flexibility, and originality in solving non-routine problems in Palembang context. In this study the students' creativity was illustrated by their fluency, flexibility, and originality in making horizontal and vertical mathematization.

METHOD

Design

The research design was descriptive because this study aimed to describe the existing phenomena taking place at this time or in the past. This study aimed to describe and compare the fluency, flexibility, and originality in solving non-routine problems in Palembang context. The creativity was reflected in the fluency, flexibility, and originality of students in making horizontal and vertical mathematization.

The research procedure consisted of three stages, namely the preparation stage, the implementation stage, and the data analysis stage. The preparation stage covered (1) assessing theories of creativity and components of creativity used to measure students' creativity in solving mathematical problems; (2) arranging non-routine problems in "Palembang" context; and (3) preparing interview instruments. The implementation stage included (1) giving test questions containing non-routine problems in "Palembang" context to students, in which the problem is used to see the emergence and shape of horizontal and vertical mathematization forms; (2) conducting observations during the test; and (3) conducting interviews with research subjects. The data analysis stage included (1) data reduction, (2) data presentation, and (3) drawing conclusion.

Subject

The subjects of this study were 30 students of Grade IX.b in SMP Negeri 3 Palembang. The characteristics of these students were categorized as heterogeneous consisting of a mixture of high-ability, moderate-ability, and low-ability students.

Instruments

The data collecting instruments used were tests, observations and interviews. The test consisted of two questions of non-routine problems in Palembang context. It was used to describe students' creativity referring to three components, namely fluency, flexibility, and originality in making horizontal and vertical mathematization in solving non-routine problems in the "Palembang" context. A checklist was used in the observations. The observations were made to monitor the students' fluency in answering the problems. A semi-structured type of interview was conducted, in which the questions could be developed as needed. The interviews were used to get clearer information on the students' creativity in solving mathematical problems, particularly to explore deeper aspects of flexibility.

Data Analysis

The data analysis technique was divided into three parts, namely data analysis of written test results, data analysis of observations, and data analysis of interview results. The data of written test result were reduced by grouping and separating the boundaries between horizontal and vertical mathematizations and by calculating how many students were categorized in each aspect. Then, they were presented in tabular forms. The results of the reduced data were used to describe the components of students' creativity which included the fluency, flexibility, and originality in both horizontal and vertical mathematization. The data analysis of observations was carried out by comparing the data obtained from the students' answers with the observations during the test. The observation results were used to support the findings of the test results. Meanwhile, the data analysis of interview began with transcripting the conversations between teachers and students. Next, the result of the transcript was reduced and whichever information categorized as important data was selected. The results of this reduction were presented in the form of a description to be juxtaposed with the test result data. The conclusion phase was the process of compiling the information obtained from the results of the tests, observations, and interviews. Then, all the data were compared with the theories that form the basis of this study.

RESULTS AND DISCUSSION

Results

Creativity in mathematization means the fluency, flexibility and authenticity in displaying horizontal and vertical mathematization forms when solving non-routine problems in Palembang context. The following are problems used in this study.

(Problem 1)  Pagoda Roof	On Kemaro Island there is a Pagoda. When viewed from above, it appears that the roof of the pagoda is piled in an octagonal shape. If the diameter of the lowest floor of the pagoda (on the ground) is 13 m and the distance of each adjacent octagon is 50 cm, predict the diameter of the pagoda's roof and the area of the pagoda's roof. Explain the strategy you use!
 *Monumen Penderitaan Rakyat/Monpera* (Problem 2)	*Monpera* consists of eight floors. The five lower floors are filled and turned into a museum. In the museum there are various collections served as the witness to the five-days-and-five-nights war in Palembang. On the 1st floor there is a collection of weapons. On the 2nd floor there are various documents and photos of that period. On the 3rd floor there is a collection of old money. On the 4th and 5th floors there are statues and clothes from the heroes. If the *Monpera* officer wants to rearrange all the existing collections on condition that the collections are not placed in the same floor, determine how many possible ways there are to organize the collections.

Figure 1. Non-Routine Problems in Palembang Context

The fluency was seen from the ability of the students to give the correct answers and write the answers in which there were no errors at all or the mistakes made were very minimal. Flexibility was illustrated by the ability of students to display other forms or other strategies. Then, originality was seen from the peculiarities existing in the students' answers. This study presented the fluency, flexibility, and originality when the students did the process of transforming real-world problems into mathematical symbols and the process of changing from symbols to other mathematical symbols that are more abstract. The test sheet obtained the data as follows.

Table 1. Fluency, Flexibility and Originality

Problem	Horizontal Mathematization			Vertical Mathematization		
	Fluency	Flexibility	Originality	Fluency	Flexibility	Originality
1	7	5	4	7	3	3
2	14	14	4	14	10	4

Horizontal Mathematization on the First Problem

From Table 1 above, there were 7 students categorized fluent in doing horizontal mathematization. They were fluent in identifying aspects of mathematics in context, making schematics, formulating problems to other forms, visualizing problems, seeking connection between information, finding regularity, turning everyday problems into mathematical symbols, or changing everyday problems into a known mathematical model. Figure 2 are some students' answers.

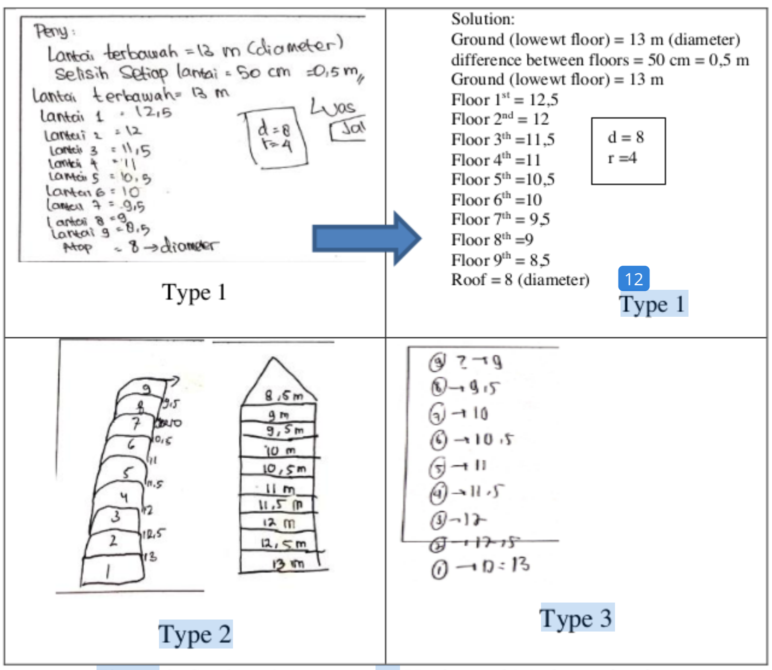


Figure 2. Students' Answers on Horizontal Mathematization

The horizontal mathematization form raised by the students was varied. The first type was visualizing form. The second type was written in numbers 1, 2, and so on until 9 to indicate that there were 9 floors in the building, and the written of numbers 13 m, 12.5 m and so on was to indicate the diameters. The third type was both sketch and numbers.

The observation results showed that the students were confident in writing their answers. In addition to being correct in answering, there were no streaks or other forms of correction made by them. The test results showed that the answers of the other students were also relatively similar to the first type.

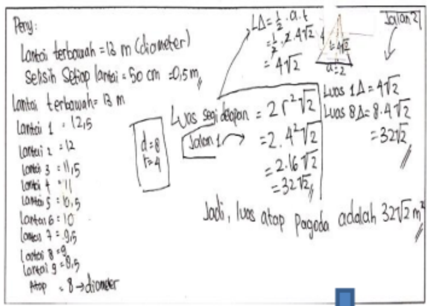
In this study, flexibility was explored at the time of the interview. In addition to telling the solution written on the answer sheet, the students were also asked to think of other strategies that could be used to answer the first problem. The results of the interviews showed that only high-ability students could display horizontal mathematization in other forms. Another alternative strategy made by the student led to one of the forms shown in Figure 2. From the students' answer sheet, only five students were categorized as flexible.

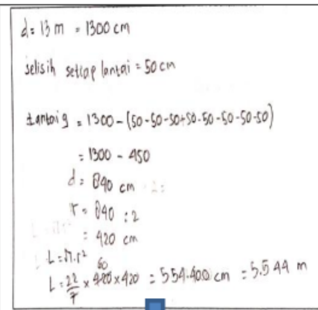
The originality in horizontal mathematization was depicted from the unique form of representation displayed by the students. It is indeed quite difficult to produce unique answers considered as the original form. Based on the form of answers written by the students, the originality was seen from the form that was not common and it appeared that there was little difference between the answers of one student and those of other students.

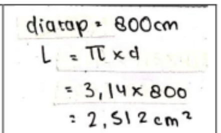
Vertical Mathematization in the First Problem

Fluency in terms of vertical mathematization form was also characterized by the ability of students to apply all related information and related concepts in order to provide correct answers or minimal errors. The fluency was seen from the ability to write mathematical symbols and the mastery of using mathematical concepts and procedures in the process of changing from one symbol to another more abstract mathematical symbol. Specifically, the fluency in verbal mathematical form was illustrated by the ability of the students in expressing a relationship in a formula, showing the regularity of using different models, combining and integrating models, and generalizing. The fluency could also be seen from the detailed strategy described in each step.

There were three types of vertical mathematization. The first type showed the fluency and proficiency in expressing the concept of diameter, radius and using an octagon as a sum of eight triangles. The second type showed incompleteness and wrong concept used causing wrong assumption. The third type showed no sufficient knowledge about the concepts causing the making of a fatal mistake. Based on the interview results, the students were also asked to think of other strategies that could be used to answer the first problem. It was found that there were only three students who were able to display another vertical mathematization form and others did not have another idea to solve this problem as shown in Figure 3.







Solution: Ground (lowewt floor) = 13 m (diameter) difference between floors = 50 cm = 0,5 m Ground (lowewt floor) = 13 m Floor 1st = 12,5 Floor 2nd = 12 Floor 3th =11,5 Floor 4th =11 Floor 5th =10,5 Floor 6th =10 Floor 7th = 9,5 Floor 8th =9 Floor 9th = 8,5 Roof = 8 (diameter) d = 8 r =4 Area triangle $=\frac{1}{2}.a.t$ $=\frac{1}{2}.2.4\sqrt{2}$ $=4\sqrt{2}$ Area one triagle = $4\sqrt{2}$ Area 8 triagle = $8.4\sqrt{2}$ $= 32\sqrt{2}$ Octagonal area is $32\sqrt{2}$ m².	d = 13 m = 1300 cm difference between floors = 50 cm floor 9th = 1300-(50-50-50-50-50-50-50-50-50) = 1300 – 450 d = 840 cm r = 840:2 = 420 cm L = π. r² $L = \frac{22}{7} x420x420$ = 554.400 cm = 5.544 m	On roof = 800 cm L = π x d = 3, 14 x 800 = 2, 512 cm²
Type 1	Type 2	Type 3

Figure 3. Students' Answers on Vertical Mathematization

The originality in horizontal mathematization form was drawn from the unique form of representation displayed by the students. It is indeed quite difficult to produce a unique answer because this vertical mathematization form contained the use of concepts, procedures, and other mathematical operations. However, if the students could show distinctive differences in using symbols and were able to change them in other forms, their answers were categorized as original. From the results of the analysis, it was found that there were only three students described as having the original answers.

Horizontal Matematization on the Second Problem

The students used the same method as in the first problem to solve the second problem. There were three types of horizontal mathematization. The first type was visualizing the problem using rectangle. The second type also used visualizing but it was a little different from the three images made, in which the visualizing shape as five floors was used. The third type did not use shape as horizontal mathematization. The curved lines represented the movement from one floor to another. The horizontal mathematization is shown in Figure 4.

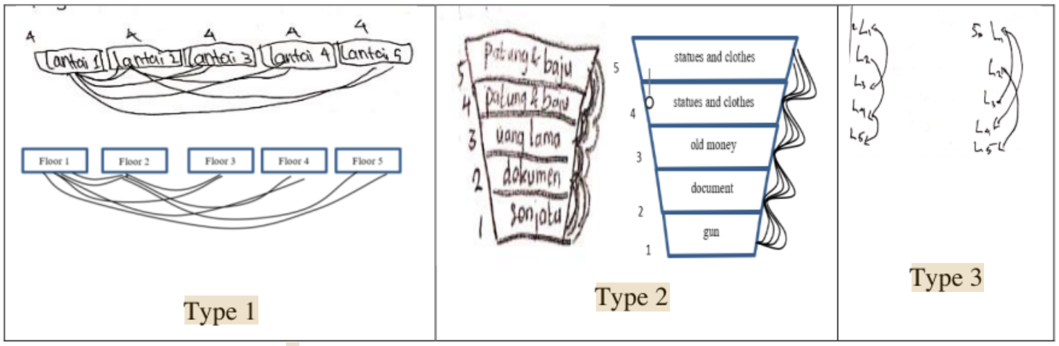


Figure 4. Horizontal Matematization on the Second Problem

The flexibility was explored at the time of the interview. In addition to telling the solution already written on the answer sheets, the students were also asked to think of other strategies that could be used to answer the first problem. From the interviews and answer sheets, 14 students could display horizontal mathematization form in another form. Although other alternative strategies were made, they still led to one of the forms as shown in Figure 4.

The originality in horizontal mathematization form was drawn from the unique form of representation displayed by the students. It is indeed quite difficult to produce unique answers considered as the original form. Based on the answers written by the students, the originality was seen from the form that was not common and it appeared that there was a little difference in the answers of one student with the other students'. Based on the students' answer sheets, there were only four students categorized as original.

Vertical Matematization on the Second Problem

The fluency was seen from the ability to write mathematical symbols and mastery of using mathematical concepts and procedures in the process of changing from one symbol to another more abstract mathematical symbol. There were only two strategies used by the students in solving the second problem which were almost the same, and only a few mathematical symbols and mathematical operations were used to solve the second problem. From the analysis results, there were 14 students categorized as fluent in doing vertical mathematization form. Through the interviews, there were 10 students who were categorized as flexible and they generally stated that they used the form of "4 + 4 + 4 + 4 + 4." It was because in one floor there were 4 possibilities of items that could be filled and in the *Monpera* building there were 5 floors that would be reorganized, so they used the above strategies. The second problem was the most difficult one to determine the originality in vertical mathematization form because almost all the students tended to answer with the same strategy. In the interview the students stated, "The second problem is a problem that is not too complicated even though there are elements of deception."

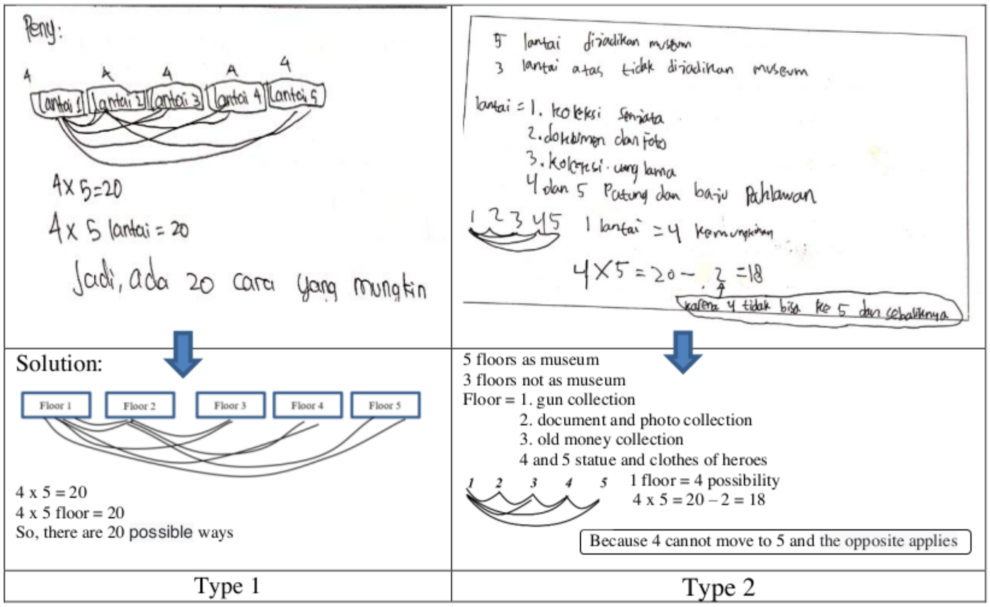


Figure 5. Vertical Matematization on the Second Problem

Discussion

The main objective of this study was to describe the creativity of students in solving the non-routine problems. The results of this study seem to imply that the non-routine problem in the "Palembang" context is not only for high-ability students but also for medium and low-ability students.

High-ability students tend to use short strategies and directly use formal mathematical symbols. This is in line with the opinion of Minarni, Napitupulu, and Husein (2016) suggesting that students who have a formal understanding tend to use symbols in representing mathematics. Those fluent in vertical mathematization are certainly automatically fluent in horizontal mathematization form. This is in accordance with Siswono (2010) stating that one's ability to think creatively higher if s/he can show many possible answers to a problem. They can process knowledge better than others, they are able to combine the ideas they have, and the ideas are from the knowledge they have learned. High-ability students tend to be more flexible than moderate-ability students, but they tend to display answers that are not original. This is in line with the opinion of Siswono (2010) that mathematically capable subjects can solve problems clearly but are unable to use more than one alternative solution and do not provide an element of novelty.

Students use their own strategies and tend to start with informal forms such as describing the situation of the problem in horizontal mathematization form. This is in line with the opinion of Arcavi (2005) pointing out that students use informal forms such as pictures and so on as an effort to understand something like a problem. Students are fluent in horizontal mathematization form but not fluent in vertical mathematization one. These students have been able to understand the problem, but they are confused in choosing and using procedures. This is in line with the claims of Yimer and Ellerton (2009) that many students can understand the problem, but they lack the skills to create procedures that will guide them in the right direction. Moderate-ability students display fluency, flexibility, and originality. It is in line with the opinion of Siswono (2010) stating that creative thinking has two assumptions, namely everyone can be creative to a certain degree in a certain way and the ability to think creatively is a skill that can be learned. In other words, a person has a different degree of creativity and has their own way to realize their creativity. Amabile also explained that someone can have the ability (higher or lower degree) to produce new works and in accordance with their fields, so they are said to be creative.

Moderate-ability students can understand the problem but do not know what procedures are used to solve the problem. This is in line with the opinion of Tambychika and Meerah (2010) pointing out that students who lack knowledge of heuristics problem-solving will have difficulty in solving mathematical problems and provide incorrect answers, conclusions, and recommendations. Some of them are unable to get points because they fail to get the right answer on some problems and feel difficult to estimate the solution to the problem. İncebacak and Ersoy (2016) state that this failure results from the fact that the students do not have enough knowledge to solve problems. Their solutions seem incomplete and unclear. Dendane (2009) emphasizes that students should not only learn mathematical content, but also study the use of mathematical content to develop thinking skills and solve mathematical problems.

CONCLUSION

Based on the results of the data analysis, the high-ability students were more fluent and flexible in solving problems, but their provided solutions were categorized as less original and they tended to use formal mathematics in the form of formulas, symbols, and mathematical operations. Meanwhile, moderate-ability students tended to start their work by simplifying problems and displaying them in the form of visual images. From their answer sheets, their originality of thinking, flexibility, and fluency showed their understanding of the problems and solution. Still, different results were obtained from the low-ability students. They tended to have difficulty in understanding problems and there were many errors in solving the problems resulting from their inability to write the known data and relate them to other facts they had already learned. Consequently, the aspects of fluency, flexibility, and originality could not be seen in their answers.

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