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How is the elementary students' creative thinking process in solving fraction problems using geometric and algebraic solutions?

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ABSTRACT

This study aimed to explore students' creative thinking process in fifth-grade elementary school in fraction problem solving based on gender differences. Subjects consisted of one male and one female with high mathematical ability. Data were collected by task-based interviews and analyzed through the sequence: data classification, data reduction, data presentation, interpretation, and conclusions. The creative thinking process in this research is a series of stages that students go through in creative thinking, including: exploring facts, identifying problems, generating ideas and completing ideas to produce solutions. By these stages, the subjects produced solutions in geometric and algebraic that showed their creative thinking that fulfilled fluency, flexibility and novelty. The subjects used algorithm solutions by repeating the completion steps. In this research, both subjects related their algebraic solutions with geometric solutions that has been produced. It was found that geometric solutions supported the subjects to deliver algebraic solutions and they related their understanding of fractions concepts to solve the problem. The more students' knowledge or experiences associated with the problem, the more ideas for solutions they found. In this research, it was also found that there were some similarities and differences between the creative thinking processes of both subjects.

INTRODUCTION

Creative thinking skills need to be encouraged and supported in solving various life problems. In learning in school, student's creative thinking skills need to be developed in problem-solving which is an integral part of the teaching and learning process. Students who have a creative thinking not only uses mathematical knowledge they have acquired during the learning in solving the problem, but can use new strategies and unusual in solving their problems (Wessels, 2014). Creative thinking skills are also considered to have a positive correlation with students' academic achievement (Ramdani, 2021)

Creative thinking is defined as a mental process that leads to a new finding (Hong and Milgram, 2010). Creative thinking is also defined as a thought process that constructs an original answer or idea (Travers, 1979). Stenberg (2007) states that creative thinking is defined here as thinking that is novel and produces ideas of value. The creative thinking process includes synthesizing ideas, generating ideas, and implementing ideas. Creative thinking includes the ability to make decisions and usually produce new products (Krulik and Rudnick, 1999). Osborn, in 1952, introduced a model of creative problem-solving. Since then, this model has been called "Creative Problem Solving (CPS)"

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and has become one of the most widely used approaches to train creative thinking. Osborn describes the creative thinking process in three stages: 1) *fact-finding*, 2) *idea-finding*, and 3) *solution-finding* (Evans, 1991).

Creative thinking is not a single skill but involves many dimensions, such as sensitivity to problems, fluency (able to generate many ideas and associations), flexibility (producing different ideas about the same stimulus and using different approaches to each other), originality (producing new and rare ideas) and elaboration (applying careful and detailed processing to expand the available simple stimulus) (Bakir and Oztekin, 2014). This is as stated in Silver (1997) that mathematical activities such as problem-solving and problem-posing are closely intertwined with creativity, which includes fluency, flexibility, and novelty. Fluency refers to the number of ideas created in response to a command. Flexibility appears in the approach changes when responding to commands. Novelty refers to the new ideas created in response to a command. Furthermore, to identify creative thinking skills in mathematics, two approaches can be used: (1) paying attention to students' answers in solving problems whose cognitive processes are considered as creative thinking processes, (2) determining criteria for a product that is indicated as the result of creative thinking or as divergent products (Haylock, 1997).

Creative thinking process

Osborn's theory has been developed by several experts, both describing and combining several stages of the creative thinking process in problem-solving. Treffinger et al. (Isaksen et al., 2011; Isaksen and Treffinger, 2004; Treffinger, 1995) modify the CPS model into three essential components, namely: (1) understanding the challenge (2) generating ideas, and (3) preparing in for action. Understanding the challenge aims to set goals, prepare and build opportunities to start generating ideas and stay focused. In the first stage, students find facts *(fact-finding)* by exploring their knowledge of the problem. In addition, students also find problems (*problem-finding)* by identifying the problems at hand. In the second stage, students generate ideas by thinking openly to solve problems (Isaksen et al., 2011). This second stage is also called *idea-finding*. In the third stage students develop solutions and build acceptance. At this stage, students evaluate, select, or develop appropriate ideas (Isaksen and Treffinger, 2004). This third stage is called *solution-finding*, the last step before the idea is implemented (Isaksen et al., 2011). Practically, the stages in CPS may not be in this order, and students may flip through the stages several times when solving problems (Isaksen et al., 2011; Treffinger, 2008). The main characteristic of the creative thinking process lies in the generating ideas. The process has the same stages, but it can be more detailed than the others (Siswono, 2008(1)).

Research by Hooijdonk, et al. (2020) describes in more detail the stages in the creative thinking process include fact-finding, problem-finding, idea-finding and solution-finding. In research conducted on fourth and fifth-grade elementary school students by giving two CPS tasks, namely science problems and social problems, the results show that fact-finding and problem-finding are positively related to the number of ideas generated and the originality of these ideas. The success of students in exploring knowledge and understanding of the problem is positively related to the ability of students to find more ideas. Exploration of knowledge is related to the number of ideas that students think so that it is possible to generate more ideas. It was also stated that students' success in understanding the problem can help find the completeness of ideas to produce solutions. By understanding the problem well, students can focus on the idea-finding stage.

Based on the description above, in this research, creative thinking is defined as a cognitive or mental activity that involves the ability to construct new or different ideas in problem-solving. Creative thinking process is a series of stages that students go through during creative thinking (including: exploring facts, identifying problems, generating ideas, and completing ideas to produce solutions). The reviews of creative thinking in this study are fluency, flexibility and novelty.

Fraction problem solving

This research was conducted in fifth-grade elementary school by providing more specific problem-solving tasks related to the material taught in fractions. According to Orton (1992) states that fractions are essential to primary education curriculum. Almost all of what is taught about fractions in elementary school is continued in secondary school. However, fractions become a complex topic for many students (Singh, 2021, Namkung &Fuchs, 2019). This includes the

implications of learning that is taught directly at the formal stage in the form of manipulative or procedural steps. Hence, it is advised that students build their experiences dealing with fractions in various representations for meaningful learning to occur.

Therefore, it is essential to support students' ability to solve problems involving creative thinking processes to develop various creative problem-solving strategies. The task of fraction problem solving for students can be done by providing everyday mathematical open problems that allow students to involve their knowledge from learning at school and their experiences outside the classroom. As stated by Bragg and Nicol (2011), students need to see and understand the relationship of mathematics when they are in the classroom and outside the classroom, and not see it as separate entities. By looking at the mathematics obtained in the classroom, it is not much different and related to everyday life, it will motivate and encourage students to think creatively. The task must meet the following criteria: (1) In the form of problem-solving, (2) Divergent in the answers and methods of completion so that the criteria for fluency, flexibility and novelty. (3) Relating to more than one student previously studied mathematical knowledge/concept. (4) Information must be easy to understand and clearly capture the meaning, not cause multiple interpretations, and the sentence structure uses good and correct rules (Siswono, 2008(2)). So, in this research, the task is given in an open-ended problem, which allows a variety of answers from students.

Gender differences

One of the factors that are considered influential in learning is gender differences. Santrock (2009) explained that gender bias could occur in learning. Many studies showed mixed results regarding the effect of gender differences on students' ability to solve problems. As research by Betancourt (2022) found that there is a relationship between gender and creativity. There are different results of males' and females' scores on different creativity and creative behaviour measure. However, in reasearch by Sokic (2021) showed no differences between genders except in one of the graphic creativity scales (Details). Hence, these research results provide further evidence that the different measures of creativity are distinct yet partially overlapping components of a coherent construct of creativity.

Based on the description above, it is necessary to research further the creative thinking process of students between male and female students, especially in elementary schools. Because previous research that has been done to describe the creative thinking process is primarily at the middle and high school level, besides that, the different topics of study may give different results or give more profound insights into the creative thinking process of males and females, not only about who has higher score in creativity. That is why it is realized the importance of efforts to explore students' creative thinking process by giving problem-solving tasks that allow them to explore ideas in solving problems creatively. So, this study aimed to describe the creative thinking process of male and female students in fifth-grade elementary school in fractions problem-solving.

METHODS

Type of research

This research type is exploratory, using a qualitative approach. The qualitative approach was chosen because data mining must be natural and in-depth in the subjects' activities in providing written and oral answers. This research was conducted exploratory because data collection was carried out by observing the subjects solving the problem and then exploring more deeply through interviews. This was aimed to describe the analyzed aspect of the subjects clearly. The assessment was carried out in detail, which was more process-oriented.

Research subject

This research was conducted on fifth-grade students of Elementary School. Subject selection was based on the students' mathematical ability when they were given the mathematical ability test (MAT). MAT was a test used to classify the level of mathematical ability of research subjects. The MAT consists of 10 questions taken from the National Examination questions in Elementary School. The National Examination questions are assumed to have good validity and reliability of the items. The MAT questions are in the form of descriptive questions containing structured answers using special mathematical knowledge and skills so that the results reflect the actual level of mathematical ability. The MAT was given to fifth-grade students of SD Muhammadiyah 4 Surabaya in grades V-G and V-C.

From the test results, students were grouped: the high mathematical ability group for students with a test score ≥ 80 and the non-high mathematical ability group for students with a test score < 80. Students were grouped until at least one male subject and one female subject were in the high mathematical ability group. Subjects were selected from the high mathematical ability group to support the emergence of aspects of the creative thinking process according to the indicators used in the study. The researcher also considered suggestions from a school mathematics teacher. Consideration of subject selection is also based on the ability to adapt and communicate with others obtained from observations and information from the teachers in the classroom.

Research instrument and validation

By the type of research, qualitative research, the main instrument in this study is the researcher. In contrast, the supporting instruments are the mathematical ability test (MAT), fractional problem-solving test (FPST) and interview guidelines. The MAT instrument was used to determine the research subject. The FPST instrument was used to collect data. The material in the problem is developed based on the curriculum that applies at the elementary level. Responses written or expressed by the subjects in each step of problem-solving were used as a guide to analyze the subjects' creative thinking process. The FPST instrument has been validated by 2 mathematics lecturers and 2 mathematics teachers. The FPST instrument in this study is formulated as follows.

> *The first person has 5 cakes and the second person has 3 cakes (all are the same shape and size). Then it comes the third person who does not have the cake. If the whole cake is to be divided among these three people with everyone getting an equal share, then:*
> *(a) Create a variety of possible ways to share the cake! How do you make the possibilities of dividing the cake?*
> *(b) Choose one possible cake sharing that can be done as you have made in part (a), then show it in another different way to complete the possibility!*

The researcher used triangulation techniques to ensure the validity of the data, namely time triangulation. In this triangulation, the question above was used as FPST1 and FPST2. FPST1 was given to the subjects in the first study and FPST2 was given in the second study. FPST 3 was given when parts of the students' work results in FPST1/FPST2 were not yet valid. FPST3 was formulated as questions, which were essentially the same/equivalent to the question in FPST1/FPST2.

Data collection and analysis procedure

Task-based interviews carried out data collection. The subjects worked on math problems by writing answers and expressing their thought. If the subjects did not reveal their thought process, the researcher asked open-ended questions to get responses. All subjects' activities while solving math problems were recorded with a video recorder. Data validation was done by comparing data from FPST1 and FPST2. If there was consistency, then it was taken as valid data, and if parts were not yet valid, comparisons were made on the invalid data with FPST3. Furthermore, the valid data were analyzed. Data analysis in this research included: data classification, data reduction, data presentation, interpretation and conclusions.

FINDINGS

This research uses 4 main stages of creative thinking process: exploring facts (*fact-finding*), identifying problems (*problem-finding*), generating ideas (*idea-finding*), and completing ideas to produce solutions (*solution finding).* By these stages, the subjects produced solutions in geometric and algebraic.

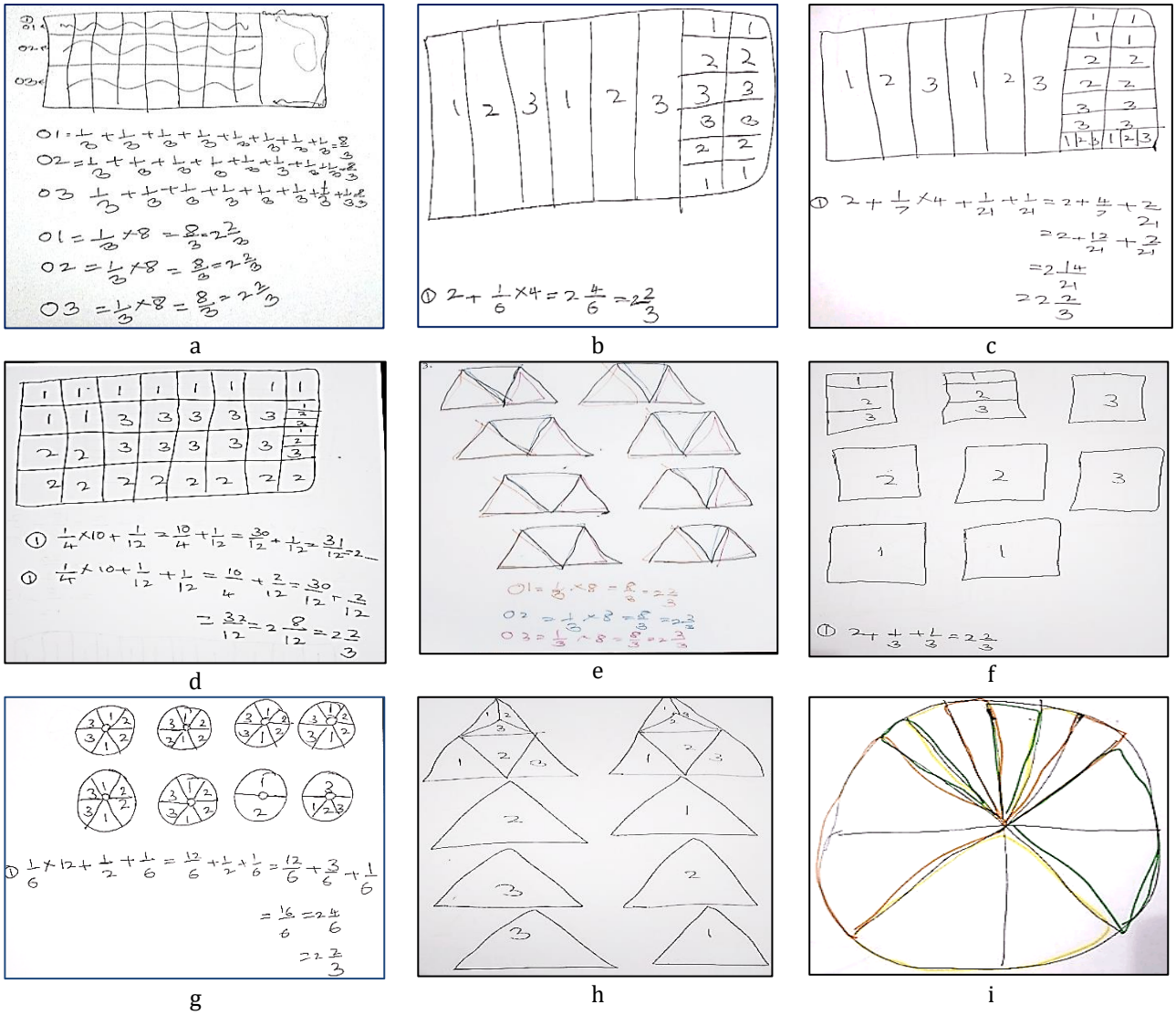
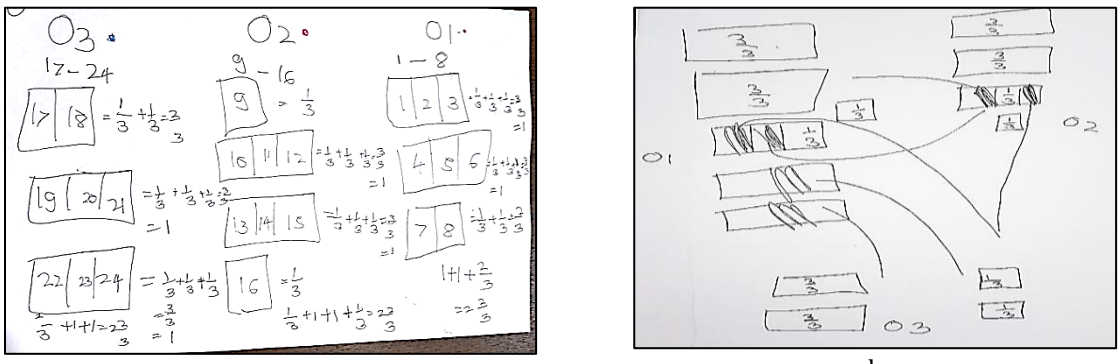


Figure 1. Some work results of male subject (MS)

Male subject (MS)

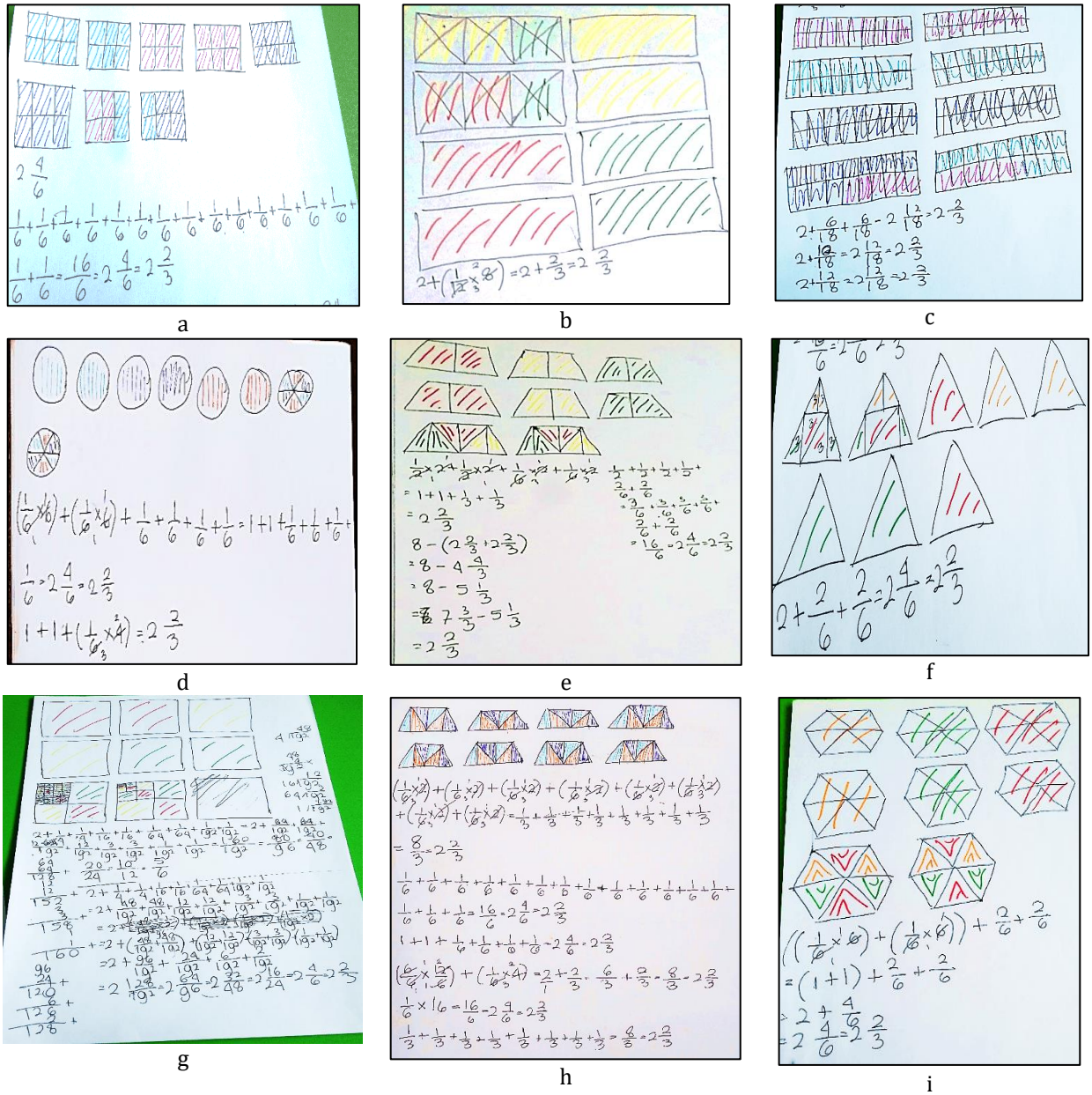
In this research, MS solved the problem by linking the information that was known on the problem and understanding of the problem with the subject's knowledge of flat shapes and image forms related to real life. With the subject's knowledge of various flat shapes, the subject produced geometric solutions such as rectangle, trapezoid, square, circle, triangle and a circle-shaped solution that was seen as a pizza. MS also produces algebraic solutions related to geometric solutions. These work results of MS in solving the problem as in the Figure 1.

In solving the problem by geometric solutions, MS produced solutions that was developed from previous solutions. As in Figure 1 (a –i), MS changed the way the images are placed (merged and split), changed from cropping all images to cropping in parts and vice versa, and changed from cropping by multiples of 3 to other than multiples of 3. MS also solved the problem by building ideas



a b

Figure 2. Work result of MS that different from the previous solutions



a b c

d e f

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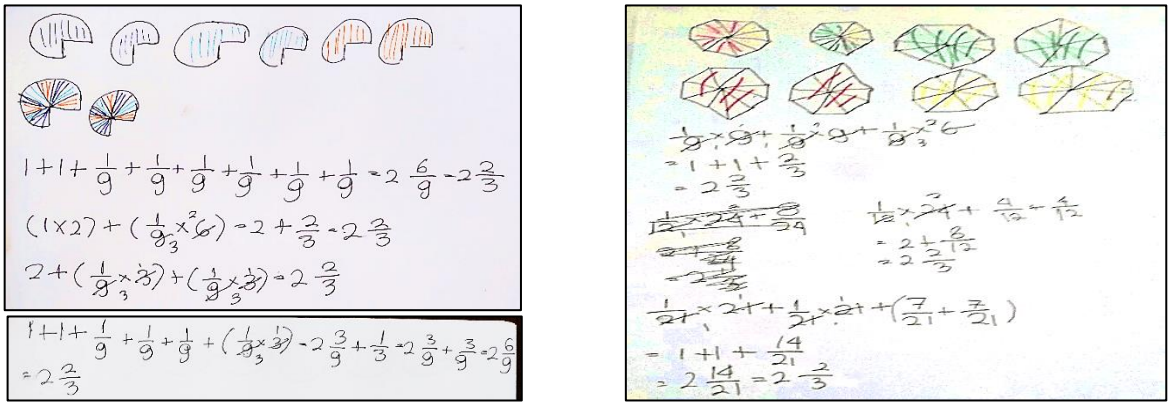
to produce new and different solution from the previous solutions, namely: MS changed his perspective on the problem and changes the completion steps as in Figure 2a, MS analogizes the way to solve the problem with his experience when distributing cakes in real life as in Figure 2b.



a b

Figure 4. Work result of MS that different from the previous solutions

In this research, MS produced algebraic solution based on geometric solution that had been produced. In this case, the subject related parts of fraction in algebraic solution to parts of image in geometric solution that had been produced. The subject solved the problem with linking the information that is known on the problem and understanding of the problem with his knowledge of the concept of multiples. He also related his understanding of fraction concepts and procedures to solve the problem. He used his knowledge of addition, division, multiplication and mixed operations of integers and fractions, so he could produced various solutions in algebraic solutions.

Female subject (FS)

As MS, FS also produced solutions in geometric and algebraic. In solving the problem by geometric solutions, FS produced solutions by relating the problem with her knowledge of flat shapes and modified images associated with the problem, namely: square, rectangle, trapezoid, circle, triangle and hexagon. Figure 3 shows some work results of FS in solving the problem.

In geometric solutions, FS also solved the problem by building ideas to produce new and different solution from the previous solutions. She solved the problem by coming up with an idea to develop the image used, namely by linking it to information and problems in questions about the number of people. Therefore she produced solution in the form of three-quarter circle as Figure 4a. The subject also solved the problem by coming up with an idea to develop the image used, namely by relating it to his knowledge and previous solutions. Therefore she developed her previouse solution about hexagon to nine-sided as Figure 4b.

In this research, as MS, FS also produced algebraic solution based on geometric solution that had been produced. In this case, the subject related parts of fraction in algebraic solution to parts of image in geometric solution that had been produced. The subject solved the problem with linking the information that is known on the problem and understanding of the problem with her knowledge of the concept of multiples. She also related her understanding of fraction concepts and procedures to solve the problem. She used her knowledge of addition, substraction, division, multiplication and mixed operations of integers and fractions. Therefore she could produced various solutions in algebraic solutions.

The similarites of creative thinking process of MS and FS

MS and FS go through the same stages of the creative thinking process: exploring facts, identifying problems, generating ideas, and completing ideas to produce solutions. This similarity is mainly in the ideas built by linking the information known to the problem and understanding the problem with the knowledge/experience. In solving the problem both subjects used algorithm solutions by repeating the completion steps. The difference is that MS chosed developed ideas along with showing the steps of his work, while FS chosed developed ideas before showing her work steps. Both subjects solved the problems by using geometric and algebraic representations. In fraction problem solving, they produced solutions that show their creative thinking, namely fluency, flexibility and novelty.

The differencess of creative thinking process of MS and FS

At the stage of the creative thinking process, the difference appears when the subjects explore the things that were known in the problem, MS focused more on the critical part of the questions, while FS paid more attention to the information contained in the questions. In conveying the known information on the question, MS paraphrased it by using his own sentence without changing the meaning. In contrast, the female subject conveyed it in detail using the sentence written in the question. MS is more flexible and shows persistence in geometric solutions by choosing geometric shapes that are easier to be draw or partition. FS is more flexible and shows persistence in solving problems using algebraic solutions by manipulating calculations.

MS tends to choose solutions from relatively easy to complex, requiring a shorter time to produce solutions. Meanwhile, FS tends to choose random solutions between relatively easy and complex solutions and takes a longer time to produce solutions. In addition, to produce different solutions, MS tends to focus on things that will differ from the previous solutions. Meanwhile, FS tends to observe in detail at the previous settlement, then modifies or develops it.

DISCUSSION

Based on research result, the main stages of the students's creative thinking process in this study are exploring facts (*fact-finding*), identifying problems (*problem-finding*), generating ideas (*idea-finding*), and completing ideas to produce solutions (*solution-finding*). These stages occur back and forth and are repeated many times as long as the subjects solve the problem. This is what Isaksen et al. (2011) and Treffinger (2008) state that in practice students may flip through the stages in the creative thinking process several times in problem-solving. An explanation of the stages of the creative thinking process of the students in this study is as follows.

Fact-finding and problem-finding

During the fact-finding and problem-finding stages, the subjects solved the problem by reading the question silently to explore the known things and to understand the problem. At these two stages, the male subject (MS) gave more concern on important part of the question, while the female subject (FS) paid attention to detailed information on the question. In conveying the information on the question, MS paraphrased it using his own words, while FS conveyed it in detail using the sentences as written in the question.

Idea-finding

In the idea-finding stage, the subjects related the known information and understanding of the problem with their knowledge or experiences to generate ideas for solving the problem by using geometric and algebraic visual representations. MS related the known information and understanding of the problem with his knowledge of flat shapes and image forms that were associated with real life, so that he generated ideas to draw in various flat shapes and images forms associated with real life. FS related the known information and understanding of the problem with her knowledge of flat shapes and modified images associated with existing problem so that she generated ideas for drawing in various forms of flat shapes and modified images (from the development of flat shapes that was known and associated with existing problem).

Both subjects used some similar geometric solutions, especially in flat shapes. However, there was a difference in how the images was drawn. MS generated ideas to draw the images according to the known information by placing the images together and separately, while FS placed the images separately only. In geometric solution, MS generated ideas to use various ways of showing his solutions, while FS generated the idea to use certain way of showing her solutions.

The subjects related the known information and the problem with their knowledge of dividing two integers and fractional numbers. They used image representation to show their solutions. They also used everyday knowledge/experiences to come up with ideas for cropping images in various directions. MS related the existing problems to the concept of *multiples numbers*. FS related the existing problems to the concept of *divisible numbers*. Their solutions show that they related the existing problem with their prior knowledge and experiences.

The subjects related the geometric solutions with their knowledge of the integers and fractions concepts so that they built ideas to solve the problem in algebraic solution. They understood the fraction as part of the whole and built an idea to determine the fractional value of the parts in the

image. They also understood the concepts of integers and fractions and arithmetic operations on integers and fractions, so they came up with ideas to vary writing in numerical forms. So, most of solutions in the algebraic were adjusted to the results of geometric solution based on the subjects' understanding of the fractions concepts. In problem-solving using algebraic solution, it was found that FS also generated idea of manipulating in the writings and calculations, so she produced many various answers in numerical forms.

By paying attention to the solutions that have been produced, the subjects-built ideas to produce other solutions by developing ideas or combining ideas from previous solutions, repeating the previous completion steps, or using other ideas and other completion steps. For MS, the previous solutions become new knowledge or experiences for him to compare with other solutions by focusing on the part that would be changed to produce a different solution from the existing ones. For FS, the previous solutions became new knowledge or experiences for her to develop the ideas to produce other solutions by generalization. This as stated by Lau (2011) that creative thinking skills generate or bring up a new idea based on previous experience. New ideas emerge from old ideas combined with new ways.

The descripton above shows that the subjects understand relationships among the known information, the problem at hand, and the knowledge/experiences possessed so they can generate ideas to solve the problem. This is as research by Siswanto, et al (2023) that students collect as much related data as possible about the problem, the data then processed analogically to respond to questions. At this stage, the student trains his mind to identify solutions by examining the relationship between the main problem, related problems, and available data.

This study also shows a relationship between fact-finding and problem finding on idea-finding. In the idea-finding stage, the subjects generate ideas based on the knowledge/experiences, which is always associated with the known information at the fact-finding stage and understanding of the problem at the problem-finding stage. The more knowledge involved, the more ideas generated to solve the problem. This is as stated by Hooijdonk, et al. (2020) that students' success in exploring knowledge and understanding problems is positively related to students' ability to find more ideas.

Solution-finding

To produce solutions, the subjects formulated ideas built in a series of work steps by understanding the relationship between the ideas needed to solve the problem. In this stage, ideas were selected, developed, or complemented to produce solutions. MS and FS solves the problem by showing the completion steps as the ideas were built. The difference in showing their ideas in work sheet is that MS chose his ideas step by step and showed the solution in geometric. While FS chose her ideas entirely before showing the solution in geometric. MS chose ideas built gradually, along with showing the work steps. He produces geometric solution first, and then, from it, he related the image form with algebaic solution. So, in this case, MS showed the algebraic solutions associated with the geometric solutions. FS also produced solutions in geometric first. Then, she showed the algebraic solutions associated with the geometric solutions by varying the writing and manipulating calculations.

The solution steps by both students were carried out repeatedly to produce solutions in geometric and algebraic. These solving steps were carried out repeatedly to produce completion after completion. By solving steps like this, the student breaks down complex problem into more straightforward ones. This makes it easier for the subject to focus on a particular part or stage of completion before moving on to another part or stage of completion. The repetition of the completion steps is by a study of a fundamental strategy for problem-solving, which is to break down the problem task into a series of steps. Each step involves a set of rules for which procedures ('operations') can be implemented. These steps are seen as solving algorithms, namely sequences of operations that can be repeated again, which theoretically can guarantee the solution of a problem (Hunt, 1975 & Sternberg, 2000).

This study also found that there was a link between fact-finding and problem-finding towards solution-finding. The exploration of knowledge and the subject's success in understanding the problem affect the completeness of the idea and the application of the idea. The application of these ideas is supported by the subject's ability to establish relationships between the ideas built by forming a series of work steps according to these ideas. In addition, the subject's success in solving

this problem is supported by the subject's ability to relate the final result of the solution to the problem. The subject understands the problem in the question that everyone must get the same piece of cake. The subject believes everyone has the same piece of cake by looking at the final results in geometric and algebraic solution. The subject re-examines and improves the completion steps when the results are unexpected. So, the subject relates the final result and the problem initially. This is what Isaksen (1995) stated: In solving problems, there is a process of closing or eliminating the gap (difference) between what is the problem and what is expected.

Related to aspects of creating thinking process, MS and FS solved the fraction problem that indicated their creative thinking process. The subjects could produce many solutions for the given problem. They built new ideas that were developed and modified from previous solutions. This is as resercah by Ritter, S.M. & Mostert, N. (2017) that Individuals who can think creatively tend to build new ideas and come up with various original solutions.

The solutions of the subject were represented in geometric and algebraic solutions that fulfilled creative thinking aspects of fluency, flexibility and novelty. It was found that geometric solutions supported the subjects to produce algebraic solutions and they better understood the concepts of fractions. This is wahat is stated by Agustini, et al (2017) that learn about geometry not just learn about formula, but we can learn other subjects to solving problems of geometry.

From this research, it was found that the more knowledge or experiences that the subjects associate with known information and the problem, the more ideas can be generated. However, for the application of this idea what is needed is the ability to establish relationships between ideas that are built by forming a series of work steps according to these ideas. In addition, the ability to relate the final result of the solution is also needed so that an examination of the work steps and the final result can be carried out, whether it is by the purpose of the problem or not.

In this research, it was also found that MS is more flexible and shows persistence in geometric solutions by choosing geometric shapes that are easier to be drawn or partitioned. FS is more flexible and shows persistence in solving problems using algebraic solutions by manipulating calculations. This result support the argue that males score higher than females on tests that measure visual-spatial ability (Reilly, 2017). In spatial ability have been shown to yield gender differences favoring males (Reinhold, 2020). This result also support the other study that was suggested that females have a more efficient structural organization for object manipulation knowledge retrieval than males (Lee, 2021)

CONCLUSIONS

The main stages of the creative thinking process that the male subject (MS) and the female subject (FS) go through in this study are exploring facts (*fact-finding*), identifying problems (*problem-finding*), generating ideas (*idea-finding*), and completing ideas to produce solutions (*solution-finding*). In this study, it was found that there were differences in the creative thinking process in fraction problem solving between male and female subjects. The differences appear along all the stages, especially in fact-finding, problem-finding and solution-finding. While in the idea finding, MS and FS have similar ideas built to solve the problem. They both related the information and the problem with their knowlede or experiences to generate ideas for solving the problems using geometric and algebraic representation. In the solution-finding, there are some similarities and differences between selected and developed ideas by the subjects. With selected ideas shown in the work steps, the subjects produced many correct solutions. Although both of them used an *algorithm solution* in the form of repetition of completion steps, the way they chose their ideas and show them in their wrok steps are different. The difference was that MS chose his ideas along with showing his work steps, while FS chose her ideas before showing her work steps. This study shows that the creative thinking process of the students in fifth-grade elementary school in fraction problem solving fulfills the creative thinking aspects of fluency, flexibility and novelty. This study indicates that in fraction problem-solving, geometric solutions supported the subject to produce algebraic solutions and they better understood the concepts of fractions. Other findings are about the importance of subject's understading of the fraction meaning as a part of a whole, which includes an understanding of "equal parts" and "whole" so that the subjects can determine the fraction value of parts in the image. The research results also show the importance of using geometric representation to solve

fraction problem. However, the subjects can produce solutions in algebraic by mentally representing the images and generalizing the solutions from the previous solutions

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AUTHOR'S DECLARATION

Authors' contributions	ST: main idea, conceptualization, data analysis, and wrote the manuscript, IKB and SMA: supervision and review.
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Competing interests	The authors declare that the publishing of this paper does not involve any conflicts of interest. This work has never been published or offered for publication elsewhere, and it is completely original.

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