Research Article doi: 10.12973/eu-jer.9.3.1281

European Journal of Educational Research
Volume 9, Issue 3, 1281 - 1295.
ISSN: 2165-8714
http://www.eu-jer.com/

Primary School Students' Creative Thinking Skills in Mathematics Problem Solving

Erna Yayuk*
State University of Malang/ University Muhammadiyah of Malang, INDONESIA

Purwanto
State University of Malang, INDONESIA

Abdur Rahman As'ari
State University of Malang, INDONESIA

Subanji
State University of Malang, INDONESIA

Received: April 13, 2020 ▪ Revised: June 5, 2020 ▪ Accepted: July 14, 2020

Abstract: This study aims to analyze students' creative thinking skills in answering the problem-solving questions. This study employs qualitative design, involving 110 fifth graders in Malang Municipality and Regency as the subjects. The obtained data were analyzed using the descriptive-explorative approach. The findings reveal that the high-achievers in Mathematics showed good skills in the aspects of fluency and flexibility, but were still struggling in the novelty aspect. The average-achievers showed good skills in flexibility aspects but were lacking in the fluency and novelty aspects. They showed an understanding of Mathematics problems but found it difficult to decide the solving strategies, and thus their answers were lacking in structure and less systematic. When solving a problem, the calculation made seemed rushing, was less careful, and frequented with trial and error strategy. The low-achievers showed difficulties in understanding the problems. Their answers were not systematic, not well-structured, and not detailed. This indicates that the low-achievers had not shown creative thinking skills in fluency, flexibility, and novelty aspects.

Keywords: *Mathematics problem solving, creative thinking, primary students.*

To cite this article: Yayuk, E., Purwanto, As'ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281-1295. https://doi.org/10.12973/eu-jer.9.3.1281

Introduction

In primary school level, Mathematics is one of the compulsory subjects which is taught to train students to think logically, analytically, systematically, critically and creatively. Studies show that there are significant correlations among creative thinking skills, learning achievement and the whole education implications (Anwar et al., 2012; Saragih & Napitupulu, 2015). Therefore, it is safe to say that higher order thinking skills play a crucial role in high Mathematic achievement. Higher order thinking is skills to manipulate and make use of the existing knowledge and experiences to think critically and creatively in order to decide and solve daily problems (Sari & Yunarti, 2015; Soeyono, 2014; Supardi, 2015). As a consequence, Mathematics learning at schools needs to be emphasized on the development of students' creative thinking skills which serves as one of the characteristics of higher order thinking skills. Creative thinking skills, also termed as creativity, are argued to guarantee one's Mathematic skills development as a whole (Nugraha & Mahmudi, 2015; Nuryanti, 2016, Pehkonen, 1997; Sriraman & Lee, 2011, Sunaryo, 2014).

According to Pehkonen (1997), creative thinking is a higher order thinking skill that is logical and divergent to construct new ideas ignited by problems that are different and challenging. Specifically, Arends (2009), Papalia et al. (2008), and Nolan (2014) define creative thinking as "*a cognitive function which refers to the ability to generate new ideas and concepts, and the ability to think divergently and productively in an academic domain*" (p.1). This definition indicates that creative thinking is a cognitive function which refers to the ability to produce new ideas and concepts, and the ability to think differently and productively in the academic domain.

Creative thinking involves problem solving that include the initiatives to develop, implement and lead to new ideas. Creative thinking aims to grow original ideas, encourage curiosity, improve flexibility, and increase one's ability in identifying the connections between concepts and ideas in order to design instructional programs (Lombard & Grosser, 2008, Meintjes & Grosser, 2010).

* **Corresponding author:**
Erna Yayuk, Jl. Raya Tlogomas No 246, Malang, East Java, 65144, Indonesia. ✉ ernayayuk17@gmail.com

Ruggiero (1998) asserts that creative thinking is a mental activity that aids in formulating or solving problems, makes decisions, and achieves comprehension. It is the answer seeking and meaning making activities. While according to Kampylis and Berki (2014), creative thinking is defined as cognitive activities that allow students to produce ideas, questions, and hypothesis, as well as to experiment with alternatives and to evaluate their own and their peers' ideas, process and final products. From those definitions, it can be concluded that creative thinking is a process to create new ideas, and to find various alternative answers to a problem.

The ability to think creatively is an important aspect to solve a problem and create or find ideas to solve the problem (Salih, 2010; Okpara, 2007). Creative thinking skills train students to develop ideas and arguments, pose questions, acknowledge correct arguments, and influence students to think openly and to be more responsive towards differing perspectives (Tahir, 2017; Forrester, 2008; Tendrita et al., 2016).

Davis (1984) explains six reasons why Mathematics instruction needs to emphasize creativity: (1) Mathematics comprises a wide and complex knowledge that cannot be taught only through memorizing. (2) Students can find original solutions to a problem by themselves and by doing so attain self-rewards. (3) Teachers need to give students opportunities to show authentic and challenging contributions. (4) Mathematics instructions using memorizing and routine problems demotivate students and may result in low understanding. (5) The support of original ideas is an acquired knowledge, just like creating original proof for mathematical theorems. (6) Mathematics is needed in daily life, and many daily problems are not part of routine and thus creativity is needed in solving them.

The development of communication and information technology, social media, the limitedness of natural resources, and the unpredictable changes demand creative thinking skills and ability. Stein et al. (2007) suggest: "*Virtually every business or industry position that involves responsibility and action in the face of uncertainty would benefit if the people filling that position obtained a high level of the ability to think critically and creative*" (pp. 79-82).

Survey results about the skills needed in the workplace reveal that creative and critical thinking skills are two of the four big skills necessary for business. Mathematics plays a crucial role not only in educating students but also in shaping students' characteristics, including training them how to think creatively. Such skill does not come naturally but is acquired and nurtured from primary to tertiary education level. Such skill and ability need to be developed in every subject, including Mathematics. Those skills need to be taught and trained during teaching and learning sessions. Therefore, teachers are expected to be able to design supportive learning atmosphere to nurture students' creative thinking skill (Newman & Wehlage, 1993; Shriki, 2010; Thomas &Thorne, 2009).

Creative thinking skills have been the one of the objectives of Mathematics education for a long time, either explicitly or implicitly. Based on the observations and discussion with Mathematics teachers in the Greater Malang area, it was revealed that many teachers have the awareness to emphasize creative thinking during teaching, but the format of the current curriculum make them prioritize other aspects more, such as conceptual understanding (Yayuk, et al., 2018). Generally, Mathematics instruction has not provided sufficient opportunity for students to seek answers in different ways from what has been taught. The classroom instruction tends to focus on the development of analytical thinking with routine problems. Many primary school teachers reported lack of updates related to the ways to create mathematical problems that require higher order thinking skills. The demand to achieve the minimum passing grade also pressures teachers to create easier types of questions (Siswono, 2018).

This condition results in students' lack of ability to construct their own ideas and understanding towards mathematical concepts. Thus, students are deprived from developing their creative thinking skills. In Mathematics, it is important to develop creative thinking skills to solve problems, attain new and original ideas, and develop new ideas and make decisions regarding a situation relevant to Math. The awareness to use creative thinking skill needs to be complemented with good instructional planning (Sarwinda, 2013). In the problem solving standard set by National Council of Teacher of Mathematics (NCTM, 2000), creative thinking skill can be implemented and adjusted using various problem solving strategies.

Creative thinking is a crucial cognitive skill to be included in the instructional activity as it comprises discovery process that trains students' creative thinking skills. Teachers need to know the strategies to develop students' creative thinking potentials during the teaching and learning process, as each student has different level of creative thinking skill (Silver, 1997).

Creative and critical thinking skill is seldom applied in Mathematics instruction as the currently implemented instruction model tend to focus on the development of analytical thinking using routine problems. Beghetto (2010) states that researchers have identified various problems in developing students' creativity in the classrooms, some of them are due to the convergent instructional practices and teachers' negative attitude towards creativity. Convergent instruction tend to dominate teachers to 'talk' or more than 70% of teaching and learning time is used to transfer information. Teachers do not accept students' ideas as they are considered disruptive and destructive.

Such practice is usually influenced by the teacher's own attitude and belief which were constructed since school age and also shaped by their environment and past experiences. Many still see that creativity and academic knowledge are separate entities; instruction for developing students' creative thinking skills is different from that for developing their

academic knowledge. Beghetto (2010) exemplified the views of Guilford, Vygotsky and other education experts who connect creativity and instruction. Teachers can support students' creativity at the same time with their academic knowledge.

Mathematics instructions with specific orientation towards developing students' creative thinking in Mathematics are rarely found. School teachers commonly teach Mathematics using memorization and routine problems (Davis, 1984).

Some of the following studies show that there are problems with the attempt to develop students' creative thinking skills: (1) it has not been properly addressed in the instruction, and thus it is important to integrate creative thinking skill into each subject (Rofi'udin, 2000); (2) in the instruction of problem posing and solving, especially in Mathematics subject, students' creative thinking skill is still low, proven by a few number of students who could answer with ease (Palmer & van Bommel, 2018); (3) for several years, teachers only consider creative thinking skill as a process capable to be done individually (Gomez, 2007); (4) teachers do not know the appropriate ways to improve students' creativity during classroom instruction (Laius & Rannikmae, 2014); (5) the approach used to improve students' creative thinking skill is too difficult for students with limited knowledge and skills (Cheng, 2010).

Based on the above discussion, it can be concluded that teachers' motivation and ability to support students' creative thinking skills are still lacking. This conclusion is also supported by the researchers' experiences when giving training and clinical supervisions, as well as when conducting monitoring activities at schools. This condition happens due to the lack of systematic strategies and instructional model which focus on improving students' creative thinking skills for Mathematics subject. Besides, there is a view that says that teaching creative thinking requires students to answer complex problems, while many students still face difficulties for simple problems. In other words, many still view that divergent problems used to support students' creative thinking skills are too difficult. Creativity is part of the higher order thinking skills which is considered important for students to improve the quality of education (Hwang et al., 2007; Yen & Halili, 2015).

One of the strategies to support students' creative thinking skill is through problem solving. Silver (1997) support this by stating that "*inquiry-oriented mathematics instruction which includes problem-solving and problem-posing tasks and activities can assist students to develop more creative approaches to mathematics. Through the use of such tasks and activities, teachers can increase their students' capacity with respect to the core dimensions of creativity; namely, fluency, flexibility, and novelty*" (p.75). According to Bal (2015), it is suggested that importance be given to classroom activities that positively affect the beliefs of primary school teacher candidates in regard to problem solving and learning mathematics. Mehmood (2014) suggests that Problem Solving Method was recommended for teaching of Mathematics at Elementary level and also suggested to add it in teachers training programs as well.

Considering the importance of creative thinking in Mathematics and the lack of research related to students' creative thinking skills in primary school level, there is an urgent need to study students' creative thinking skill in Math. Analyzing primary students' creative thinking skills when answering the problem posing and solving questions is considered important as a basis for determining the strategies, teaching materials and instructional model. Based on the discussion and the previous studies, this research is focused on "primary students' creative thinking skills in answering Mathematics problem solving."

Methodology

Research Design

This study employs qualitative design since the research was conducted in the natural settings with researchers directly go to the source of data. Descriptive research is used in this study. Descriptive research is a study used to describe existing phenomenon in the form of activities, characteristics, changes, connections, similarities, and differences between one phenomenon and others (Sukmadinata, 2011).

Study Group

The subjects of this study were 110 primary school students in Malang city, East Java, Indonesia. The detail was: 35 fifth graders from SD Mapan, 43 fifth graders from SDN Tunjung Sekar, and 32 fifth graders from SDN Kauman. Those students were then classified based their abilities in Math: there were 24 high achievers, 52 average achievers, and 34 low achievers.

Research Instrument

The researchers serve as the main instrument in this research, while the supporting instrument is Mathematics test of problem solving questions. The high level of validity, among other researchers involved in the lives of participants for a long time and trying to confirm and clarify the data obtained with the participants or conduct panel discussions with experts to re-analyze the data that is was obtained. Other activities are conducting in-depth observations to photograph the best possible social phenomena under study such as reality. Furthermore, researchers' efforts to increase dependability (reliability) is by choosing the right method to achieve research objectives. Besides, researchers open

themselves as well as possible by utilizing different methods to achieve research objectives and conduct intensive discussions with others about the various findings and analysis of these findings.

This research made observations six times a month and a half while working on the problem-solving test questions. This data is used to capture the subject's thought process information, especially looking at the subject's expression, the time spent in solving problems, seeing the method used in working on the problem.

The guideline for interview and observation refer to the criteria of creative thinking skills using three indicators: *fluency, flexibility,* and *novelty.* The fluency aspect is characterized by students being able to express ideas and mathematical ideas smoothly and correctly in solving problems. The aspect of flexibility is marked by students being able to use various ways and strategies correctly in solving problems. The novelty aspect is characterized by students being able to use it in new ways, or be different from others in solving problems.

Data Collection

In this research, students' creative thinking skills are trained through test and interview results. The data is analyzed using descriptive-explorative method. The data collection methods used in this research were interview, observation, and document analysis (Moleong, 2002). To gain information about students' creative thinking skills, think aloud and task analysis were conducted to explore their thoughts (Calder & Carlson, 2004; Van Someren et al., 1994).

Data Analysis

The data of students' creative thinking skill was analyzed through written answers by coding and classifying their learning ability in Math. The data that has been collecte dis then carried out the data Coding process or data encoding. This process plays a very important role in the process of data analisys. Where in this activity segmentation process is carried out in the text label wrapping to describe the data. Code in the the form of symbols that represent prominent part or important part of the focus of research in the form of sound data, images, or documen.

This research was also carried out using different data sources from the phenomena studied in the form of texts and the use of guidelines (observations and interviews) that have been validated by experts so that researchers can find the validity of the data through triangulation and member inspection. Triangulation is the process of corroborating evidence from different data, which in this study the data in the form of student work, observations, interviews.

The data from interview and observation were analyzed using content analysis with three concurrent activities: data reduction, data display, and conclusion drawing (Miles et al., 2014). The three data analysis procedure were of no hierarchy, they were interwoven activities that were done before, during and after data collection.

Findings

This section presents the analysis result of students' creative thinking in dealing with Mathematics problem posing and solving, including the students with high, average, and low achievement in Mathematics. The analysis is based on three aspects, namely fluency, flexibility, and novelty.

In the current study, the problem posing and solving learning was started by delivering the goals of the lesson and motivating the students in learning Mathematics. Initially, the teacher asked the students to work individually, and then posed a problem relating to students' daily life. There were two questions provided, and the students were required to answer one question within the provided time limit of 40 minutes. The students were given flexibility in answering the question using any way they wanted based on their background knowledge. When finished, the students were then interviewed to complete the research data.

When the students were answering the questions, the teacher assisted by giving simple and specific questions as scaffolding to understand the question better. After that, the teacher supervised the students' progress. An example of problem posing and solving can be seen on Figure 1.

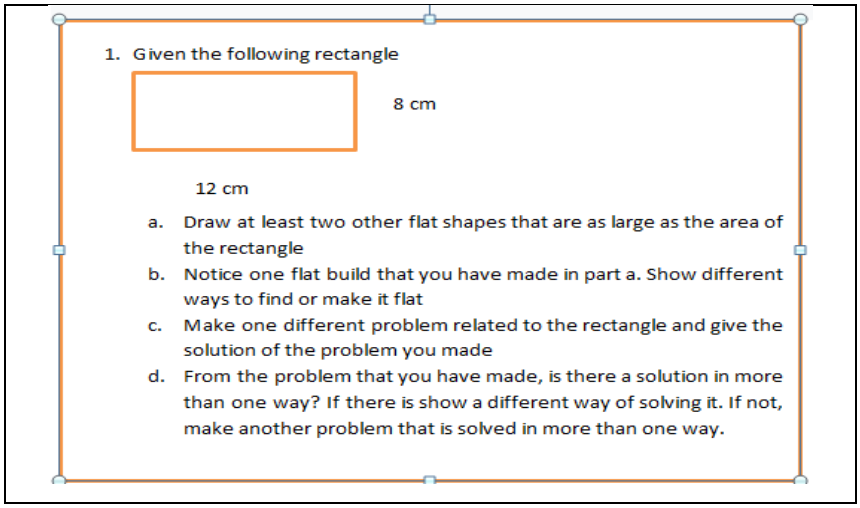

Figure 1. An example of Problem Solving for Question Number 1

The dialogues between the teacher and the students were as follows:

Teacher : "Students, please have a look at question number 1."

Students : "Yes, Ma'am..."

Teacher : "On question number 1, there is a rectangle with the length of 12 cm and 8 cm. Then, on point (a), you need to draw a minimum of two planes which has the same area as the rectangle. Can you find any?"

Students : "Yes, Ma'am..."

Teacher : "How do you know if there are any other shapes which have the same area as the rectangle?"

Students : "By counting the rectangle's area first, and then we look for the other two numbers which, when multiplied, have the same result as the area."

Teacher : "Correct. So, you understand it well, students. Now, do the question by drawing the rectangle first, and then determine the length of each side. Please ask if you find any difficulty."

Students : "Yes, Ma'am. Thank you."

The dialogue indicates that the teacher gave scaffolding to the students to understand Question number 1. Simple questions were proposed to guide students in dealing with the question. After discussing and understanding the question well, the students started finding answers to the question.

The following is the data of the students' strategies in dealing with the problem posing and solving based on their ability in Mathematics:

The Analysis Results of the High Achievers' Creative Thinking in Mathematics

The high achievers acted calmly and confidently in dealing with the problem posing and solving question. It can be seen from their work as described on Figure 2.

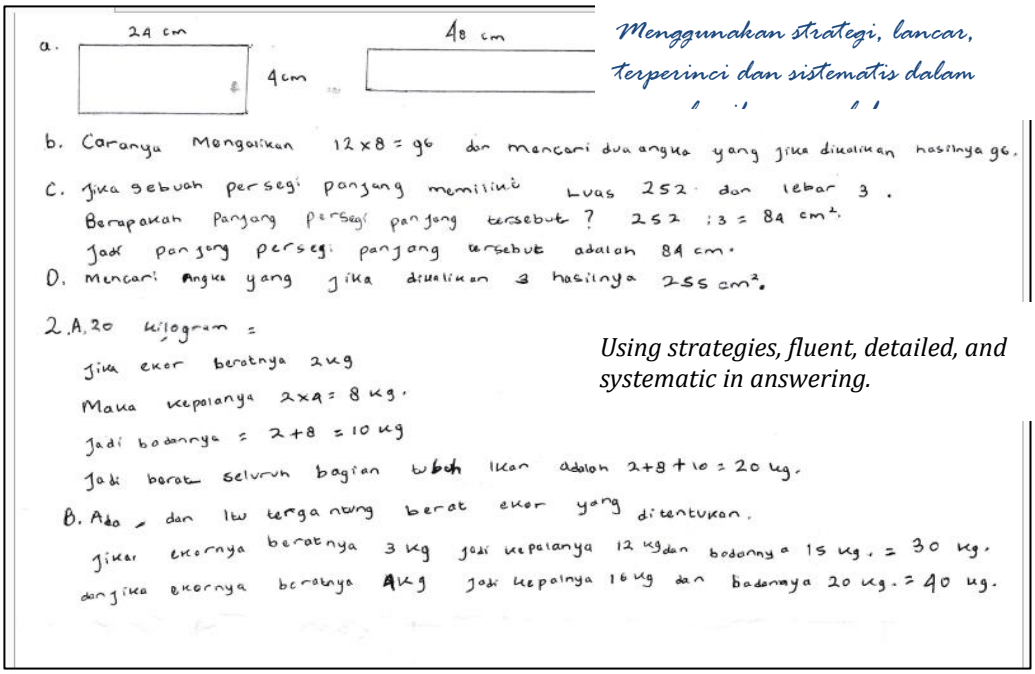

Figure 2. An Example of Problem Solving by Student K

Based on the student K's work, it can be seen that his work looks neat, systematics, and correct. It indicates that he could answer the question calmly and fluently during the process compared to other students. In addition, his answer sheet is full of answers which show that he could understand the question well and thus he could perform appropriate steps in answering the question.

Slightly different from student K's work, another student with the initial C.L could give correct response to the question. C.L showed good problem solving skill because he understood the question well, and then applied appropriate strategies to answer the question. C.L's response can be seen in Figure 3.

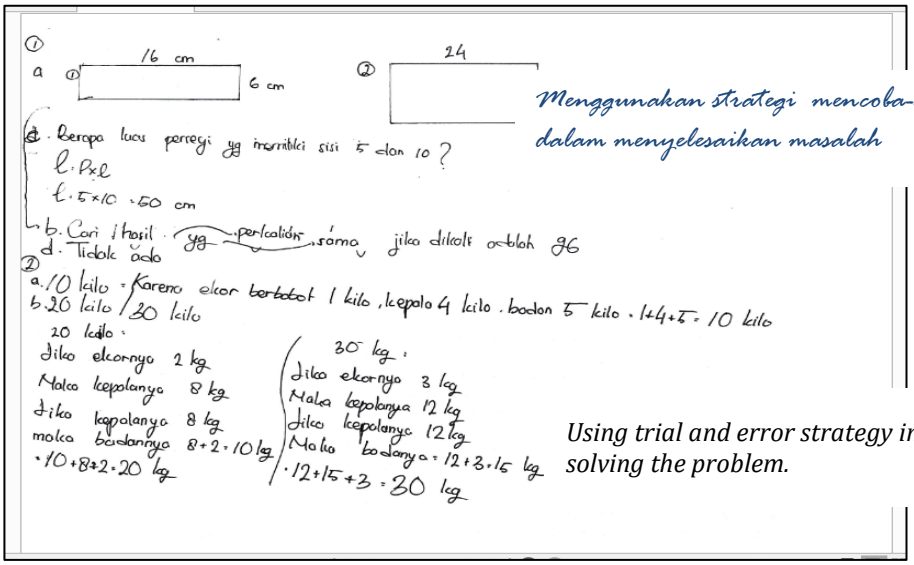

Figure 3. An Example of Problem Solving by Student C.L

Figure 3 describes the student who could solve the Mathematics problem easily. He applied a correct strategy by finding two multiplied numbers which have the same area as the rectangle in the question. After finding the numbers, he then looked for other alternative solutions. After that, he started to draw the shapes.

During an interview, C.L admitted that he could find another solution to answer the question, yet it took him more time to draw the answer on the answer sheet. It can be seen from the following interview excerpt:

Teacher : *"Did you think of another way to answer the question?"*

Student : *"Yes, Ma'am. But it would take too long."*

Teacher : *"Could you please draw it?"*

Student : *"Yes, Ma'am."*

Here is the technique drawn by C.L to solve the same problem.

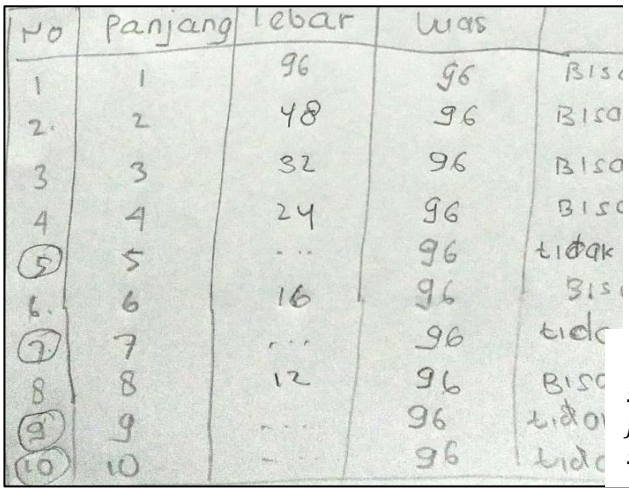

Figure 4. An Example of Problem Solving by Student C.L using Table

Based on C.L's work, it seems that he could do the problem solving easily. He chose table technique to find solution for the question, and then decided the first length (p) and the second length (l). After that, he multiplied both lengths (p x l) so he could get the same area as the rectangle of 96 cm^2. Finally, he could obtain the answer to the question.

Below is another technique drawn by student K to solve the question (Figure 5).

Figure 5. Student K's Problem Solving by "Finding two numbers which, when multiplied, result in the same number as the area"

Here, the flexibility aspect was reflected from student K's ability in deciding two different techniques to solve the Mathematics problems. The second technique was different from the first one, even though they applied the same strategy, which was finding two numbers which could have the same result of 96 cm^2 when they were multiplied.

Based on the steps used by the students in solving the Mathematics question, it can be seen that both of them are systematics and detailed. Accuracy could also be found in the both techniques applied by students K and C.L. Yet, the both techniques were commonly applied by other students, therefore, *novelty* aspect could not be found in solving the problems.

From the above explanations, it can be concluded that the 24 students with high achievement in Mathematics have fulfilled the aspects of *fluency* and *flexibility* when solving Mathematics problems, but most of them still find difficulty in the *novelty* aspect. The data can be seen in Table 1 below:

Table 1. The Data of Problem Solving Ability of High Achievers

No	Problem Solving Ability	Number of Students	Percentage (%)
1	*Fluency*	24	100
2	*Flexibility*	24	100
3	*Novelty*	2	8,33

The data shows that all 24 students (100%) had capability in solving the Mathematics problems *fluently*. They (100%) also met the *flexibility* aspect, and only 2 students (8.33%) who could reach the *novelty* aspect, while others found difficulty.

The Analysis Results of the Average Achievers' Creative Thinking in Mathematics

A student with initials J.S tried to answer the question seriously. The result is shown on Figure 6:

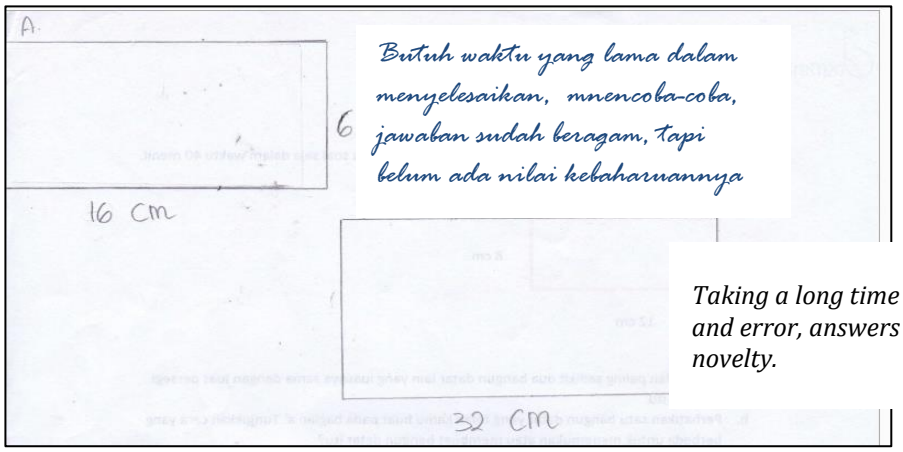

Figure 6. An Example of Problem Solving by Student J.S

In answering Question 1a, initially J.S. could do it fluently. He tried several ways, yet he still failed to find the correct answer. However, after trying hard, he succeeded to get the right answer.

Based on the interview, he claimed that he was confused in deciding the steps to solve the question.

The following interview excerpts support the above statements.

Teacher : "How did you deal with Question 1a?"

Students : "First, I tried to multiply 16 x 4 = 64, and I found that the result was incorrect. The expected result was 96. And then, I tried another numbers, 16 x 5, but it was still incorrect. Finally, I got the correct answer after I tried another numbers, which were 16 x 6 = 96. Honestly, I was confused in finding the fast way to get the correct answer. But, I kept trying again and again. Luckily, I got the answer. But, it took time, Ma'am."

(The students did not realize that the answer lies in the factor material).

Another student with initials S.N, who was categorized as average achiever, also tried to deal with the question like other students. In the initial steps, he found some difficulties. He tried different ways, yet he was confused in solving the problem. His work can be seen in Figure 7:

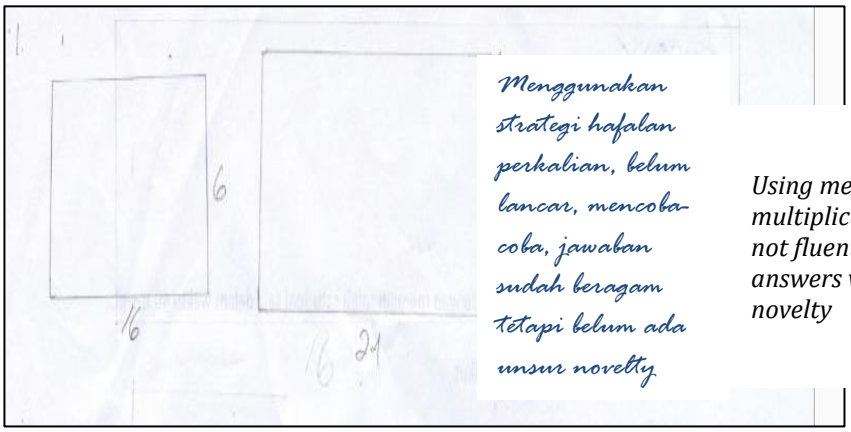

Figure 7. An Example of Problem Solving by Student S.N

From his work, he seemed trying to answer the question by remembering multiplication that he knew which could result in 96, until he finally got the correct answer after he multiplied numbers 16 x 6. With the same method, he tried multiplying other number combination with the same result of 96, and he got numbers 24 x 4 = 96. In fact, this method took him a long time. In this context, the methods applied by students S.N and J.S indicated that they performed their creative thinking on the aspect of *flexibility*, but they found difficulty on the aspects of *fluency* and *novelty*.

Based on the explanation above, the ways of the 52 average achievers in solving the problems can be seen in Table 3 below:

Table 2. The Data of Problem Solving Ability among Average Achievers

No	Problem Solving Ability	Number of Students	Percentage (%)
1	Fluency	16	30,77
2	Flexibility	46	88,46
3	Novelty	0	0

The data above shows that 16 students (30.77%) performed the fluency indicator, 46 students performed flexibility indicator (88.46%), and no students could perform novelty (0 %).

The Analysis Results of the Low Achievers' Creative Thinking in Mathematics

The current section presents the result of the low achievers' works in performing problem solving in Mathematics. The analysis result for question 1a can be seen in the following figure:

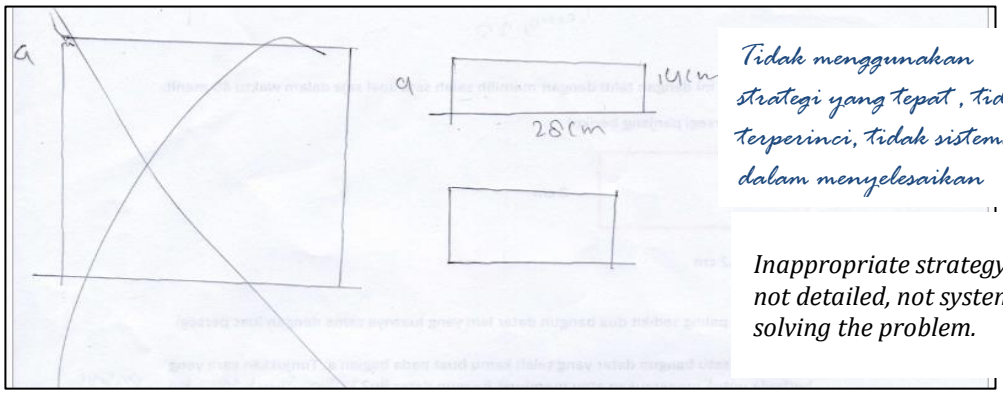

Figure 8. An Example of Problem Solving by Student L.N

Based on student L.N's work, he seems not fluent in solving the question. He did not carefully understand the question even though he had tried to answer the question by drawing a rectangle with certain measurements. He did not re-check the answer whether it was correct or not.

It can be seen from what he wrote, and then he crossed it. Uncertainty in answering the question indicates that the student was not able to answer correctly. He merely focused on the picture that it was a rectangle.

The following is the interview excerpt with student L.N:

Teacher : "How did you answer question number 1a?"

Student : "By drawing a rectangle, Ma'am."

Teacher : "What is the length of each side of the rectangle that you drew?"

Student : "One side should be longer than the other side, Ma'am. Thus, I drew 28 cm for one side and 14 cm for the other side."

Teacher : "Were you sure that your answer was correct?"

Student : "I have no idea, Ma'am. He. he…"

The student's lack of understanding on the question could impact on the wrong strategies and steps they applied in solving the problem. The student only understood that he was required to draw a rectangle with different measurements. He did not pay attention on the requirement that a rectangle should have the same area of 96 cm^2.

During the interview, the student could not realize his mistake. Therefore, he could not meet the *fluency* and *flexibility* aspects. He could not meet the *novelty* aspect in which he did not pay attention on details. The lack in understanding the question and applying steps in solving the problems resulted in irregular problem solving, not systematic, and not details. It appeared that the students seemed to focus on the shape. As the result, he could not answer correctly and novelty did not appear on his way of thinking.

Another student with initials R.H tried to solve the problem for Question 1a. He looked nervous when doing the task, and he took very long time in doing it. The result of his work can be seen in Figure 9 below:

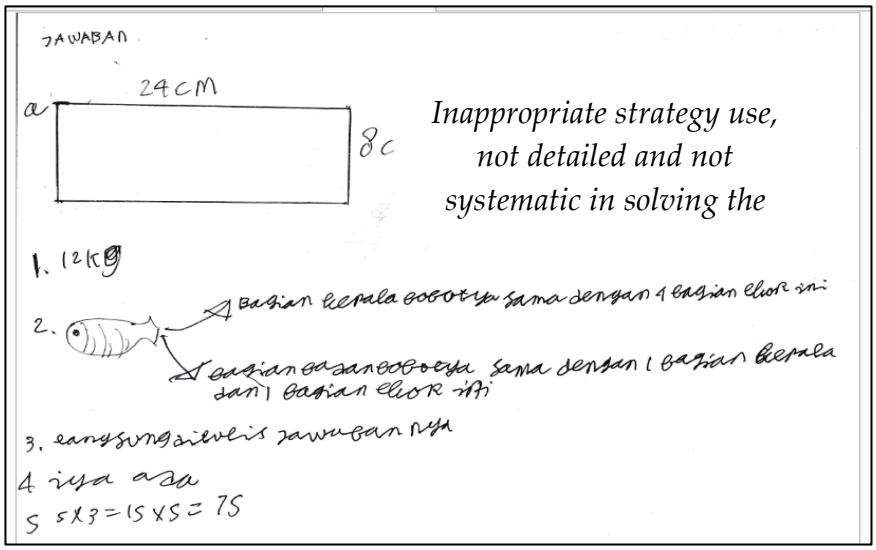

Figure 9. An Example of Problem Solving by Student R.H

Based on the student's work on Question 1a, he seemed to not understand the problem so that he could not solve the problem correctly. He's tried to give an answer, yet his answer was incorrect. The interview with the student is shown below:

Teacher : "You answer the question by drawing a rectangle with each side measurements of 24 cm and 8 cm. Please explain, how did you get it?"

Student : "By looking at the example, Ma'am. That's a rectangle, so I drew the same rectangle."

Teacher : "I see. But, please pay attention on question number 1. The rectangle has measurements of 12 cm and 8 cm. When they are multiplied, then we could get the area. What is the area approximately?"

Student : (He did not answer for long because he could not master multiplication well)... "Wait a second, Ma'am."

Based on the interview, it indicates that the student had not mastered the pre-requisite material, which is multiplication. Therefore, he faced difficulty in solving the question. It impacts on the student's next ability in which he felt difficult in dealing with another Mathematics problem. The results of the low achievers' problem solving can be seen in the following table:

Table 3. The Data of Problem Solving Ability among Low Achievers

No	Problem Solving Ability	Number of Students	Percentage (%)
1	Fluency	8	23,52
2	Flexibility	3	8,82
3	Novelty	0	0

The table shows that 8 low achievers (23.5%) could meet fluency indicator. However, there are only 3 students (8.83%) who could meet flexibility indicator, and no students who could meet the novelty indicator.

Discussion

Having creative thinking can produce new ideas in understanding certain problems. The ideas could lead to finding some ways in solving a problem. In problem posing and solving, there are three aspects or indicators to decide creative thinking skills in Mathematics, including *fluency*, *flexibility*, and *novelty* (Haylock, 1997; Krutetskii, 1976; Pehkonen, 1997, Silver, 1997). In this study, it was found that students were able to demonstrate their ability to think creatively in solving problem-solving problems. Although some students are not optimal. This finding is based on the results of tests, observations and interviews during the learning process which includes indicators: (1) students being able to express ideas and mathematical ideas smoothly and correctly in solving problems (fluency), (2) students being able to use various ways and strategies correctly in solving problems (flexibility), (3) students being able to use it in new ways, or be different from others in solving problems (novelty). These findings are consistent with the opinion of Craft (2005) which says that indicators of creativity are fostered by teachers and parents when someone shows "flexibility, intelligence and novelty" in their thinking. This type of creativity is included in the Mini-C category, where Mini-C is

defined as 'novels and meaningful personal interpretations of experiences, actions, and events' (Beghetto & Kaufman, 2007, p. 73).

Based on the findings, high achievers could understand Mathematics questions well. They could produce many ideas smoothly. They could also answer the proposed questions within approximately 25 minutes, much faster compared to other students, and their answers were correct (*fluency* aspect). This creativity may not be visible to outsiders and may consist purely of ideas and connections that the learner creates. As Vygotsky (1967, p. 7) explains: 'Any human act that gives rise to something new is referred to as a creative act, regardless of whether what is constructed is a physical object or some mental or emotional construct that lives within the person who created it and is known only to him'.

Students who have the low ability in mathematics have more difficulties compared to students who have moderate abilities. To understand the problem, they still find it difficult. This research shows that a person cannot think creatively unless someone knows to think creatively. 'Creativity represents a balance between knowledge and freeing oneself from that knowledge' (Johnson-Laird, 1988, p. 207, quoted by Sternberg, 2012, p. 4). On the aspect of the results of this study is supported by the opinion of Siswono (2014) which states that for each student who has different levels of ability in doing sites, contracting ideas, planning and choosing strategies and implementing from what has been planned is different.

The questions presented in this study are in the form of solving mathematical problems. With this problem-solving model, it can challenge the mind and nuance of puzzles for students so that it can increase curiosity, motivation, and persistence to always be involved in mathematics. This agrees with Taplin (2007) which emphasizes the importance of mathematical problem solving through three functional, logical, and aesthetic values. Functionally, problem-solving is important because, through problem-solving, the value of mathematics as an essential discipline can be developed. With a focus on mathematical problem solving as a tool in solving problems can be adapted to various contexts and everyday problems. Apart from being a tool to improve mathematical knowledge and help understand everyday problems, problem-solving is also a way of thinking (way of thinking). In this last perspective, problem-solving helps us improve the ability of logical and creative reasoning. Finally, problem-solving also has aesthetic values. Problem-solving can also challenge the mind and nuances of puzzles for students.

Instruction asking students to think about their questions in this study is a very valuable activity. Guy Claxton (quoted in Scales, 2013, p.250) points out: 'Asking good questions is the basis for becoming a successful learner. If children don't ask questions, they are being scooped'. Students who formulate questions can illuminate their current thinking, help guide instruction, and become creative activities in their way.

Somebody with creative thinking surely needs sensitivity in understanding problems they face. They would consider any given information, connect several related concepts, decide some steps to solve the problems, and apply their imaginations to create new ideas. When students are given non-routine problem posing and solving questions, they could produce different correct responses. From their way of thinking, there is similar patterns, starting from how the students understand the questions, then start to plan strategies to solve the problems, and think of a number of alternative solutions. 'Piaget suggested that 'to understand is to invent' (1976, cited by Richards, 2007, p. 95) meaning that a learner 'invents' an understanding of new material for themselves. Mini-c creativity could describe a learner's achievement in finding several different ways of approaching a maths problem. It could also involve making a new connection between their existing knowledge and a new piece of information which helps them to understand the subject more fully.

The above explanation is in accordance with Siswono (2004), Kaufman & Beghetto (2009) who argued that creative thinking is needed to solve Mathematics problems fluently, systematically, and thoroughly to produce correct and extraordinary solutions based on students' ability. Different results which do not follow certain patterns are called extraordinary results.

The findings support a research by Anwar et al. (2012) which found that there is a significant relationship between creative thinking and students' learning achievement. This result is supported by Saragih and Napitupulu (2015) who claimed that students' academic achievement could be predicted based on their creative thinking skill.

When solving Mathematics problems, students could face a number of challenges such as in understanding the questions. It is because the Mathematics problems could be new for the students to deal with (Yayuk et al., 2018; Yayuk, 2019).

When students find it difficult to solve problems and find solutions, help from the teacher by stimulating students' thinking to start solving problems is urgently needed. This supports the opinion of Sharan (1990) who said the teacher is a learning facilitator who guides student tracking, asking questions that can broaden their understanding, and encourage students to convey their thoughts.

One limitation of this study is that the types of questions used are not simple and the types of questions used are less varied and contextual. Nevertheless, our findings that given complex questions, can foster students thinking creatively and this is still rarely done by teachers and there is rarely research that discusses this at the elementary school level

Conclusion

Based on the result of findings and discussion, it can be concluded that the elementary school students of Grade V still find difficulties in dealing with problem solving lesson using a non-routine problem, specifically those categorized as having low and average ability. While the students with high ability find no significant difficulties in dealing with Mathematics problem solving.

The high achievers found no difficulties in understanding the questions provided. Their initial ideas came up, proven by the use of different strategies in solving the questions. They found no significant barriers. Their works seemed fluent, thorough, structured, and systematic. *Fluency* and *flexibility* aspects were fulfilled. However, the high achievers cannot reach the *novelty* aspect.

On the other hand, the average achievers faced some difficulties in dealing with the Mathematics questions given. As the result, the solutions proposed were not well structured, not thorough, and not systematic, especially on question number 1. The students were less careful when solving the problems. The strategies they applied were trial and error. Even though the strategies were successful, it reflects the students' average ideas (creative thinking). The *flexibility* and elaborative elements could be met, while *fluency* and *novelty* could not be met yet. The average achievers were less creative in dealing with Mathematics questions.

Lastly, the low achievers found difficulties in understanding the questions. The ideas they had tended to be trials and errors, not structured, not systematic, and not thorough. As the consequence, they faced difficulties in applying strategies to solve the problems. The creative thinking indicators did not appear on low achievers in dealing with Mathematics questions; or in other words, they are not creative.

Suggestion

Suggestions from researchers to the teacher, namely (1) to increase student activity, develop reasoning abilities, and creative thinking students can apply problem Solving learning through the presentation of problems that are familiar with students and (2) the presentation of contextual problems can be used as a bridge towards formal mathematical concepts so mathematics will be more meaningful for students.

Based on the weaknesses of this study, it is recommended to do further research by adding various types of questions that are varied and contextual, the number of respondents is not too much so that the observation activities of children are more in depth when solving question.

Limitations

Some limitations of this study include the large number of students involved in working on problem solving resulting in less than the maximum when observing at the moment of working on the questions, the types of questions used are not simple and types of questions used are less varied and contextual.

References

Anwar, N. M., Aness, M., & Khizar, A. (2012). Relationship of creative thinking with academic achievements of secondary school students. *International Interdisciplinary Journal of Education, 1*(3), 12–24.

Arends, R. (2009). *Learning to teach*. Mc Graw Hill Companies.

Bal, A. P. (2015). Examination of the mathematical problem-solving beliefs and success levels of primary school teacher candidates through the variables of mathematical success and gender. *Educational Sciences: Theory & Practice*, *15*(5), 1373–1390.

Beghetto, R. A. (2010). Creativity in the classroom. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity*. Cambridge University Press.

Beghetto, R. A., & Kaufman, J. C. (2007). Toward a broader conception of creativity: A case for mini-c creativity. Psychology of Aesthetics, Creativity and the Arts, *1*, 73-79.

Calder, L., & Carlson, S. (2004). Using "Think alouds" to evaluate deep understanding. In R. L. Swing (Ed.), *Proving and improving, volume II: Tools and techniques for assessing the first college year* (Vol. II, pp. 35–38). University of South Carolina.

Cheng, V.M.Y. (2010). Teaching creative thinking in regular science lesson: Potential and obstacles of three different approaches in an asian context. *Asia Pasific Forum on Science Learning and Teaching*, *1*(17), 1.

Craft, A. (2005). *Creativity in schools: Tensions and dilemmas*. Routledge.

Davis, R. E. (1984). *Learning mathematics: The cognitive science approach to mathematics education*. Croom Helm Australia Pty Ltd.

Forrester, J. (2008). Thinking creatively; thinking critically. *Asian Social Science Journal, 4*(5), 100-105.

Gomez, J. G. (2007). What do we know about creativity? *The Journal of Effective Teaching, 7*(1), 31-43.

Haylock, D. (1997). Recognising mathematical Creativity in Schoolchildren. *Central Journal for Didactics of Mathematics/ Zentralblatt fur Didaktik der Mathematik, 29*(3), 68-74.

Hwang, W. Y., Chen, N. S., Dung, J. J., & Yang, Y. L. (2007). Multiple representation skills and creativity effects on mathematical problem solving using a multimedia whiteboard system. *Educational Technology & Society, 10(2),* 191-212.

Kampylis, P., & Berki, E. (2014). *Nurturing creative thinking*. International Academy of Education.

Kaufman, J. C. & Beghetto, R. A. (2009). Beyond Big and Little: The Four C Model of Creativity. *Review of General Psychology*, *13*(1) pp. 1–12.

Krutetskii, V. A. (1976). *The psychology of mathematical abilities in schoolchildren*. The University of Chicago Press.

Laius, A. & Rannikmae, M. (2014). Longitudinal teacher training impact on students' attributes of scientific literacy. *International Journal of Humanities and Social Science, 4*(6), 63-72.

Lombard, K., & Grosser, M. (2008). Critical thinking: Are the ideals of OBE failing us or are we failing the ideals of OBE. *South African Journal of Education*, *28,* 561-589.

Mehmood, S. T. (2014). *Effect of Polya's problem solving method of teaching on achievement of revised Bloom's taxonomy in mathematics at elementary level* [Unpublished doctoral dissertatiion]. International Islamic University Islamabad.

Meintjes, H. & Grosser, M. (2010). Creative thinking in prospective teachers: The status quo and the impact of contextual factors. *South African Journal of Education, 30*(3), 361-386.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE.

Moleong, L. J. (2002). *Metodologi penelitian kualitatif* [Qualitative research methodology]. Remaja Rosdakarya.

National Council of Teacher of Mathematics. (2000). *Principles and standards for school mathematics*. NCTM.

Newman, F. M., & Wehlage, G. G. (1993). Five standards for authentic instruction. *Educational Leadership, 50*(7), 8-12.

Nolan, V. (2004). *Creativity: The antidote to the argument culture*. In M. Fryer (Ed.), *Creativity and cultural diversity* (pp. 45-51). The Creativity Centre Educational Trust.

Nugraha, T. S., & Mahmudi, A. (2015). Keefektifan pembelajaran berbasis masalah dan problem posing ditinjau dari kemampuan berpikir logis dan kritis [The effectiveness of problem-based learning and problem posing in terms of the ability to think logically and critically]. *Journal of Mathematics Education Research/ Jurnal Riset Pendidikan Matematika, 2*(1), 107-120. https://doi.org/10.21831/jrpm.v2i1.7154.

Nuryanti, M. (2016). Peningkatan kemampuan komunikasi dan berpikir kritis matematis melalui model kooperatif STAD dan Murder [Improved communication skills and mathematical critical thinking through the STAD and Murder cooperative models]. *Journal of Mathematics and Natural Sciences Teaching/ Jurnal Pengajaran Matematika dan Ilmu Pengetahuan Alam, 21*(1), 9-13 http://doi.org/10.18269/JPMIPA.v21i1.654

Okpara, D. F. (2007). The value of creativity and innovation in entrepreneurship. *Journal of Asia Entrepreneurship and Sustainability, 3*(2), 1-14.

Palmer, H., & van Bommel, (2018). Problem solving in early mathematics teaching-A way to promote creativity? *Creativity Education, 9,* 1775-1793. https://doi.org. /10.4236/ce.2018.912129

Papalia, D. E., Wendkos, O. D., & Feldman, R. (2008). *A child's world: Infancy through adolescence*. McGraw Hill.

Pehkonen, E. (1997). The state-of-art in mathematical creativity. *Zentralblatt fur Didaktik der Mathematik/Central Journal for Didactics of Mathematics, 29*, 63–67. https://doi.org/10.1007/s11858-997-0001-z.

Richards, R. (Ed.) (2007). *Everyday creativity and new views of human nature: Psychological, social, and spiritual perspectives.* American Psychological Association. https://doi.org/10.1037/11595-000

Rofi'uddin, A. (2000). Model pendidikan berpikir kritis kreatif untuk siswa sekolah dasar [Educational model of creative critical thinking for elementary school students]. *Language and Art Journal/ Majalah Bahasa dan Seni, 28*(1), 72-94

Ruggiero, V. R. (1998). *The art of thinking: A guide to critical and creative thought.* Wesley Longman, Inc.

Salih, M. (2010). Developing thinking skills in Malaysian science students via an analogical task. *Journal of Science and Mathematics Education in Southeast Asia, 33*(1), 110-128.

Saragih, S., & Napitupulu, E. (2015). Developing student-centers learning model to improve high order mathematical thinking ability. *Canadian Center of Science and Education, 8,* 104–112.

Sari, I. P., & Yunarti, T. (2015). Open-ended problems untuk mengembangkan kemampuan berpikir kreatif siswa [Open-ended problems to develop students' creative thinking abilities]. In M. Marsigit & S. Sugiman (Eds), *National Seminar of Mathematics and Education of Math* (pp. 315-320). State University of Yogyakarta-Indonesia.

Sarwinda, W. (2013). Pemberdayaan keterampilan berfikir kreatif siswa melalui strategi reciprocal teaching pada pembelajaran biologi SMA [Empowerment of student's creative thinking skills through reciprocal teaching strategies in high school biology learning]. In S. Kubikazari & H. Rahmawati (Eds), *National Seminar X Biology Education* (pp. 14-139). Sebelas Maret University-Indonesia.

Scales, P. (2013). *Teaching in the lifelong learning sector*. Open University Press.

Sharan, S. (Ed.) (1990). *Cooperative learning: Theory and research*. Praeger.

Shriki, A. (2010). Working like real mathematicians: developing prospective teacher's awareness of mathematical creativity through generating new concepts. *Educational Studies in Mathematics*, *73*, 159–179. https://doi.org/10.1007/s10649-009-9212-2.

Silver, E.A. (1997). Fostering creativity through instruction rich in mathematical problem solving and thinking in problem posing. *Central Journal for Didactics of Mathematics/ Zentralblatt fur Didaktik der Mathematik, 29*(3), 75–80. https://doi.org/10.1007/s11858-997-0003-x

Siswono, T. Y. (2004). Identifying creative thinking process of students through mathematics problem posing. In M. Nita Nur (Ed.), *Proceeding of the International Conference on Statistics and Mathematics and Its Application in the Development of Science and Technology* (pp. 85-80). Bandung Islamic University.

Siswono, T. Y. E. (2018). *Pembelajaran matematika berbasis pengajuan dan pemecahan masalah* [Mathematical learning based on submission and problem solving]. Remaja Rosdakarya.

Soeyono, Y. (2014). Pengembangan bahan ajar matematika dengan pendekatan open-ended untuk meningkatkan kemampuan berpikir kritis dan kreatif siswa SMA [Development of mathematics teaching materials with an open-ended approach to improve the critical and creative thinking skills of high school students]. *PYTHAGORAS: Journal of Mathematics Education/ PYTHAGORAS: Jurnal Pendidikan Matematika, 9*(2), 205-218.

Sriraman, B., & Lee, K. H. (2011). *The elements of creativity and giftedness in mathematics*. Sense Publisher. https://doi.org/10.1007/978-94-6091-439-3

Stein, B, Haynes, A., Redding, M., Ennis, T., & Cecil, M. (2007). Assessing critical thinking in steam and beyond. In M. Iskander (Ed.), *Innovation in e-learning, instruction technology, assessment and engineering education* (pp. 79-82). Springer.

Sternberg, R. J. (2012). The Assessment of Creativity: An Investment-based Approach. *Creativity Research Journal*, *24*(1), 3–12.

Sukmadinata, N. S. (2011). *Metode penelitian pendidikan* [Educational research methods]. Remaja Rosdakarya.

Sunaryo, Y. (2014). Model pembelajaran berbasis masalah untuk meningkatkan kema'ampuan berpikir kritis dan kreatif matematika siswa SMA di Kota Tasikmalaya [Problem-based learning model to improve the mathematical critical thinking and creative ability of high school students in the City of Tasikmalaya]. *Jurnal Pendidikan dan Keguruan/Journal of Education and Teacher Training,* 1(2), 41-51.

Supardi, S. (2015). Peran berpikir kreatif dalam proses [The role of creative thinking in the process]. *Formative Journal / Jurnal Formatif*, *2*(3), 248-262.

Tahir, A. (2007). *Upaya diri menjadi guru profesional* [Self efforts to become a professional teacher]. Alfabeta

Taplin, M. (2007). *Mathematics through problem solving*. Institute of Sathya Sai Education.

Tendrita, M., Mahanal, S., & Zubaidah, S. (2016). Pemberdayaan keterampilan berfikir kreatif melalui model remap think pair share [The empowerment of creative thinking skills through remap think pair share]. *Proceeding Biology Education Conference, 13*(1), 285-291.

Thomas, A., & Thorne, G. (2009). *How to increase higher order thinking*. Center for Development and Learning.

Van Someren, M. W., Barnard, Y. F., & Sandberg, J. A. C. (1994). *The think aloud method: A practical guide to modelling cognitive processes*. Academic Press.

Vygotsky, L. S. (1967). Play and Its Role in the Mental Development of the Child. *Soviet Psychology, 5*(3), 6–18.

Yayuk, E., Ekowati, D. W., Suwandayani, B. I., & Ulum, B. (2018). *Pembelajaran matematika yang menyenangkan* [Fun

mathematics learning]. UMM Press.

Yayuk, E. (2019). *Pembelajaran matematika SD* [Elementary mathematics learning]. UMM Press

Yen, T. S., & Halili, S. H. (2015). Effective teaching of higher-order thinking (HOT) in education. *The Online Journal of Distance Education and e-Learning, 3*(2), 41-47.