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# Analysis of Mathematic Creative Thinking Ability of 10th Grade High School Students About Solution Mathematics Problems

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## *Abstract*

The ability to think creatively is an important component needed in the 21st century. Creative thinking is a person's ability to produce various ideas or concept and or new alternative solutions in solving a problem. Three important aspects of creative thinking are fluency, flexibility, and novelty. Teachers have an important role in preparing creative students, but there are still many teachers who do not understand what abilities students already have and how they should be treated. This research is a qualitative research about the level of mathematical creative thinking ability of 10th grade high school students in solving mathematical problems. This study uses purposive sampling techniques and triangulation methods. The research subjects are 62 students of 10th grade of high school. The data are collected using test and interview guidelines. The results showed that the level of mathematical creative thinking ability of 10th grade high school students was still low. A total of 33 students (53%) were not creative (level 0), 26 students (42%) were less creative (level 1), 1 student (2%) were quite creative (level 2), 2 students (3%) were creative (level 3), and no student (0%) was very creative (level 4). So, students' mathematical creative thinking abilities still need to be developed, such as by getting students to work on a Multiple Solution Task (MST) and or applying a 3CM (Cool-Critical-Creative-Meaningful) model in the learning process.

***Keywords:*** *Mathematical Creative Thinking; High School; Mathematical Problems*

## *Introduction*

The ability to think creatively is very important and needed in the 21st century. In this century, the world of education must be able to prepare the quality of human resources. One way is to provide provisions to think creatively in order to be able to solve various challenges that arise, both in everyday life and in the world of work. Creative thinking is a person's ability to generate various ideas or concept and or new alternative solutions in solving a problem (Lestari & Yudhanegara, 2015; Abraham, Thybusch, & Pieritz, 2014). Guilford argues that creative thinking can be seen as a dynamic mental process involving convergent thinking to find the right solution of a problem or divergent thinking (Nadjafikhah & Yaftian, 2013).

Three important aspects of creative thinking are fluency, flexibility, and novelty (Silver, 1997; Siswono, 2011). Fluency is related to the correctness of the answers given by students, flexibility is

related to the diversity of ideas or solutions provided, and novelty is related to the uniqueness of ideas or concept which are different from other students (Silver, 1997; Siswono, 2011; Damayanti & Sumardi, 2018). Basically, each individual has the potential to be creative (Treffinger, 1995). In line with Adams and Hamm, the ability to think creatively is a natural potential of each individual and can be developed through awareness and practice (Nasution, Surya, Asmin, & Sinaga, 2017). One of them is through learning mathematics in school. Thus, the teacher has an important role in preparing creative students to be able to compete in the 21st century.

The ability to think creatively owned by each student is very diverse. The teacher must know and understand in advance the extent to which the creative thinking abilities students already have. Referring to the three aspects of creative thinking, Siswono (2011) distinguishes the level of creative thinking in mathematics categories into five categories, namely Level 4 (Very Creative), Level 3 (Creative), Level 2 (Fairly Creative), Level 1 (Less Creative) , and Level 0 (Not Creative). Meanwhile, Levav-Waynberg and Leikin (2009) provide alternatives to evaluate students' creative thinking abilities through scoring schemes.

Teachers have an important role in preparing creative students, but there are still many teachers who do not understand what abilities students already have and how treatments should be done. In this study, it will be discussed about the extent to which the level of mathematical creative thinking abilities of 10th grade high school students so that teachers can take appropriate treatment to improve students' abilities. Then, there will be discussion several alternatives that can be done by the teacher to improve students' mathematical creative thinking abilities.

## *Methodology*

This type of research is a qualitative research with a case study approach about the level of mathematical creative thinking ability of 10th grade high school students. The research subjects are 62 of 10th grade students at SMA Negeri 2 Sukoharjo. The mathematical test instrument about the three-variable linear equation system and interview guidelines are the supporting instruments used in collecting research data. The test instrument and interview guidelines are based on three aspects of creative thinking, namely fluency, flexibility and novelty, and are validated by three validators. Next, the interview subjects are selected using purposive sampling. Triangulation method is a technique used to check the validity of the data in this study. Data reduction, data presentation, and data verification are the analysis techniques used in this study.

Mathematical creative thinking ability of students is measured based on scoring criteria adapted from Leikin's scoring scheme (2009), as in **Table 1**. In this study aspects of fluency are shown if students are able to produce at least three correct answers $(Fa \geq 3)$. The aspect of flexibility is shown when students are able to show at least one way of solution that is completely different from the way of solution used before $(Fl \geq 20)$. The novelty aspect is shown if students are able to produce at least one way of solving that has a level of rarity of less than 15% of all students with the same answer $(Ba \geq 10)$.

**Table 1.** Scoring Scheme

| | Fluency $(Fa)$ | Flexibility $(Fl)$ | Novelty $(Ba)$ |
|---|---|---|---|
| Score of Every Answer | 1 | $Fl_1 = 10$ -for the first solution method<br>$Fl_i = 10$ -using different solution methods before<br>$Fl_i = 1$ -Using a solution method similar to previous solution, but the representation is different<br>$Fl_i = 0{,}1$ -using the same method of solution and representation as the previous one | $Ba_1 = 10$ –if $P < 15\%$ or the resulting solution is unconventional (unusual)<br>$Ba_i = 1$ –if $15\% \leq P < 40\%$ or the resulting solution is not entirely conventional (only partial)<br>$Ba_i = 0{,}1$ –if $P \geq 40\%$ or the resulting solution is unconventional (unusual) |
| Total Score | n | $Fl = \sum_{i=1}^{n} Fl_i$ | $Ba = \sum_{i=1}^{n} Ba_i$ |

n : total of correct answers

P : $\left(\frac{m_j}{n}\right) 100\%$, $m_j$ is the number of students using the strategy j.

Furthermore, the level of students' mathematical creative thinking ability is determined based on the formulation of the Level of Creative Thinking by Siswono (2011) with scoring criteria based on the scoring scheme adapted from Leiken (2009), as in **Table 2**.

**Table 2**. Students' Creative Mathematical Thinking Ability Levels

| Level | Creative Mathematical Thinking Aspects | | |
|---|---|---|---|
| | Fluency $(Fa \geq 3)$ | Flexibility $(Fl \geq 20)$ | Novelty $(Ba \geq 10)$ |
| Level 0 | - | - | - |
| Level 1 | ✓ | - | - |
| Level 2 | - | - | ✓ |
| | - | ✓ | - |
| Level 3 | ✓ | - | ✓ |
| | ✓ | ✓ | - |
| Level 4 | ✓ | ✓ | ✓ |

### *Result and Discussion*

The results of the analysis of 62 students of 10th grade of high school showed that each student had a different level of mathematical creative thinking. A list of each level of students' mathematical creative thinking is presented in **Table 3**.

**Table 3**. List of Students' Mathematical Creative Thinking Levels

| Subject | Creative Mathematical Thinking Aspects | | | Level |
|---|---|---|---|---|
| | Fluency $(Fa)$ | Flexibility $(Fl)$ | Novelty $(Ba)$ | |
| S1 | ✓ | - | - | 1 |
| S2 | - | - | - | 0 |
| S3 | - | - | - | 0 |
| S4 | - | - | - | 0 |
| S5 | ✓ | - | - | 1 |
| S6 | - | - | - | 0 |
| S7 | - | - | - | 0 |
| S8 | ✓ | - | - | 1 |
| S9 | - | - | - | 0 |
| S10 | - | - | - | 0 |
| S11 | ✓ | - | - | 1 |
| S12 | ✓ | - | - | 1 |
| S13 | ✓ | ✓ | - | 3 |
| S14 | ✓ | - | - | 1 |
| S15 | - | - | - | 0 |
| S16 | - | ✓ | - | 2 |
| S17 | ✓ | - | - | 1 |
| S18 | - | - | - | 0 |
| S19 | - | - | - | 0 |
| S20 | - | - | - | 0 |
| S21 | ✓ | - | - | 1 |
| S22 | - | - | - | 0 |
| S23 | - | - | - | 0 |
| S24 | - | - | - | 0 |
| S25 | ✓ | - | - | 1 |
| S26 | - | - | - | 0 |
| S27 | - | - | - | 0 |
| S28 | - | - | - | 0 |
| S29 | ✓ | - | - | 1 |
| S30 | - | - | - | 0 |
| S31 | - | - | - | 0 |
| S32 | ✓ | - | - | 1 |
| S33 | - | - | - | 0 |
| S34 | - | - | - | 0 |
| S35 | ✓ | - | - | 1 |
| S36 | ✓ | - | - | 1 |
| S37 | - | - | - | 0 |
| S38 | - | - | - | 0 |
| S39 | ✓ | - | - | 1 |

| Subject | Creative Mathematical Thinking Aspects | | | Level |
|---|---|---|---|---|
| | Fluency $(Fa)$ | Flexibility $(Fl)$ | Novelty $(Ba)$ | |
| S40 | - | - | - | 0 |
| S41 | - | - | - | 0 |
| S42 | ✓ | - | - | 1 |
| S43 | ✓ | ✓ | - | 3 |
| S44 | ✓ | - | - | 1 |
| S45 | - | - | - | 0 |
| S46 | ✓ | - | - | 1 |
| S47 | ✓ | - | - | 1 |
| S48 | - | - | - | 0 |
| S49 | - | - | - | 0 |
| S50 | ✓ | - | - | 1 |
| S51 | ✓ | - | - | 1 |
| S52 | - | - | - | 0 |
| S53 | - | - | - | 0 |
| S54 | ✓ | - | - | 1 |
| S55 | ✓ | - | - | 1 |
| S56 | ✓ | - | - | 1 |
| S57 | ✓ | - | - | 1 |
| S58 | - | - | - | 0 |
| S59 | ✓ | - | - | 1 |
| S60 | ✓ | - | - | 1 |
| S61 | - | - | - | 0 |
| S62 | - | - | - | 0 |
| Number of students | 28 | 3 | 0 | |
| Percentage | 45,16% | 4,84% | 0 | |

**Table 3** shows that the largest percentage of the three aspects of mathematical creative thinking possessed by students is fluency, which is 45.16% (28 students). Meanwhile, flexibility is fulfilled by 4.84% (3 students) and none of the students show the novelty aspect in solving the given math problems. These results show that 10$^{th}$ grade students have varying degrees of creative thinking ability, namely level 0 (not creative), level 1 (less creative), level 2 (quite creative), and level 3 (creative). Next, interviews are conducted with students at each level of mathematical creative thinking ability to ensure the correctness of the data. Interview results show similar results where students at level 0 are unable to demonstrate all three aspects of mathematical creative thinking, students at level 1 are able to demonstrate fluency, students at level 2 are able to show flexibility, and students at level 3 are able to demonstrate fluency and flexibility. Large percentage of the level of students' mathematical creative thinking ability can be seen in **Figure 1**.

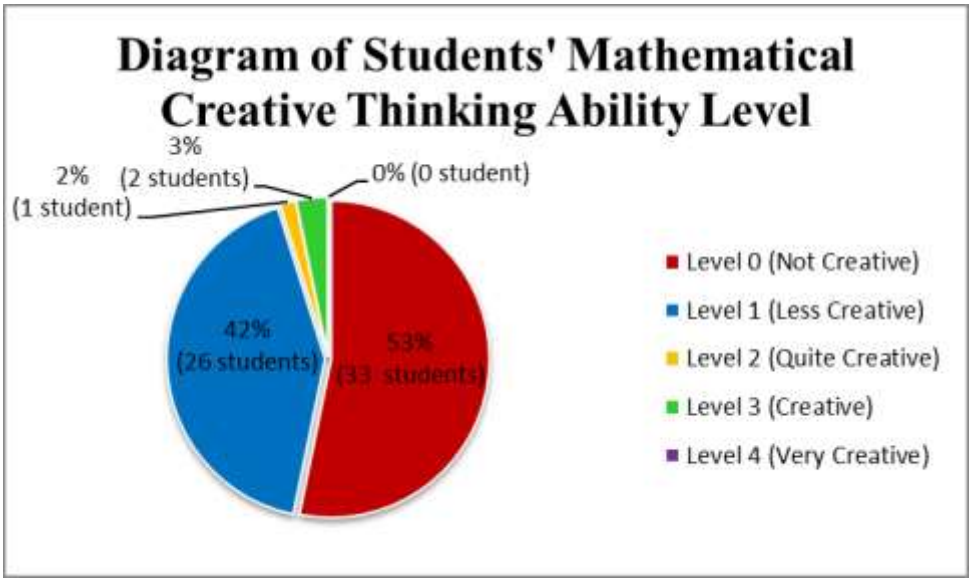


**Figure 1.** Circle Diagram of Students' Mathematical Creative Thinking Ability Level

**Figure 1** shows that most students were at level 0 (not creative), as many as 33 students (53%) and at level 1 (less creative) as many as 26 students (42%). There are 1 student (2%) at level 2 (quite creative), 2 students (3%) are at level 3 (creative), and no students (0%) are at level 4 (very creative).

Based on Figure 1, the level of mathematical creative thinking ability of 10$^{th}$ grade of high school students is relatively low because it is still dominated by levels 0 and 1. Therefore, it is necessary to make some efforts to improve students' creative mathematical thinking abilities, for example by practicing students' creative thinking abilities using Multiple Solution Task (MST). MST is a task that explicitly asks students to solve a mathematical problem in a different way (Levav-Waynberg & Leikin, 2009). In addition, teachers can apply the 3CM (Cool-Critical-Creative-Meaningful) model with blended learning. This learning is effective to improve the ability to think creatively because it provides opportunities for students to think systematically, from criticizing an interesting contextual problem to doing meaningful reflection with adequate learning resources face-to-face and online (Wahyudi, Waluyo, Suyitno, & Isnarto , 2019). With some of the alternatives above, the teacher is expected to be able to do treatment to improve students' creative thinking abilities.

## *Conclusion and Recommendation*

Based on the results and discussion, the conclusion of this study is the level of mathematical creative thinking ability of 10$^{th}$ grade high school students is still dominated by level 0 (not creative) and level 1 (less creative) with percentage of 53% and 42%, respectively. While, students who are at level 2 (quite creative), level 3 (creative), and level 4 (very creative) show a low percentage in a row, namely 2%, 3%, and 0%. In other words, the level of mathematical creative thinking ability of 10$^{th}$ grade high school students is still low. Therefore, some efforts need to be made to improve students' mathematical creative thinking abilities. For example by getting students accustom to do Multiple Solution Tasks (MST) and or apply the 3CM (Cool-Critical-Creative-Meaningful) model.

It is expected that the teacher is able to understand students' mathematical creative thinking abilities and determine the appropriate treatment to prepare creative human resources. And it is hoped that there will be new research related to alternative solutions that are effective and efficient in improving and or accustoming students to think creatively.

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