

# Higher Order Thinking Skill and Creative Thinking on Mathematics Learning

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**Abstract - Creative thinking has a vital role in generating innovations, especially in the millennial era as it is today. The habit of creative thinking needs to be applied primarily in the field of education. This study aims to describe the level of creative thinking of students in solving story problems on algebraic material. This type of research is descriptive qualitative research. This research was conducted on high school students, with a population of 120 tenth grade students. Research subjects by taking four selected subjects in tenth-grade mathematics and science groups who can think creative that is different from the creative category, quite creative, and less creative. The level of creative thinking of students is obtained through tests that include indicators of creative thinking, namely: fluency, flexibility, sensitivity, and elaboration. The second stage is a four-subject interview test based on the results of tests that have been carried out. In the next step, the researcher analyzed the results of the two tests according to the ability of creative thinking of each subject. The results of this study are descriptions of the level of students' creative thinking abilities in solving problems in algebra material. In conclusion, not all levels of students' creative thinking are achieved well. This result is influenced by the obstacles that might be encountered when the creative thinking process takes place.**

***Keywords: creative thinking, mathematical problems, algebra***

## I. INTRODUCTION

Mathematics has an essential role in preparing human resources to face the era of industrialization and globalization (Akgul, 2016). (Perry & Karpova, 2017) argue that this can be realized if mathematics education can produce capable and successful students to grow their ability to think logically, critically, creatively, initiative and be adaptive to change and development.

(Runco & Jaeger, 2012) said that creative thinking is a new, divergent thought. Whereas

(Pehkonen, 1983) views creative thinking as a combination of logical thinking and divergent thinking based on intuition but still in consciousness. Divergent thinking itself is to provide various possible answers to the same question (Runco & Acar, 2012). Meanwhile, (Livne, Livne, & Wight, 2008) argue that creative mathematical thinking refers to the ability to produce different solutions that are new to open-ended mathematical problems. Thus, the ability to think mathematically creative is the ability to find varied solutions that are new to mathematical problems that are open quickly and flexibly, but the truth can be accepted.

The ability to think creatively can be developed and developed by making a divergent mindset (Sternberg, 2012). If creative abilities have grown, then someone is expected to be able to develop their creativity. For that reason, (Gajda, Beghetto, & Karwowski, 2017) said that a person needs to busy himself creatively to carry out activities that can foster a creative mindset.

Creative thinking as the ability to see a variety of possible solutions to a problem is a form of thinking that until now has received less attention (Petre, 2018). According to (Mace & Ward, 2010) the ability to think creatively includes four criteria, including fluency, flexibility, authenticity in thinking and elaboration or detail in developing ideas. Fluency in thinking is the ability to produce many ideas and answer solutions and a relevant problem, the flow of thought smoothly. Flexibility (flexibility) in thinking is the ability to provide answers/ideas that are uniform, but the direction of thinking is different, able to change the way or approach and can see the problem from various points of view of review, authenticity (originality) is the ability to give birth to new expressions, unique and think of an unusual way, different from the others, given by most people. Elaboration in thinking is the ability to enrich, develop to add an idea, detailing details and expanding an idea.

Assessment of creative thinking skills can be done on an individual or group of students. According

to (Meintjes & Grosser, 2010) the assessment must include four indicators of creative thinking, (Nami, Marsooli, & Ashouri, 2014) divergent testing thinking towards achievement in four fields of mathematics (geometry, arithmetic, algebra, statistics and probability). The results of this study indicate that divergent thinking skills play an essential role in mathematics achievement. Tanggaard & Petre (2014) states that the ability to think creatively helps in creating new ideas based on existing knowledge to solve problems from a different perspective. This study examines what and how the description of the level of creative thinking is based on test and interview results. This research explores the level of students' creative thinking abilities on problems to improve students' mathematical abilities in solving algebraic material story problems. This paper also investigates the relationship between creative thinking and student achievement as a result of habitual creative thinking.

## II. METHODS

The method used in this research is descriptive qualitative research method. In the first stage, the researcher took four subjects from a population of 120 tenth grade students of the mathematics and science group. Furthermore, the selected subject is given a written test description of creative thinking with algebraic material. The subject selection consists of four categories of students, namely the level of creative thinking, quite creative, less creative, and not creative. However, in this study, there were no subjects in the non-creative category, so that only students with creative categories were left, quite creative, and less creative.

The level of creative thinking referred to here, is the levelling of creative thinking, according to (Tatag Yuli Eko, 2011). The selection of these four subjects uses a purposive sampling technique. (Palinkas, 2013) said that in purposive sampling, researchers believe that they can use their judgment or intuition to choose the best people or groups who can provide accurate information. The subject with the next level of creative thinking is called the K subject, the subject with the level of creative thinking is then called the CK subject, the subject with the less creative level of thinking is next called the KK subject, and the subject with the next level of non-creative thinking is called the TK subject. The second stage, the researchers conducted interviews with selected subjects to explore information on the level of creative thinking based on the results of the subject's written test. Interviews are conducted by asking questions between the interviewer and the interviewee.

Qualitative research combines participatory observation techniques with in-depth interviews to dig deeper into the data obtained from observations. The third step is checking the validity of the data using the triangulation method. Williams (2007) said

that method triangulation is achieved by comparing observational data (written tests) with interview data. If the answers between the results of the written test and the results of the interview test subject are the same, then the answer is valid. The last stage, the researchers conducted data analysis on selected subjects using qualitative methods. This data analysis is used to describe and conclude the results in answering the existing problems.

## III. RESULTS AND DISCUSSION

### a. *Creative Thinking Test Results*

Result of the creative thinking test was obtained after all subjects had written tests in the form of a description of the algebra material. Students complete the problem of algebra material as follows:

*“A natural number consists of two numbers. The number is seven times the number of the two numbers. If the numbers change places, then the number is 18 more than the sum of the numbers. What is the number?”*

The results of the answer sheets all subjects to the questions above are categorized into three classifications, namely subjects with a level of creative thinking (K), quite creative (CK), and less creative (KK). Subjects with a level of creative thinking (K) can write facts on the problem clearly, able to mention the prerequisite facts and connect them to solve a problem. The subject can provide more than one way to obtain answers, correct in making conclusions and believing the truth of the answers, and can recheck the answers.

Based on the triangulation of methods by comparing the answers of subject K on the answer sheet and the stages of the interview, subject K has a product component of creative thinking in solving algebra material problems. Subjects with a level of creative thinking (CK) can detect problems on the test well. CK subjects can see the situation and provide answers correctly but do not write down how to get results so that subjects cannot provide answers in more than one way. Therefore, the subject doubts the answers obtained.

Based on the triangulation of methods by comparing the answers of CK subjects on the answer sheets and interview stages, CK subjects have a component of creative thinking products, but not all of them are achieved well. CK subjects only meet a few indicators of creative thinking in solving story problems on algebraic material and place the subject at the level of creative thinking ability (TKBK) 2 with a category of quite creative.

Subjects with less creative categories (KK) have not been able to detect problems on the test, so subjects cannot provide answers in more than one way. Although the calculation flow is not clear, the results obtained by the KK subject are correct.

Based on the triangulation of methods by comparing the answers to the KK subject on the answer sheet and the interview stages, the KK subject has a product component of creative thinking, but not all of them are achieved well. The KK subject only fulfils several indicators of creative thinking in solving story problems in algebra material and places the subject at the level of creative thinking ability (TKBK) 1 with the less creative category.

The results of other answer sheets on subjects with less creative categories (KK), subjects can write facts that are given clearly but cannot write mathematical models, have not been able to find and detect things to conclude the answers. Based on the results of the test work written above, subject two has not been able to detect problems on the test. The subject can not see the situation and give the correct answer. The subject's answers are also not relevant. The subject did not write the answers that led to the elaboration and fluency indicators. The steps taken by subject 2 in solving the problem do not lead to a solution.

Based on the triangulation of methods by comparing the answers to the KK subject on the answer sheet and the interview stages, the KK subject only has one component of creative thinking products that is not well achieved. The KK subject only fulfils one indicator of creative thinking in solving story problems in algebra material and places the subject at the level of creative thinking ability (TKBK) one with the less creative category

#### IV. DISCUSSION

The data obtained in this study illustrates the real situation in the field using the detailed data in the form of written test results and interview tests of students' creative thinking abilities on the algebra material of tenth-grade students.

##### *a. Students' creative thinking skills in subjects with creative categories.*

The subject can detect questions from questions by writing information obtained from the questions. The subject can detect problems with the problem correctly. The subject can give the idea of completion in more than one kind of way, and the subject can also provide answers to more than one (diverse). The subject's answers are correct and detailed, and even the subject can recalculate the answers that have been obtained.

##### *b. Students' creative thinking skills on subjects with quite creative categories .*

Subjects with the category of creative enough can detect the statement of the problem by writing down the information obtained even though it is not detailed. Subjects can provide ideas for problem-solving even if they are not diverse. The subject is correct in doing the calculation, but the

subject does not write down the steps in obtaining these results.

##### *c. Students' creative thinking abilities on subjects with less creative categories.*

The subject can detect the statement of the problem by writing down the information obtained on the problem. The subject did not write down the answers that led to the elaboration indicator. The subject cannot provide an idea of problem-solving, so the subject cannot provide answers in more than one way (diverse). The completion step by the subject is not right. None of the subject's answers leads to the flexibility indicator.

Subjects with the level of creative thinking ability (TKBK) 3 achieve all indicators of creative thinking well. The subject can explain in various ways and solutions in solving the given problem. Subjects with the level of creative thinking ability (TKBK) 2 almost reach all indicators of creative thinking well. While subjects with a level of creative thinking (TKBK) 1 have not been able to reach the elaboration sub-indicator.

Elaboration is one indicator that plays an essential role in the process of creative thinking. According to (Elsayed, 2015), (Salwah & Ashari, 2015), and (Tanggaard & Petre, 2014), creative thinking is the ability to see various possibilities in problem-solving that are shown by fluency, flexibility, originality, sensitivity, and elaboration. According to (Chiu & Kwan, 2010), elaboration is to start solving problems from the general level to move to an appropriate level, so that it can regrow students' old knowledge. Also, (Tran, Ho, Mackenzie, & Le, 2017) said that elaboration encourages students to broaden their ideas and organize their thinking and helps students clarify and articulate their thoughts. Therefore, elaboration becomes one of the critical sub-indicators in the habit of creative thinking. Elaboration often does not appear on subjects with the ability to think creatively with less creative categories, because the subject is not accustomed to being given problems by solving divergent problem types (Wang et al., 1999).

The shape of the problem affects the students' thought processes (Alamolhodaie, 1976). The more often the subject is given problems with divergent problem types, the subject will get used and adapt quickly. (Cohen, 2012) said that adaptation and creativity have interrelated relationships. Adaptation can support or inhibit creativity. Adaptation supports creativity if the subject can think divergent in solving problems. Conversely, adaptation inhibits creativity if the subject is still thinking (converging) in solving problems.

## V. CONCLUSION

Every student can think creatively, but with different levels. The ability to think creatively consists of several levels. Not all levels of students' creative thinking can be achieved well. This condition is influenced by the obstacles that may be encountered when the creative thinking process takes place. These obstacles include the environment, habits, and the mindset of students themselves. If the three obstacles are successfully dismissed, it will help students in finding many creative solutions in overcoming mathematical problems. Also, the level of creative thinking of students is influenced by how often students practise creative thinking skills. This research has not examined the related patterns of thinking at the level of creative thinking so that it can still be studied further.

## REFERENCES

- [1] Akgul, S. (2016). A Study on the Development of a Mathematics Creativity Scale. *Eurasia Journal of Education Research*, (62), 57–76.
- [2] Alamolhodaei, H. (1976). Convergent / Divergent Cognitive Styles and. *Journal of Science and Mathematics Education in Southeast Asia*, XXIV(2), 102–117. Retrieved from [http://www.recsam.edu.my/R%26D\\_Journals/YEAR001/2001Vol24No2/102-117.pdf](http://www.recsam.edu.my/R%26D_Journals/YEAR001/2001Vol24No2/102-117.pdf)
- [3] Chiu, C. Y., & Kwan, L. (2010). Culture and Creativity : A Process Model Culture and Creativity : A Process Model. *The International Association for Chinese Management Research*, (April 2018), 447–461. <http://doi.org/10.1111/j.1740-8784.2010.00194.x>
- [4] Cohen, L. M. (2012). Adaptation and creativity in cultural context. *Revista de Psicología*, 30(1), 4–18. Retrieved from <http://www.scielo.org.pe/pdf/psico/v30n1/a01v30n1.pdf>
- [5] Elsayed, A. M. (2015). Effectiveness of Using Elaboration Theory in Teaching Mathematics to Develop Academic Achievement and Critical Thinking For Primary Students in Oman. *International Journal of Humanities And Cultural Studies*, 2(March), 851–865.
- [6] Gada, A., Beghetto, R. A., & Karwowski, M. (2017). Exploring Creative Learning in the Classroom: A Multi-Method Approach. *Thinking Skills and Creativity*. <http://doi.org/10.1016/j.tsc.2017.04.002>
- [7] Lince, R. (2016). Creative Thinking Ability To Increase Student Mathematical of Junior High School By Applying Models Numbered Heads Together. *Journal of Education and Practice*, 7(6), 206–212.
- [8] Livne, N., Livne, O., & Wight, C. A. (2008). Enhancing Creative Mathematical Thinking through Multiple Solutions to Open-Ended Problems Online. *Research Gate*, (February 2015), 1–13.
- [9] Mace, M., & Ward, T. (2010). Modelling The Creative Process : A Grounded Theory Analysis of Creativity in the Domain of Art Making, (October 2014), 37–41. <http://doi.org/10.1207/S15326934CRJ1402>
- [10] 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, 361–386.
- [11] Nami, Y., Marsooli, H., & Ashouri, M. (2014). The Relationship Between Creativity And Academic Achievement. *Procedia - Social and Behavioral Sciences*, 114, 36–39. <http://doi.org/10.1016/j.sbspro.2013.12.652>
- [12] Palinkas, A. L. (2013). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Adm Policy Ment Health*. <http://doi.org/10.1007/s10488-013-0528-y>
- [13] Pehkonen, E. (1983). Fostering of Mathematical Creativity, 63–64.
- [14] Perry, A., & Karpova, E. (2017). Efficacy of Teaching Creative Thinking Skills: A Comparison of Multiple Creativity Assessments. *Thinking Skills and Creativity*. <http://doi.org/10.1016/j.tsc.2017.02.017>
- [15] Petre. (2018). Educating which creativity ? *Elsevier*, 27(August 2017), 25–32. <http://doi.org/10.1016/j.tsc.2017.11.006>
- [16] Runco, M. A., & Acar, S. (2012). Divergent Thinking as an Indicator of Creative Potential Divergent Thinking as an Indicator of Creative Potential. *Creativity Research Journal*, (January 2012), 66–75. <http://doi.org/10.1080/10400419.2012.652929>
- [17] Runco, M. A., & Jaeger, G. J. (2012). The Standard Definition of Creativity. *Creativity Research Journal*, 92–96. <http://doi.org/10.1080/10400419.2012.650092>
- [18] Salwah & Ashari, N. W. (2015). The Effectiveness of Elaboration Strategy In Improving Students Learning Achievement. *Journal of Pedagogy*, 1(1), 97–113.
- [19] Sternberg, R. J. (2012). The Assessment of Creativity : An investment-based approach. *Creativity Research Journal*, 24(1), 3–12. <http://doi.org/10.1080/10400419.2012.652925>
- [20] Tanggaard, L., & Petre, V. (2014). New Ideas in Psychology Creativity, Identity, And Representation : Towards a Socio-Cultural Theory of Creative Identity. *Elsevier*, 34, 12–21. <http://doi.org/10.1016/j.newideapsych.2014.02.002>
- [21] Tatag Yuli Eko, S. (2011). Level of student's creative thinking in classroom mathematics. *Educational Research and Review*, 6(7), 548–553. Retrieved from <http://www.academicjournals.org/ERR>
- [22] Tran, T. B. L., Ho, T. N., Mackenzie, S. V., & Le, L. K. (2017). Developing Assessment Criteria of A Lesson for Creativity To Promote Teaching for Creativity. *Elseviersevier*, 25(November 2016), 10–26. <http://doi.org/10.1016/j.tsc.2017.05.006>
- [23] Wang, C., Wu, J., & Horng, R. (1999). Creative Thinking Ability, Cognitive Type And R & D Performance. *R & Management*, 247–254.
- [24] Williams, C. (2007). Management research methods. *Journal of Business & Economic Research*, 5(3), 1–338. <http://doi.org/10.1017/CBO978051181052>

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