



FACTORS INFLUENCING CREATIVE THINKING IN PROBLEM-SOLVING

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ABSTRACT:

Creativity is one of the essential components of 21st-century education. Someone is said to be creative if they can think creatively. So creative thinking becomes one of the focuses in mathematics education. However, some research shows students' creative thinking in solving problems is still low. Therefore, analyzing what factors affect creative thinking in solving problems is necessary. The research was conducted on 7th-semester students who have taken transformation geometry courses with qualitative research methods. The data is retrieved using tests, interviews, and study documents. The analysis showed that factors that influence creative thinking in solving problems include learning conducted by the learning model, teaching materials used, academic ability, and non-cognitive factors such as students' attitude towards learning and test questions and confidence in their abilities.

Keywords: Faktor Influencing, creative, and creative in solving problems

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INTRODUCTION

One of the main components in 21st-century education is creativity (Sternberg, 2006) Sternberg, 2012; (Navarrete, 2013) (Tindowen et al., 2017) (Kawuryan et al., 2018) (Suryandari et al., 2018). Creativity is undoubtedly needed in producing

innovation. Creativity is often interpreted as thinking related to ideas, imagination, inspiration, intuition, and ingenuity. Torrance (Maharani, 2014) defines creativity as being sensitive to problems, understanding knowledge gaps or barriers, identifying difficulties, finding solutions, formulating hypotheses, modifying and

testing developed ideas, and communicating the results. If one can think creatively, then this creativity will be born. Therefore, the contemporary curriculum emphasizes developing creative thinking skills for learners (Vale & Barbosa, 2015) (Sternberg, 2006) (Drigas & Papoutsis, 2018) (Apriliani & Suyitno, 2016)m. So creative thinking becomes one of the focuses of mathematics education.

(Pehkonen, 1997) Creative thinking is a logical and divergent high-level thinking skill to build new ideas triggered by different and challenging problems. Logical thinking involves systematic and rational processes verifying and making valid conclusions (Siswono, 2010). At the same time, divergent thinking is seen as a mental operation that demands the use of creative thinking abilities, including smoothness,

flexibility, originality, and elaboration in mathematics problem-solving and problem-posing (Haylock, 1997) (Silver, 1997).

Creative thinking is a whole set of cognitive activities individuals use according to specific objects, problems, and conditions or types of efforts towards particular events and situations based on individual capacity (Birgili, 2015). This aligns with (Potur & Barkul, 2009), which defines creative thinking as an original cognitive ability and problem-solving process that allows individuals to use their intelligence uniquely and be directed towards an outcome.

According to (Silver, 1997) and (Mann, 2005), Creative thinking in mathematics

emphasizes fluency, novelty, and flexibility. Furthermore, in solving problems, students can think creatively if they can show creative thinking characteristics in their thinking process. Based on Wallas's theory (Kattou et al., 2015), the creative thinking process consists of four stages: preparation stage, incubation stage, illumination, and verification stage. The locations of creative thinking in detail can be seen in the table below.

Table1. Stages of Creative Thinking
According to Wallas

Stages of Creative Thinking According to Wallas	Description of Creative Thinking Stages
Preparation	Able to collect various information relevant to the given problem.
Incubation	Temporarily escapes from the problem and tries to find inspiration. During the incubation stage, the emerging ideas will be interconnected and arranged in mind without directly working on the problem.
Illumination	Start to raise an idea or idea that solves the problem.
verification	Solutions obtained at the illumination stage need to be identified, examined, refined or developed at the verification stage to get conclusions.

Based on the above definition, creative thinking in solving problems is an important thing that needs to be mastered by students. Therefore, prospective students of mathematics teachers need to have creative thinking skills in solving math problems. However, some research shows that the ability to think creatively in solving problems is still lacking. Based on (Maharani et al., 2017), only 16.67% are complete in creative thinking in solving problems. Also analyzed creative thinking in solving

problems. The results showed that the highest students were reasonably clever, not to arrive at a very creative condition. In solving the problem, of course, searching to determine what factors cause low creative thinking in solving problems is necessary.

RESEARCH METHODS

This study aims to determine factors affecting students' low creative thinking in solving math problems. The research was conducted at STKIP Sebelas in April with 7th-semester students who have taken geometry transformation courses. The method used in this study is qualitative. Where the data collection is done using written tests, interviews, and document studies. Reported test results are the primary data source to uncover the factors that cause students' low creative thinking in solving the problem of transformation geometry. The written test is a matter of creative thinking in solving the problem of transformation geometry consisting of 4 questions in the description. Static reasoning tests were conducted in one class of 24 people. Researchers did not interview all students who had attended the geometry transformation course; only nine people were interviewed. Students are selected for interviews based on test results and activities during learning. Document studies are conducted on the teaching and implementation of tests. Data analysis is performed using the Fixed Comparison method. In general, the process of data analysis includes data reduction, data

categorization, synthesis, ending with working hypotheses.

RESULTS AND DISCUSSION

Students' creative thinking skills and causal factors are collected by conducting written tests, interviews, and documentation studies. However, the first is a written test of mathematical creative thinking skills in solving the problem of transformation geometry. Written tests are used as early identification of creative thinking skills in solving transformation geometry problems. Researchers carefully correct student work results as an initial analysis, then recapitulate by grouping student answers into correct, incomplete, incorrect, and non-answering. The results of the recapitulation can be seen in Table 2.

Table 2. Recapitulation of Creative Thinking Test Answers in Solving Transformation Geometry Problems

No Test	Problem Indicators	Answer (person)			
		True	Incomplete	Wrong	No Answer
1	Use isometrics to troubleshoot problems	2	6	0	15
2	Determine the isometric of a transformation	0	20	2	1
3	Specify point mirroring on a line	1	1	21	0
4	Specify points on parallelograms with directional line segments	0	10	0	13

Researchers conducted further analysis by analyzing each student's work to determine which stage students have difficulties. The steps of creative thinking used in this study are those proposed by Wallas (Kattou, Christou Pitta, Christou and Pitta, 2016), which consists of four stages: preparation and incubation,

illumination stage, and verification stage. The student's creative thinking analysis results in solving the problem of transformation geometry show that students have difficulty at each stage of creative thinking. In contrast, students have many issues at the location of the process (Incubation and illumination) and the verification stage.

After analyzing the students' answers, interviews were also conducted

with students about the test questions, learning, and teaching materials. The interview was born with nine students, where the student represented a high, medium, and low group that researchers obtained from academic grades (GPA) the previous semester. Table 4.3 summarises the results of the interview analysis of test questions, learning, and teaching materials used.

Table 3. Summary of Interview Results

Students	Test Questions	Learning	Teaching Materials
R	<ul style="list-style-type: none"> Do not understand the problem well, so tend to copy what is described in the question. When working on it. I feel anxious and do not know how to solve it. Some students work but are unsure of the answers they are working on. The problem is given on the test, different from the usual question 	<ul style="list-style-type: none"> Students feel that the learning is not allowing them to express ideas. Teachers only focus on highly qualified students. 	<ul style="list-style-type: none"> Teaching materials felt by students back and forth Terms in some teaching materials are different, making it difficult for them to understand them
S	<ul style="list-style-type: none"> I understand the question well, but some things are still written in sentences. Not in mathematical form Know how to solve problems Some of the students did not re-examine the results of the work The questions given are not like the usual practice questions, but they know what concepts to use to solve them 	<ul style="list-style-type: none"> The learning does not allow them to explore their abilities. The learning tends to be centred on lecturers. Students are passive, and lecturers sometimes ask only a few students to explain the results of the work. 	<ul style="list-style-type: none"> Teaching materials are lacking especially pre-quality materials. The term teaching materials is not the same, so it is best to use customized teaching materials.
Students	Test Questions	Learning	Teaching Materials
T	<ul style="list-style-type: none"> Students can understand the problem and write the information according to the mathematical term. Knowing how to solve it, some ideas come up to finish. Some students spend in different ways. They believe the work is correct because they double- 	Students are satisfied with the learning, but the training questions provided are less challenging for them.	Different terms sometimes confuse students.



Figure 1. Interviews with Several Students

In addition to conducting tests and interviews, studies of documents used in learning are conducted. Document studies are conducted during the teaching and implementation of tests. There are still few books on Transformation Geometry in Indonesian. Each book that researchers analyze uses a different mathematical term. For example, for "Mirroring" in the book Agile Geometry Transformation Works (Kurniasih & Handayani, 2017) using the symbol "R," while in the book Geometry Transformation (Setyo & Ba'diah, 2021) using the symbol " μ ." In addition to the differences in terms, there are differences in the order of matter. (Setyo & Ba'diah, 2021), Transformation and reverse

transformation composition materials are given before isometry. In understanding the material composition of change and reverse conversion, students must realize isometric material first. In addition to the analysis of teaching materials, analysis of RPS documents is also usually used. RPS, commonly used in the mathematics education program STKIP eleven April Sumedang learning method, is still centred on lecturers. So students are allowed to express their ideas. Besides, the questions given are procedural ones that do not explore students' concept knowledge. Document analysis is also conducted on student academic achievement, where some students have less ability in

prerequisite Geometry Transforamasi courses.

Based on the analysis done on the test results, interviews, and document studies conducted, broadly speaking, the factors that cause low creative thinking of students in solving the problem of geometry transformation are learning factors and student factors. This study's results are in line with those (Hendriana & Fadhillah, 2019) (Qadri, Ikhsan, and Yusrizal (2019) mentioned that the lack of creative thinking in mathematics learning is due to the learning model used by teachers. The learning factor in question is that the teaching does not provide students with opportunities to express the ideas they get at the time of learning. In addition to the learning model used, teaching materials are also factors that cause low creative thinking of students in solving the problem of transformation geometry. In contrast, the student factors in question are cognitive and non-cognitive. Cognitive factors here are related to students' academic abilities, especially in materials related to transformational geometry. Non-cognitive factors are student anxiety when learning mathematics and completing test questions and students' confidence in their abilities.

The results showed that one of the factors that cause low learning is that the teaching does not allow students to express ideas. As stated (by Rusilowati & Wahyudi, 2020), creativity is growing because of opportunities to provide opportunities to students. Some studies show that learning that supports student creativity positively

influences creative thinking (Mann, 2005) (Tabach & Friedlander, 2013) (Walia, 2012). Therefore, a learning environment is needed that provides opportunities for students to develop ideas that can support the growth of creative thinking students in solving the problem of geometry transformation. As suggested by (Kozlowski et al., 2019), the teacher's approach to a learning environment that fosters the affective nature of students could foster creative thinking in mathematics. Therefore, developing a learning model allowing students to express their ideas is necessary.

In addition to the learning model, the teaching materials used have a role in students' low creative thinking in solving the problem of transformational geometry. Suitable teaching materials should be used by students independently, thus providing many opportunities for students to learn them. Besides, the teaching materials used should present problems that solve them do not use the usual algorithms/procedures to train students when asked to solve problems in different forms. As stated (Hidayat & Prabawanto, 2018), it does not happen that when required to think creatively in solving problems, the solution still uses the usual procedures/algorithms. Therefore, it is necessary to develop teaching materials in mathematics learning, especially transformation geometry materials. As stated (by Siniguan 2017), teaching materials are one solution to overcome learners' difficulties in solving mathematical problems. Of course, the

teaching materials developed must contain strategies that can help students solve problems (Fitriyah et al., 2018).

Academic ability is the next factor that causes students' low creative thinking in solving transformational geometry. This is following research conducted by (Samsiyah & Rudyanto, 2015) (Maharani et al., 2017) (Sari et al., 2017) (Puspitasari et al., 2018) and (Yayuk & As' ari, 2020) stated that students with low abilities showed that they had difficulty in understanding problems, in contrast to high-ability learners who could solve problems. Learning conducted should facilitate all students with low, medium, and high academic abilities.

Other factors that cause students' lack of creative thinking in solving transformation geometry problems are non-cognitive factors such as students' attitudes towards learning and test questions and students' belief in their abilities. The results of (Semeraro et al., 2020) show that non-cognitive factors (mathematical anxiety and self-esteem) influence the results of mathematics learning. Therefore, developing a learning strategy that provides opportunities for students to develop their cognitive abilities and knowledge that pays attention to learners' non-cognitive aspects is necessary.

CONCLUSION

Based on the analysis done on the test results, interviews, and document studies conducted, broadly speaking, the factors that cause low creative thinking of students in solving the problem of geometry

transformation are learning factors and student factors. The learning factor in question is that the learning done does not provide students with opportunities to express the ideas they get at the time of knowledge. In addition to the learning model used, teaching materials are also factors that cause low creative thinking of students in solving the problem of transformation geometry. In contrast, the student factors in question are cognitive and non-cognitive. Cognitive factors here are related to students' academic abilities, especially in materials related to transformational geometry. Non-cognitive factors are student anxiety when learning mathematics and completing test questions and students' confidence in their abilities.

From the discussion and conclusion above, students' creative thinking in solving the problem of transformation geometry is influenced by learning models, teaching materials, academic ability, and non-cognitive factors. Thus, a learning model and tools are needed to support students' creative thinking. The author suggests that in helping creative thinking, students need to develop a learning model that involves the provision of problems and, at the same time, the discovery of solutions and the use of learning modules as learning media.

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