

Analysis of Answer Processes Based on Mathematical Creative Thinking Abilities in Contextual Teaching and Learning

Lois Oinike Tambunan¹

¹Universitas HKBP Nommensen Pematangsiantar, Indonesia

Sahat Saragih²

²Universitas Negeri Medan, Indonesia

Elvis Napitupulu³

³Universitas Negeri Medan, Indonesia

Corresponding Author: loistamb@gmail.com

Abstract

This study aims to analyze and determine: (1) the level of students' mathematical creative thinking ability when taught using the Contextual Teaching and Learning (CTL) model; (2) a description of the students' creative thinking process in mathematics during the learning process using the Contextual Teaching and Learning (CTL) model. This research is a descriptive qualitative study. The subjects of this research were 30 students of class VIII-2 from SMP Negeri 1 Pematangsiantar. The research findings are as follows: (1) 18 students in the high-ability category were classified as highly creative, fulfilling 3 indicators of creative thinking: fluency, flexibility, and novelty; 9 students in the moderate-ability category were classified as creative, fulfilling 2 indicators of creative thinking: fluency and flexibility; and 3 students in the low-ability category were classified as less creative, fulfilling only 1 indicator of creative thinking: fluency. These results indicate that students demonstrated an improvement in creative thinking abilities after being taught using the Contextual Teaching and Learning (CTL) model. It is also hoped that the Contextual Teaching and Learning model can be applied in the learning process to enhance students' mathematical creative thinking abilities.

Keywords: Answering Process; Contextual Teaching and Learning; Creative Thinking.



INTRODUCTION

Human life undergoes changes every day, and over time, it has reached the 21st century, marked by global openness (Palennari et al., 2023). According to Partnership for 21st Century Learning (Saputra et al., 2019), the skills that everyone should have in the 21st century are critical thinking, problem-solving, creative thinking, communication, and collaboration. (Dariman, 2019) also states that the basic skills needed by students to face the challenges of 21st-century education are commonly known as the 4Cs: Critical Thinking Skills, Creative Thinking Skills, Collaboration Skills, and Communication Skills.

To meet these skills, a platform for their implementation is needed. As stated in the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 103 of 2014 on learning in primary and secondary education, the mechanism for learning emphasizes that "The learning process is designed to focus on students to encourage motivation, interest, creativity, initiative, inspiration, independence, and enthusiasm for learning, using a scientific approach that includes observing, questioning, gathering information, reasoning/associating, and communicating." Therefore, the role of education is crucial in enhancing creative thinking skills, one of which is in mathematics education. It can be concluded that one of the essential abilities that everyone should possess is the ability to think creatively. However, in general, there is a fact that one of the problems faced in the learning process is the lack of students' mathematical creative thinking abilities. This is evidenced by the results of the Program for International Student Assessment (PISA, 2022), which shows that Indonesia ranks 68th out of 81 countries with a mathematics score of 379. Moreover, the results from TIMSS place Indonesia at 46th out of 51 countries with an average score of 397 (Retnowati & Ekayanti, 2020). Hierarchically, creative thinking occupies the highest position in the levels of human thinking and is classified as a higher-order thinking process. This position can be clearly understood as illustrated in Figure 1 below (Januariawan et al., 2020).

Creative Thinking Pyramid According to Krulik & Rudnik

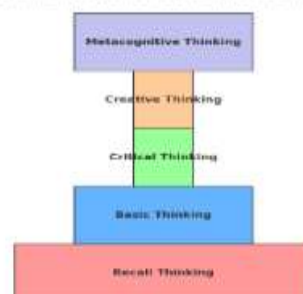


Figure 1. Hierarchy of Thinking According to Krulik and Rudnick

Based on the hierarchy of thinking skills proposed by Krulik and Rudnick, creative thinking occupies a prominent position as one of the higher-order thinking processes. Unlike basic or critical thinking, creative thinking involves the capacity to construct new ideas, identify alternative solutions, and approach problems from multiple perspectives. This ability is essential in supporting students' cognitive development, particularly in the context of modern education, where innovation and adaptability are highly valued. In mathematics learning, creative thinking enables students not only to solve problems effectively but also to design original strategies and generate meaningful connections between concepts. Therefore, the development of creative thinking should be emphasized as a core objective in instructional design, as it contributes significantly to both academic achievement and the cultivation of students' self-efficacy.

Creative thinking ability is the capacity to manifest or cultivate new things, in other words, something different and unique through ideas that are manifested by the majority of people. In addition, creative thinking skills are a form of thinking that can generate new knowledge, methods, and ways when understanding something. Through mathematics education, students are expected to have logical, analytical, systematic, critical, and creative thinking skills, as well as the ability to collaborate (Maryati, 2021). To enhance creativity, several skills are required, including mathematical creative thinking abilities.

Mathematical creative thinking ability is one of the essential skills that must be possessed and developed by students in mathematics education to face the challenges of the 21st century (Fayesa et al., 2023). Students are taught to connect the knowledge they already have with the ability to view problems from a broader or different perspective (Utami et al., 2020). Through creative thinking, we can create opportunities in our lives. Often, we are unable to make decisions due to a lack of opportunities, although these opportunities are always in front of us. By thinking creatively, we can identify opportunities in every experience we encounter.

Creative thinking is the skill of analyzing new information and combining unique ideas or concepts to solve a problem (Moma, 2015). According to (Saputra et al., 2019) creative thinking ability can be seen from the expertise in analyzing data and providing varied responses to problem-solving. High creativity indicates that someone is capable of creative thinking (Lisnani et al., 2020). Complex thinking branches into both cognitive and non-cognitive thinking. Creative thinking is a form of cognitive thinking (Hanipah et al., 2018). Indicators of creative thinking include five aspects: (1) Fluency thinking, where students can come up with various ideas to solve a problem; (2) Flexible thinking, where students can provide multiple solutions from different angles; (3) Original thinking, where students can generate unique answers using their own words



that are easy to understand; and (4) Elaboration ability, where students can expand or elaborate on an idea in detail (Utami et al., 2020).

In this research, the researcher uses three indicators of creative thinking ability: fluency, flexibility, and novelty. One of the learning models that can improve students' creative thinking ability and motivation is the Contextual Teaching and Learning (CTL) model. CTL is a learning strategy that emphasizes full student engagement in discovering learning materials and relating them to real-life situations. The goal of CTL learning is to equip students with knowledge that can be flexibly transferred across different problems and contexts (Fajartriani, 2020). (Agung, 2012) states that CTL is a strategy that emphasizes the connection between learning materials and real-life situations, so students can relate and apply their learning competencies to everyday life. This learning assumes that the mind naturally seeks meaningful connections with real-life situations, which can occur through finding logical and beneficial relationships. According to Johnson, Elaine (2007), to help students develop their intellectual potential, CTL teaches critical and creative thinking steps and provides opportunities to use these thinking skills at higher levels in real-world contexts.

In line with the problems mentioned above, this research is consistent with previous studies regarding the analysis of students' mathematical creative thinking abilities in contextual learning models. For example, (Handoko et al., 2022) analyzed the mathematical creative thinking abilities of 8th-grade students in a contextual learning model, while (Pratama et al., 2022) analyzed common mistakes made by students and the causes of these mistakes. Therefore, this study aims to determine the level of students' mathematical creative thinking abilities in learning and to analyze each answer based on their skill level. Creativity in mathematical thinking has various levels. According to (Richardo et al., 2014) students' creativity can be classified into five levels: Level 4 (Very Creative), Level 3 (Creative), Level 2 (Quite Creative), Level 1 (Less Creative), and Level 0 (Not Creative). The levels of Creative Thinking Ability (CTBA) are shown in the following table:

Table 1. Creativity Levels and Characteristics

Level	Characteristics
Level 4 (Very Creative)	Students can demonstrate fluency, flexibility, and novelty, or novelty and flexibility in solving and presenting problems.
Level 3 (Creative)	Students can demonstrate fluency and novelty or fluency and flexibility in solving and presenting problems.



Level	Characteristics
Level 2 (Quite Creative)	Students can demonstrate novelty or flexibility in solving and presenting problems.
Level 1 (Less Creative)	Students can demonstrate fluency in solving and presenting problems.
Level 0 (Not Creative)	Students cannot demonstrate any of the three creative thinking indicators.

RESEARCH METHODS

This study uses a qualitative research approach with a descriptive method. In general, this research describes the process of student answer solutions, focusing on the analysis of students' mathematical creative thinking abilities in class VIII at SMP Negeri 1 Pematangsiantar, consisting of 30 students. Participants were selected using purposive sampling, which is the process of selecting participants based on predetermined criteria or viewpoints (Sugiyono, 2012). The qualification in this study refers to students who are active during the learning process. The research instrument used was a test sheet containing essay questions adjusted to the creative thinking index according to (Hanifah et al., 2024).

The three components of creative thinking indicators that students should meet to solve a problem include fluency, flexibility, and originality/novelty. The researcher uses creative thinking indicators based on Silver (Mulyatiningsih, 2012) who states that the indicators of creative thinking ability are:

Table 2. Indicators of Creative Thinking Ability

Creative Thinking Indicator	Student's Ability
Fluency	Students can complete tasks by providing various answers.
Flexibility	Students can solve problems not just with one method, but also by creating alternative solutions from different perspectives.
Novelty	Students can solve problems with solutions that are usually not available to other students.

The test instrument was validated by three expert validators using a Likert scale to



determine the appropriateness of the instrument. The researcher then analyzed the data using descriptive statistical analysis, which involves describing the percentage of scores obtained by the students as is (Sugiyono, 2012). Regarding the scoring standards or criteria, the researcher referred to the scoring rubric from (Moma, 2015), which had been modified. The formula to determine the percentage of students' creative thinking scores was adapted from (Riduwan, 2015) which involves dividing the student's score by the maximum score of the test, then multiplying it by one hundred percent. The results of the percentage data were then categorized based on the creative thinking skill categories to determine the level of students' creative thinking competence.

Table 3. Levels of Creative Thinking Competence

Total Score Range (%)	Creative Thinking Category
81-100	Very Creative
61-80	Creative
41-60	Quite Creative
21-40	Less Creative
0-20	Not Creative
<i>(Adapted from Riduwan, 2015)</i>	

The students' creative thinking abilities were categorized into high, medium, and low levels. The coding of research subjects in Table 4 is as follows:

Table 4. Research Subject Coding

Ability Type	Ability Code
High Ability	KT
Medium Ability	KS
Low Ability	KR

RESULTS AND DISCUSSION

The stages of assessing the creative thinking competence of students in class VIII at SMP Negeri 1 Pematangsiantar during mathematics learning on the topic of flat-sided space shapes are



as follows: First, students are given a test sheet containing essay questions that are adjusted to the parameters or indices of creative thinking after being treated with the Contextual Teaching and Learning (CTL) model. The test scores of each student are then calculated to determine the percentage of their creative thinking ability. Following this, the results are categorized based on the creative thinking competence categories. Here are the results of the summary of students' creative thinking abilities, as shown in Figure 2 below:

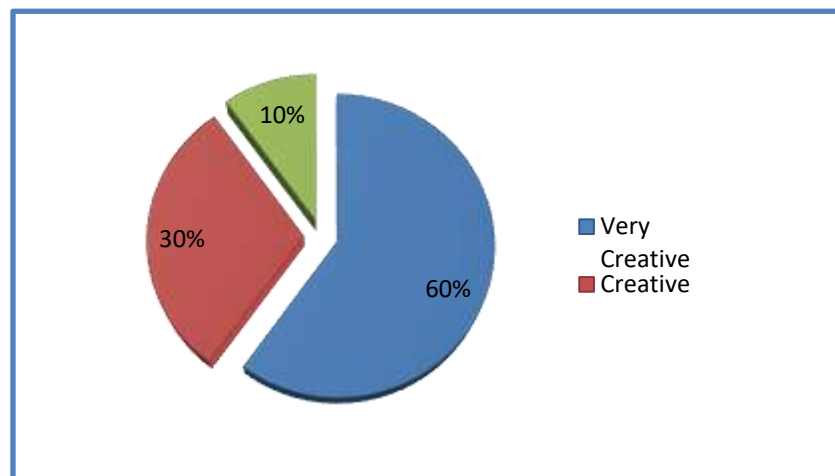


Figure 2. Recap According to Indicators

Based on the diagram in Figure 2, it can be stated that 18 students (60%) fall into the "Very Creative" category, indicating that these students have met the indicators of fluency, flexibility, and novelty. Nine students (30%) fall into the "Creative" category, indicating that they have met the indicators of fluency and flexibility. Three students (10%) fall into the "Less Creative" category, indicating that they have met only the fluency indicator.

Description of High-Classification Student Answers

1. Fluency Indicator

With this indicator, it is expected that students will be able to find various answers to a problem fluently.

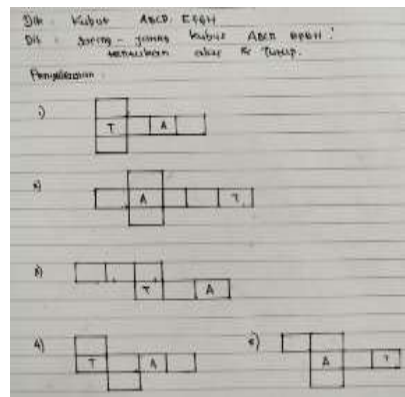


Figure 3. KT with Fluency Indicator Question

The results of the essay test show how students can express their methodology in a unique way, especially when comparing students with different approaches. A student with high ability (KT) identified the space figure in question from problem number 1 by drawing its net. Based on the interview, the student clearly explained how to determine the top and bottom faces of the net of a rectangular prism to form a cube. The student was also able to provide more than one answer to the question posed. According to the research findings (Putri, hafiziani eka, Muqodas et al., 2020) students meet the fluency indicator when they can provide various answers to a problem fluently. From the written test and interview results, it is evident that the KT student was able to offer multiple solutions to problem number 1 fluently. Therefore, the KT student meets the fluency indicator.

2. Flexibility Indicator

With this indicator, it is expected that students can solve a problem with different alternatives.

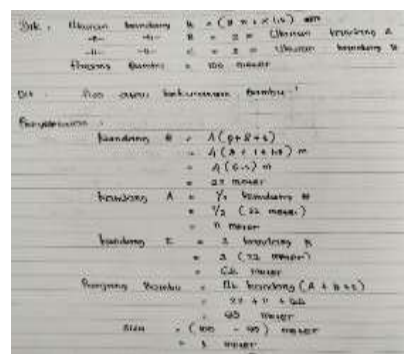


Figure 4. KT with Flexibility Indicator Question

In solving the problem, the student was able to demonstrate the result from different perspectives. The method used was similar to the general approach, with the KT student applying the formula for the perimeter of a rectangular prism, which is $4(p \times l \times t)$. However, the student was able to provide a new perspective in solving the problem by creating a mathematical model based on the story problem given. According to (Siswono, 2008) in his research, students meet the flexibility indicator when they are able to provide alternative solutions to solve a problem. The findings above show that Student A was able to meet the flexibility indicator.

3. Novelty Indicator

With this indicator, it is expected that students will be able to express new and unique ways to solve a problem.

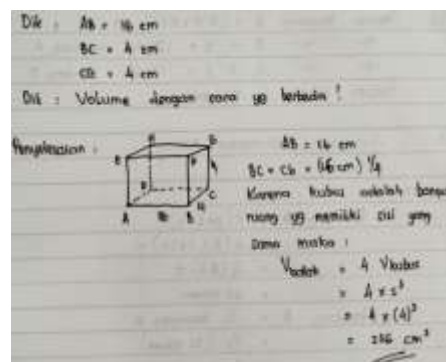


Figure 5. KT with Novelty Indicator Question

The student was able to handle the problem accurately, as seen in Figure 4, and the student used a new approach to determine the volume of a cube, applying a unique method. During the interview, Student A was able to explain the method used, which involved the formula for finding the volume of a rectangular prism applied to the cube, while considering the property of the cube where all sides are of equal length. In the research (Putri, hafiziani eka, Muqodas et al., 2020), it is stated that to meet the novelty indicator, students are expected to express a new and unique approach. Based on the results obtained through the test and interview, the student was able to meet the novelty indicator.

Description of Student Answers Classified as Moderate

1. Fluency Indicators

With these indicators, students are expected to be able to find various answers to a problem

fluently.

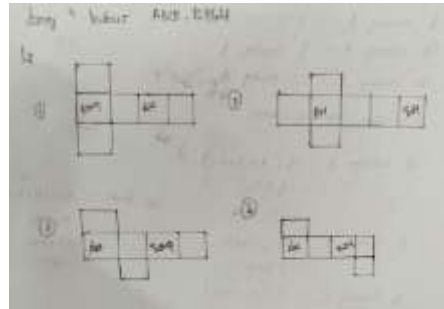


Figure 6. KS with Questions on Fluency Indicators

The results of the students' written test for question number 1 show that after conducting an interview, the students were able to correctly explain how to find the net of a cube. They could clearly describe how to determine the top and bottom of a rectangular prism's net so that it could eventually form a cube. According to research (Putri, hafiziani eka, Muqodas et al., 2020), with fluency indicators, students are expected to find various answers to a problem smoothly. Based on the written test and interview results, KS students were able to solve the problem fluently and correctly. This indicates that they have successfully met the fluency indicator.

2. Flexibility Indicator

With this indicator, students are expected to solve a problem using different alternatives.

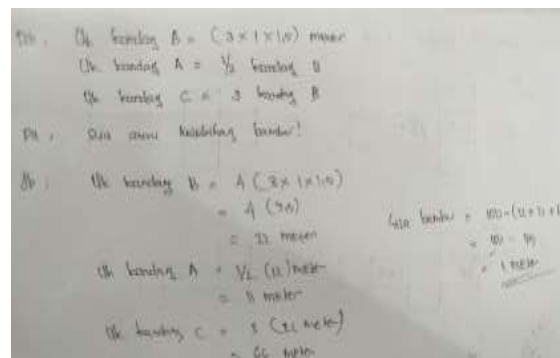


Figure 7. KS with Questions on Flexibility Indicators

The results of the KS students' written test show that they were able to solve problems using different methods. This means that they solved the problem by applying mathematical modeling in the word problem, enabling them to determine the required length of bamboo. After

the interview, the students could only explain the solution they had worked on. According to (Siswono, 2008) in his research, students can meet the flexibility indicator if they can provide alternative solutions to a problem. Based on the written test and interview, student B successfully met the flexibility indicator.

3. Novelty Indicator

With this indicator, students are expected to express new and unique ways to solve a problem.

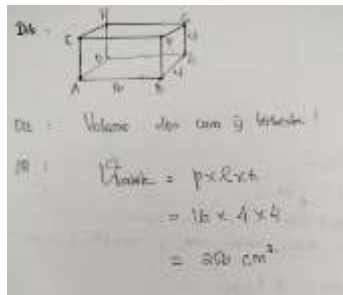


Figure 8. KS with Questions on Novelty Indicators

Figure 8 represents the results of the written test, where the student has not yet been able to solve the essay test with original thinking. The answer given was a common response. The student was then evaluated and stated that there were no alternative ways to solve the problem. Regarding the originality indicator, the findings above show that student B has not yet met the originality criteria.

Description of Student Answers Classified as Low

1. Fluency Indicator

With this indicator, students are expected to find various answers to a problem fluently.

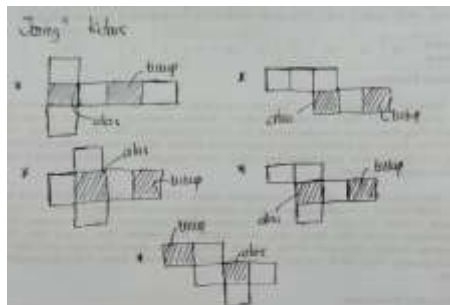


Figure 9. KR with Questions on Fluency Indicators

Figure 9 shows that students in the KR category have found the correct answer. They were able to determine the net of a rectangular prism. Based on the interview results, the students understood what a rectangular prism net is, allowing them to provide answers that aligned with the requirements of the question, including identifying the base and top of each cube net they drew. According to research by (Putri, hafiziani eka, Muqodas et al., 2020) to meet the fluency indicator, students must solve a mathematical problem smoothly. Since KR students were able to find the answer fluently, they successfully met the fluency indicator.

2. Flexibility Indicator

With this indicator, students are expected to solve a problem using different alternatives.

$$\begin{aligned}
 \text{Uk. kandang B} &= (3 \times 1.5 \times 1) \text{ meter} \\
 \text{Uk. kandang A} &= \frac{1}{2} \text{ uk. B} \\
 \text{Uk. kandang C} &= 3 \text{ uk. B} \\
 \text{Maka: } &3 \times 1.5 \times 1 \\
 &= 4.5 \\
 \text{Uk. A} &= \frac{1}{2} \times 4.5 = 2.25 \text{ m} \\
 \text{Uk. C} &= 3 \times 4.5 = 13.5 \text{ m} \\
 \text{Maka} &= 100 - (4.5 + 2.25 + 13.5) \\
 &= 100 - 20.25 \\
 &= 79.75
 \end{aligned}$$

Figure 10. KR with Questions on Flexibility Indicators

The solution provided by the student for the problem of finding the remaining or required bamboo length was incorrect. The student with the KR code gave an answer but was unable to determine the perimeter of the rectangular prism for the size of cage B. During the interview, the student forgot the formula for the perimeter of a rectangular prism and was also uncertain about their answer while solving the problem. Based on these findings, the student provided more than one solution, but the answers were incorrect. Therefore, for the flexibility indicator, the student's written test answers did not meet the expected criteria.

3. Novelty Indicator

With this indicator, students are expected to express new and unique ways to solve a problem.

Dik: $AB = 16 \text{ cm}$
 $BC = 4 \text{ cm}$
 $CG = 4 \text{ cm}$
 Dit: Volume Bangun Ruang Beraturan?
 Jk = $\frac{1}{2} (p + l + t)$
 $= \frac{1}{2} (16 + 4 + 4)$
 $= \frac{1}{2} (24)$
 $= 12 \text{ cm}$

Figure 11. KR with Questions on Novelty Indicators

The student in the KR category did not provide a good solution in the written test. The answer written was clearly not correct, and the student was also unable to correctly determine the volume of the rectangular prism as stated in the problem. From the interview, it was found that the student with the KR code struggled to determine what was needed for the problem. This indicates that the KR student has not yet met the originality indicator.

Table 5. Summary of Descriptive Results

Category	Indicator of Mathematical Creative Thinking Ability		
	Fluency	Fleksibility	Novelty
KT	✓	✓	✓
KS	✓	✓	-
KR	✓	-	-

Table 5 can be described as follows for the fluency, flexibility, and novelty indicators, these were met for students with the KT code. The moderate indicators of fluency and flexibility were met for students with the KS code, while students with the KR code met the fluency indicator of creative thinking ability after being treated with the contextual teaching and learning (CTL) model. (Majid, 2014) states that contextual learning is based on the research of John Dewey (1916), who concluded that students will learn well if what they learn is related to what they already know and with activities or events that will happen around them. Based on this research, it is the teacher's task to apply the contextual learning model. According to (Majid, 2014) one of the most important elements in applying the contextual approach is the teacher's understanding of how to implement contextual learning strategies in the classroom. In CTL activities, the teacher facilitates students

to search, process, and discover more concrete learning experiences (related to real life) through student involvement in trying, doing, and experiencing things for themselves. Students are not just passive listeners who receive all the information delivered by the teacher. Learning is not only viewed from the product side, but the most important aspect is the process (Rusman, 2018).

Mathematics learning in schools needs to be designed in such a way that teachers can help students achieve their learning objectives. Educational research provides evidence that students learn mathematics well only if they construct their own understanding of mathematics (Turmudi, 2018). In achieving this goal, students are able to develop their creativity with new knowledge ideas. According to (Zahorik, 1997) what should be considered in contextual learning practices is acquiring new knowledge by first studying the whole, and then focusing on the more specific aspects. In this learning activity, the teacher encourages students to relate the material they receive in class to their everyday life. In the process of linking these relationships, students are required to use creative thinking skills and apply new knowledge ideas. In implementing contextual learning, the teacher's task is to manage the class as a team working together to discover something new for the students. New knowledge and skills are obtained from the students' own inquiry ability (discovery), not just from what the teacher says.

The application of the Contextual Teaching and Learning (CTL) model greatly influences students' creative thinking abilities because CTL involves students in essential activities that help them connect the learning material in the media with their real-life experiences. By using the CTL model, students can see the meaning of the material they have learned in school. They can find meaning in the learning material when they actively choose, organize, arrange, touch, plan, investigate, experiment, search for information, and draw conclusions from the activities they do themselves. The implementation of the CTL model in the learning process is seen in the students' enthusiasm to successfully conduct experiments and answer the questions provided by the teacher. The students' curiosity when the teacher explains the material shows a strong learning motivation. In addition, students are also more eager to participate in engaging learning activities and a conducive learning environment, such as conducting experiments and discussing.

With the main components of CTL learning, namely constructivism, questioning, discovering, learning communities, modeling, and assessment, students' creative thinking abilities can actually be enhanced. In this process, students do not easily forget the new knowledge they have discovered, so when confronted with new problems, they can solve them independently, wherever they are. Creative thinking skills in mathematics can be seen in fluency, flexibility, originality, and elaboration when solving mathematical problems. These four aspects can be seen



altogether in solving a problem or one of them, depending on which aspect is more dominant.

CONCLUSION

The review of this study shows that students in the high and moderate ability categories fall under the very creative and creative categories after being treated with the Contextual Teaching and Learning (CTL) model for learning solid geometry. Meanwhile, students in the low ability category, when exposed to the CTL model, were unable to meet any of the creative thinking ability indicators. According to the completion criteria, students with high ability are categorized in level 4, students with moderate ability are in level 2, and students with low ability are in level 1. Based on the findings of this study, it is highly recommended that the Contextual Teaching and Learning (CTL) model be proposed as an alternative for enhancing mathematical creative thinking abilities, particularly in demonstrating fluency, flexibility, and novelty.

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