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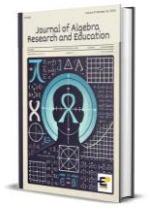

Analysis of Mathematical Creative Thinking Ability Based on Students' Academic Ability

Nana Karina Madya[1*],Lilis Marina Angraini[2], Ebenezer Bonyah[3]

[1,2]Universitas Islam Riau, Indonesia
[3]Akenten Appiah Menka University of Skills Training and Entrepreneurial Development, Ghana

*Corresponding author: nanakarinamadya@student.uir.ac.id

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Abstract

This study aims to analyze students' mathematical creative thinking skills based on their academic abilities. The essential elements that include creative thinking are 1) fluency; 2) flexibility; 3) originality; 4) Elaboration. This study uses descriptive research with a qualitative approach. The subject in this study is a student of Junior High School 4 Koto Gasib. The subject of this study is grade IX students as many as 28 purposive sampling students who have studied the data collection techniques used in this study, namely in the form of mathematical creative thinking ability test questions on TVLES material and interviews. The results of the analysis showed that the average score was 56.25 based on the four indicators, students had quite high creative thinking skills. The average ability of students to think creatively in the Elaboration category is 89% which indicates a very high Average ability of students to think creatively in the originality category is 75%, the average ability of students to think creatively in the flexibility category is 23%, the average ability of students to think creatively in the fluency category is 38%.

Keywords: Analysis; Mathematical Creative Thinking Ability: Students' Academic Ability

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1. Introduction

Mathematics is an exact science and one of the subjects taught in schools. Mathematics, as an exact science, holds a pivotal role in education and everyday life. Its universal nature makes it a powerful tool for developing systematic and logical thinking patterns, fostering creativity, critical analysis, and problem-solving skills. By engaging with mathematical concepts, students learn to approach problems methodically, breaking them down into manageable parts and applying precise reasoning to arrive at solutions. This process not only enhances their mathematical abilities but also cultivates transferable skills that are essential in various aspects of life and other academic disciplines. As a discipline with a universal nature, mathematics can train understanding and systematic thinking patterns, fostering creative, critical, logical, and analytical thinking because it is a precise science present in our daily environment (Tsaqila et al., 2023).

This discipline can enhance students' mathematical creative thinking abilities. The creative thinking abilities nurtured through mathematics are particularly significant. As Tsaqila et al. (2023) highlight, mathematics encourages students to think outside the box, explore multiple solutions, and innovate. This creative dimension is crucial in a world that increasingly values innovation and adaptability. Furthermore, Aini (2018) emphasizes that mathematics is the foundation of modern technological advancements, underpinning fields such as engineering, computer science, economics, and data analysis. Its influence extends beyond technical applications, shaping the way humans conceptualize and solve problems across diverse domains.

Creative thinking is an essential cognitive process that involves generating novel ideas, exploring unconventional solutions, and approaching problems with originality and insight. In the context of mathematics education, creative thinking plays a vital role in helping students move beyond rote memorization and formulaic problem-solving. According to Wardani & Suripah (2023), creative thinking skills are particularly important in mathematics because they enable students to produce unexpected ideas and solutions, fostering innovation and deeper understanding. This process not only enhances students' ability to tackle complex problems but also encourages them to view mathematics as a dynamic and evolving discipline rather than a static set of rules.

In mathematics, creative thinking often manifests in activities such as finding multiple solutions to a problem, exploring patterns, and making connections between seemingly unrelated concepts. For example, Choudhary et al. (2022) stated students might use creative thinking to devise alternative methods for solving algebraic equations or to visualize geometric relationships in new ways. These activities not only strengthen mathematical proficiency but also build confidence and intellectual flexibility, which are valuable skills in both academic and real-world contexts. These creative activities do more than just enhance mathematical proficiency; they also foster intellectual flexibility and resilience. By encouraging students to experiment with different approaches and embrace trial and error, educators help them build confidence in their problem-solving abilities. This confidence, in turn, empowers students to

tackle unfamiliar challenges with curiosity and determination, both in academic settings and in real-world contexts.

Mathematical creative thinking is essential for students. By practicing this type of thinking, students can analyze and develop more complex thoughts, enabling them to find solutions to problems with innovative ideas (Loska, Ayuni & Ainirohmah, 2024). According to Susanti & Novitar (2018), mathematical creative thinking is the ability to generate new ideas and create new approaches to solve problems as alternative solutions. Similarly, Maya (2019) stated that creative thinking skills are necessary for students to analyze mathematical problems from different perspectives and solve them with multiple solutions, ideas, and creative approaches. This ability helps students solve problems not only in mathematical contexts but also in daily life, as it trains their logical, creative, and systematic thinking processes to find innovative solutions by connecting or generating new ideas from previous concepts. According to Akbar, P., Hamid, A., Bernard, M., & Sugandi (2018), creative thinking ability is a crucial factor in learning objectives, as it trains students to develop ideas that can be useful in everyday life. Bernard (2015) emphasized that creative thinking skills are essential for students to face the rapid development of science and technology.

The topic of Two-Variable Linear Equation Systems (TVLES) is one of the materials that can train students' mathematical creative thinking skills. In real life, TVLES is often applied to comparisons, value determination, or problem-solving. Through TVLES, students can practice creative thinking in solving mathematical problems. However, several studies show that students have low creative thinking skills, especially in TVLES topics. A study conducted on 33 eighth-grade students (class VIII B) at Junior High School Al Islamiyah categorized the results into three groups: 1 student with high mathematical creative thinking skills, 3 students with moderate skills, and 29 students with low skills. Many students' inability to master mathematical creative thinking skills is evidenced by research from Andiyana et al. (2018) and Laksono et al. (2021), which attributes the low ability primarily to the originality and elaboration indicators.

Additionally, research by Susanti & Novitar (2018) revealed that only 25% of students scored in the high category (4 students), 31.25% in the moderate category (5 students), and 43.75% in the low category (7 students). Another study by Kurnia (2022) found that the average percentage for the five mathematical creative thinking indicators was 21.81% (Rasnawati et al., 2019). Based on these field findings, it is concluded that students' mathematical creative thinking skills remain low due to several factors: (1) Motivation, (2) Teaching modules, and (3) Lack of understanding or knowledge, which causes students to struggle with problem-solving, as stated by Warmi et al. (2024). Therefore, this study aims to analyze students' mathematical creative thinking skills based on their academic abilities.

2. Methods

This study employs a descriptive research design with a qualitative approach. The subjects are ninth-grade students from Junior High School 4 Koto Gasib, totaling 28 students selected through purposive sampling based on their prior learning of the tested material. The research

object is students' Mathematical Creative Thinking Ability, conducted during the odd semester of the 2024/2025 academic year. Data collection instruments include a written test and interviews.

The data collection techniques involve a mathematical creative thinking test on Two-Variable Linear Equation Systems (TVLES) and informal interviews to understand students' problem-solving techniques. The test comprises four questions based on TVLES, while interviews supplement the data analysis. The test instrument assesses four indicators of creative thinking (Wardani & Suripah, 2023): (1) Fluency: Providing diverse answers and generating multiple ideas for a problem; (2) Flexibility: Solving problems using different, correct methods; (3) Originality: Solving problems through unique, self-developed approaches; (4) Elaboration: Providing detailed, step-by-step solutions. The data collection process involves administering a written test on TVLES to gauge students' creative thinking abilities, followed by interviews to gather additional insights for analysis. The collected data are categorized and analyzed accordingly. The test instruments were adapted and subsequently modified, as shown in Table 1.

Table 1 - Instrument for Mathematical Creative Thinking Ability

Indicator	Questions
Fluency	Alif has money of Rp.25,000. Alif buys the price of 1 book at Rp.3,000 and 1 pen Rp.2,000. Determine the amount of each book and pen that Alif can buy until Alif runs out of money. Make a mathematical sentence of the two equations and give at least 2 possible answers!
Flexibility	Karin, Fina, and Irma will buy snacks in the school canteen in the form of bread and chips. Karin bought 4 breads, 3 chips at a price of Rp. 11,000. FIna bought 2 breads, 2 chips at a price of Rp. 6,000. Meanwhile, Irma buys 2 breads, 4 chips for Rp.8,000. What is the price of each snack (bread and chips)? Do it in 2 ways!
Originality	It is known that Nia's age is 4 years younger than Yaya. Their total age is 32 years. Their age in the next three years will increase by 3 years each. Make a question and give each of the solutions from the above statements!
Elaboration	Jarjit has a yellow and blue gift tape. The sum of the two ribbons is 275 cm. The length of the yellow band is 5 cm less than the length of the blue band. A blue ribbon will be used 40 cm. How long is the blue ribbon left after use?

The clarification criteria used in the study, as outlined by Qomariyah & Subekti (2021), provide a structured framework for evaluating and categorizing students' abilities or performance in a specific context. These criteria are essential for ensuring consistency and objectivity in analysis. Below is a summary of the clarification criteria based on their work:

Table 2 - Clarification Test Instrument

Interval (%)	Categories
81-100	Very High
61-80	High
41-60	Medium
21-40	Low
0-20	Very Low

3. Results and Discussion

3.1 Results

After analyzing the answers to the questions given which consisted of 4 questions based on the indicators, namely; 1) Smoothness, 2) Flexibility, 3) Authenticity, 4) Elaboration. After researching in the Creative Thinking Ability of Students in grade IX on the meter of the two-variable linear equation system in answering the questions, the results of data analysis were obtained as follows.

Table 3 - Description of test results

Indicator	Percentage	Categories
Fluency	38%	Low
Flexibility	23%	Low
Originality	75%	High
Elaboration	89%	Very High

Based on Table 3. The description of the test results using the guidelines of the test caricature instrument shows that the indicators of creative thinking ability are obtained: the lowest average is 38% Low Fluency, the Flexibility indicator is 43% moderate, the Originality indicator is 75% moderate, and finally the Elaboration indicator is 89% very high. Furthermore, based on Table 2. The average test results of the overall indicator were 56.25 in the medium category.

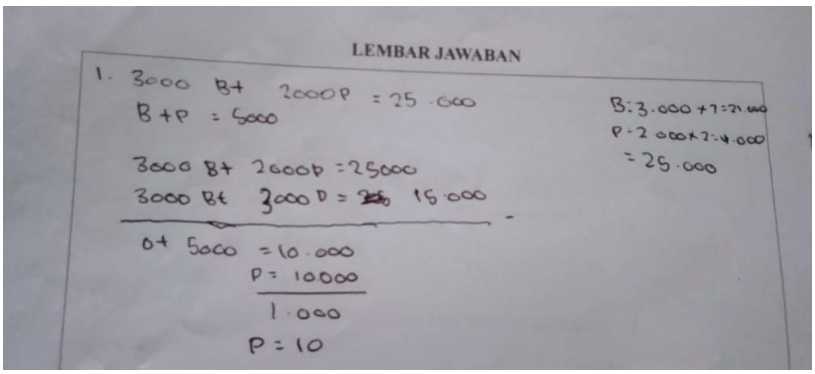

Figure 1 Student Answer Number 1

In Figure 1. Students answer with one possibility, where 3,000 times 7 and 2,000 times 3 results are added so that the answer obtained is 25,000. Meanwhile, in the question, 2 possibilities are asked. The average ability of students to think creatively in the fluency category was 38% where all students answered with the correct answer but students were only able to answer one question. In the interview, the student said that he could solve the problem, but he was not careful to pay attention to the problem of the question asked so that the student answered it with one possibility.

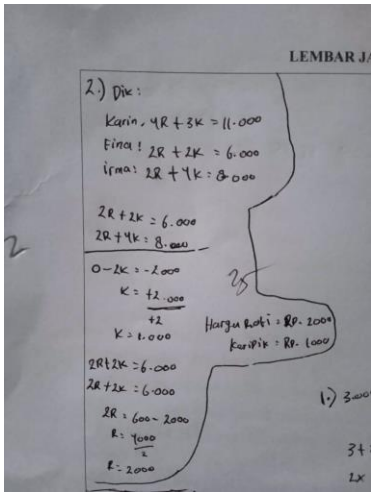

Figure 2 Student Answer Number 2

The same is true for the students' answers in Figure 2. To answer the question of the second indicator, namely flexibility, 23% is low. Students are able to solve the problem to the conclusion but students do not pay attention to the problem. The question that is intended does not refer to one method but with the same method can make ideas in answering questions not just one benchmark, for example one of the students who shows the right answer.

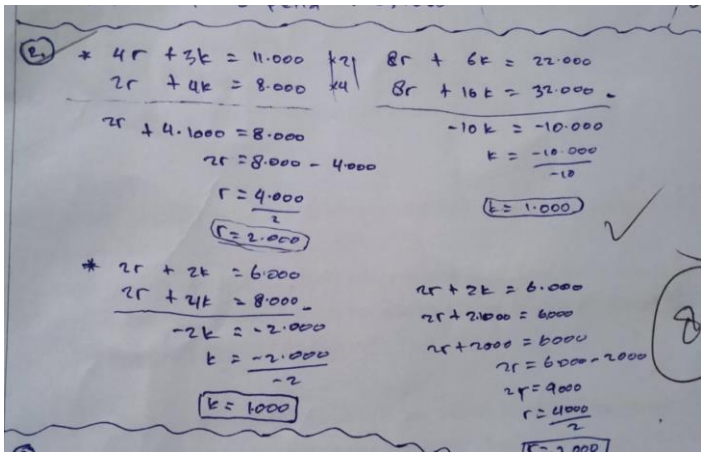

Figure 3 Student answer number 3

In Figure 3, a student with the initials DW who is able to answer correctly gives answers with different ideas. The results obtained remain the same, but creatively students are able to write with different methods by entering the same equation but in a different way of doing it. The average ability of students to think creatively on fluency category questions is 23% where students are able to answer correctly but lack to express different ideas. In the interview, the students said that the students were not thorough and did not understand the problem.

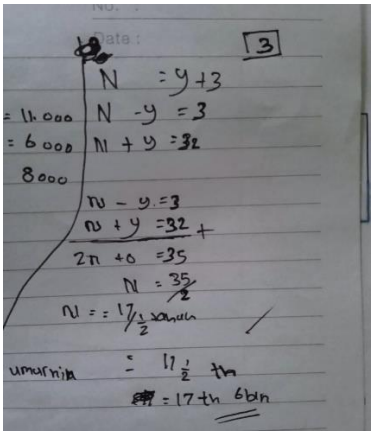

Figure 4 Student Answer Number 4

In Figure 4. Students can make questions in the statement of the question, students make questions about how old Nia is. With the right steps and methods, students solve the problem. The average ability of students to think creatively in the originality category is 75%, indicating that it is quite high. During the interview, the student said that he got the idea of this question from the statement of the question.

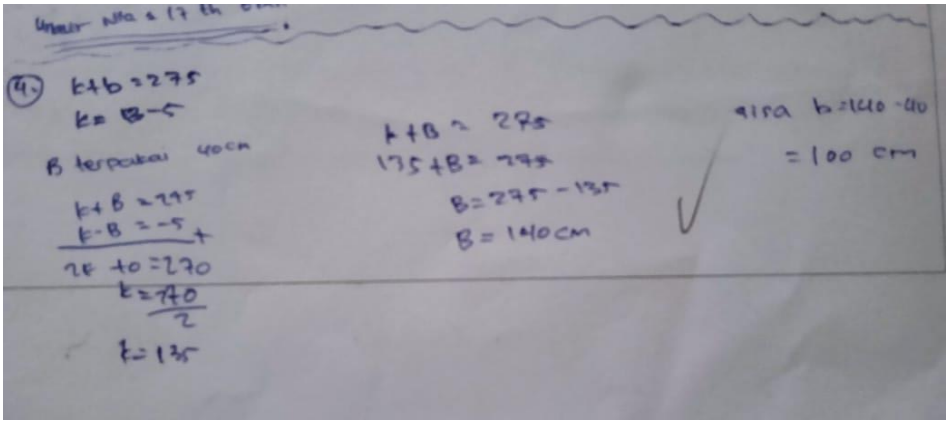

Figure 5 Student Answer Number 5

In Figure 5. Students are asked to solve the problem with complete steps. Students are able to make mathematical sentences, through the process of answers, and finally conclusions. The average ability of students to think creatively in the Elaboration category is 89%, which indicates very high. During the interview, the student said that he understood enough in solving the problem and had been taught well by the teacher.

3.2 Discussion

Research findings indicate that students' creative thinking skills, based on academic ability, were lowest in fluency, with only 38% categorized as low. Although most students could solve the Two-Variable Linear Equation Systems problems, they lacked diverse solutions, aligning with Sihotang & Warmi (2023), who found students struggled to provide varied answers (Ahmad et al., 2023). According to Suryani (Latjompoh et al., 2021), fluency in creative thinking involves generating many ideas, offering multiple approaches, and considering more than one solution. The study concludes that fluency remains low due to students' inability to produce diverse solutions in creative problem-solving.

The findings regarding flexibility in creative thinking, as highlighted by Latjompoh et al. (2021), reveal a significant area for improvement among students. With only 23% of students demonstrating flexibility, this indicator falls into the low category. Flexibility in creative thinking refers to the ability to approach problems from multiple perspectives (Kania et al., 2023), generate diverse solutions, and adapt strategies based on the context. However, the research indicates that while students were able to solve problems correctly, they often relied on a single approach or perspective, showing limited ability to explore alternative methods or think outside conventional frameworks. This lack of flexibility suggests that students are primarily focused on finding a correct answer rather than exploring the problem-solving process itself. For example, in mathematical tasks, students may apply a standard formula or method without considering whether other strategies could lead to the same or even more efficient solution (Angraini et al., 2024). This rigidity in thinking can hinder their ability to tackle complex or unfamiliar problems, where adaptability and innovative approaches are crucial.

The findings on originality in creative thinking reveal a mixed picture. While the average score of 75% indicates that students are capable of proposing their own ideas and answering questions in conventional ways, as noted by Gustiani & Warmi (2023), the study also highlights a significant shortfall in achieving true originality. Originality, in the context of creative thinking, refers to the ability to generate unique, unconventional, and innovative solutions to problems. However, the research suggests that students often rely on methods taught by teachers rather than developing their own independent approaches, as highlighted by Hendri et al. (2019). This reliance on familiar strategies limits their ability to think outside the box and produce truly original solutions.

According to Hanipah et al. (2018), students meet the originality criterion when they can provide new or unique ideas during problem-solving. This means going beyond standard methods and exploring novel ways to approach a problem. For example, in mathematics, originality might involve devising a new method to solve an equation, creating a unique visual representation of a geometric concept, or applying mathematical principles to an unconventional real-world scenario. However, the current findings suggest that students are not fully reaching this level of creative independence.

The findings on elaboration in creative thinking reveal a significant strength among students, with an average score of 89%, placing this indicator in the very high category. Elaboration, as defined by Hanany & Sumaji (2021), refers to the ability to develop and execute solutions with appropriate detail, ensuring that all aspects of a problem are addressed comprehensively. The high score in this area demonstrates that students excel at providing detailed, accurate, and thorough solutions to problems, reflecting their ability to think systematically and pay attention to the finer aspects of problem-solving.

4. Conclusions

Based on the analysis of students' creative thinking abilities based on academic ability at Junior High School 4 Koto Gasib school, based on the average score of 56.25 out of the total average score of the four indicators, students have moderate creative thinking

skills. The average ability of students to think creatively in the Elaboration category is 89% which indicates a very high Average ability of students to think creatively in the originality category is 75%, Average ability of students to think creatively in the flexibility category is 23%, Average ability of students to think creatively in fluency category 38%. From this, it is concluded that the shortcomings of students are from the lack of thoroughness in understanding the problems.

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