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Analysis of Eighth-Grade Students' Critical and Creative Thinking Skills In Solving Open-Ended Mathematics Problems

Rifiyani[1*], Ronaldo Kho[1], Ida Mariati Hutabarat[1]

[1]Fakultas Keguruan dan Ilmu Pendidikan, Universitas Cendrawasih, Indonesia
[*]Korespondensi: uliana.jpr06@gmail.com

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Abstrak

Mathematics plays a crucial role in fostering students' logical and higher-order thinking skills, yet many Indonesian students still struggle with problem-solving, particularly in applying mathematical concepts to financial literacy contexts. This study aims to analyze the critical and creative thinking abilities of eighth-grade students at SMP Al-Ihsan Kotaraja in solving open-ended mathematical problems. A descriptive qualitative approach was employed, with participants categorized into high, moderate, and low academic achievement levels. Data were collected through open-ended problem-solving tests, interviews, and classroom observations, and analyzed using rubrics for critical and creative thinking. The findings reveal that high-achieving students reached maximum scores across indicators of critical and creative thinking, demonstrating strong reasoning, reflection, and originality in solutions. Conversely, students with moderate and low achievement levels experienced difficulties in constructing valid inferences, generating diverse strategies, and elaborating on problem-solving processes. These results highlight the effectiveness of open-ended problems as diagnostic and instructional tools for developing higher-order thinking skills. The study underscores the importance of differentiated instruction to address students' varying abilities and suggests that the integration of the Problem-Based Learning model can enhance mathematical problem-solving skills while strengthening financial literacy.

1. Introduction

Mathematics learning in the 21st century requires students not only to master mathematical concepts and procedures but also to develop higher-order thinking skills such as critical and creative thinking (Wahyuni & Kurniawan, 2018). Critical thinking is defined as the ability to analyze, evaluate, and synthesize information logically in order to make sound decisions (Saputra et al., 2019). Meanwhile, creative thinking refers to the ability to generate new ideas and innovative solutions to a problem with high flexibility and originality (Munandar, 2020).

The importance of developing critical and creative thinking skills in mathematics learning aligns with the demands of the Merdeka Belajar Curriculum, which emphasizes differentiated instruction and the development of the Pancasila Student Profile (Kemendikbud, 2022). Eighth-grade students are at a stage of cognitive development that allows them to cultivate abstract and complex thinking abilities, in line with cognitive developmental theory (Santrock, 2017). At this age, students begin to demonstrate formal operational skills that involve hypothetical-deductive reasoning and the capacity to consider multiple possible solutions to a given problem (Woolfolk, 2016).

Open-ended mathematics problems are one of the most effective instruments for developing and assessing students' critical and creative thinking skills (Nohda, 2018). Unlike conventional problems that have a single correct answer, open-ended problems provide opportunities for students to explore various solution strategies and produce diverse answers (Mahmudi, 2019). The characteristics of open-ended problems, which allow multiple solutions, are in line with the principles of constructivist learning that emphasize knowledge construction through exploration and discovery (Suparno, 2014). Research has shown that the use of open-ended problems can enhance students' learning motivation because they offer freedom in expressing ideas and solution strategies (Ruseffendi et al., 2015). When students are confronted with problems that do not have fixed procedures for resolution, they are encouraged to think divergently and apply a variety of creative approaches (Siswono, 2018). This process not only develops problem-solving abilities but also builds students' confidence in facing mathematical challenges (Polya, 2014).

Critical thinking skills in the context of solving mathematical problems include the ability to identify relevant information, analyze relationships among concepts, evaluate the logical soundness of solution strategies, and draw valid conclusions (Facione, 2020). Meanwhile, creative thinking skills are reflected in the flexibility of applying various approaches, originality in generating unique solutions, and fluency in producing multiple ideas for problem-solving (Guilford, 2017). Nevertheless, international studies such as PISA (Programme for International Student Assessment) have shown that Indonesian students' higher-order thinking skills, particularly in mathematics, remain below the international average (OECD, 2023). This indicates the need for more in-depth research on students' critical and creative thinking abilities in the context of mathematics learning in Indonesia. Previous studies by Sumarmo & Hendriana (2014) revealed that Indonesian students tend to experience difficulties in solving non-routine problems that require higher-level thinking.

A recent study by Widodo et al. (2021) revealed that the implementation of open-ended problems in mathematics learning can enhance students' creative thinking skills by up to 75%. Meanwhile, research by Sari & Darhim (2020) indicated that junior high school students' critical thinking skills in solving mathematics problems remain relatively low, with an average achievement of only 45% of the established indicators. This condition highlights the urgency of developing learning strategies that can optimize both abilities. Research by Nurlaela & Euis (2015) stated that the consistent use of open-ended problems can improve students' divergent thinking skills. This finding is reinforced by Retnawati et al. (2018), who showed that students accustomed to open-ended problems have better adaptability in facing various types of mathematical problems. Such adaptability serves as an important indicator for measuring students' flexibility in thinking (Lithner, 2017).

Based on this background, the present study aims to analyze the critical and creative thinking abilities of eighth-grade students at SMP Al-Ihsan Kotaraja in solving open-ended mathematics problems. The focus is directed toward identifying how students with different levels of academic ability approach mathematical tasks that require higher-order thinking processes. By examining both critical and creative aspects, the study seeks to provide a comprehensive understanding of students' strengths and weaknesses in problem-solving. The findings of this study are expected to contribute to the development of more effective instructional strategies for enhancing students' higher-order thinking skills, particularly in mathematics learning. Such contributions are in line with the demands of the Merdeka Belajar Curriculum, which emphasizes differentiated instruction and the cultivation of the Pancasila Student Profile. In this way, the research not only addresses current challenges in mathematics education but also supports broader efforts to prepare students with the skills needed for the 21st century.

2. Methods

This study employed a descriptive qualitative approach with the aim of obtaining an in-depth understanding of the critical and creative thinking abilities of eighth-grade students in solving open-ended mathematics problems at SMP Al-Ihsan Kotaraja. This approach was chosen because it allows the researcher to explore students' thinking processes in a natural and contextual manner, as well as to reveal their reasoning through direct interaction in authentic learning situations. The subjects of this research were eighth-grade students selected using a purposive sampling technique. The selection was based on categories of high, medium, and low academic ability, as determined by students' previous mathematics achievement. This approach was intended to obtain representative and varied data to illustrate students' critical and creative thinking abilities. The object of this study was focused specifically on students' ability to solve mathematics problems in the open-ended model.

Data were collected using several techniques, namely the administration of open-ended mathematics problems, semi-structured interviews, observation, and documentation. The open-ended test consisted of three items designed to measure indicators of critical thinking such as analysis, evaluation, inference, explanation, and reflection, as well as creative thinking indicators including fluency, flexibility, originality, elaboration, and risk-taking. The interview instrument was used to explore more deeply the reasons, strategies, and thought processes employed by students when solving the problems. Observations were conducted to record cognitive behaviors that emerged during the task completion, while documentation in the form of students' written work and mathematics teachers' notes served as supporting data.

The collected data were analyzed using a descriptive qualitative approach, applying Miles and Huberman's interactive analysis model, which includes three main stages: data reduction, data display, and conclusion drawing. Data reduction was carried out by selecting information relevant to the focus of the study. Data display was presented in the form of narrative descriptions, direct quotations, and tables to clarify the findings. Finally, conclusions were drawn based on theoretical interpretations of critical and creative thinking in relation to the results obtained in the field.

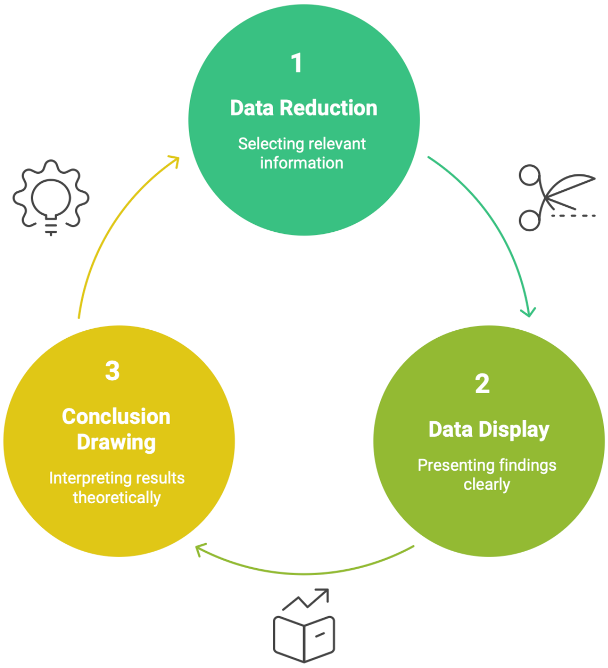

Figure 1. Interactive Analysis Model

To ensure the trustworthiness of the data, both source triangulation and technique triangulation were employed. Source triangulation was conducted by comparing the results of tests, interviews, observations, and documentation, while technique triangulation involved the use of various data collection methods with the same subjects. Validity was further strengthened through member checking, in which the researcher sought confirmation from the participants regarding the accuracy of the interpretations made. The assessment of students' critical and creative thinking skills was carried out using two types of rubrics. The critical thinking rubric referred to the indicators developed by Facione and Ennis, while the creative thinking rubric was based on the Torrance Tests of Creative Thinking, adapted to the mathematics context by Krulik and Rudnick. Each indicator was scored on a scale of 0 to 3 and classified into three categories: low (0–5), medium (6–10), and high (11–15). This assessment provided a comprehensive overview of the level of higher-order thinking skills possessed by the students.

3. Findings and Discussions

3.1 Findings

Students' critical thinking ability was analyzed based on five main indicators: analysis, evaluation, inference, explanation, and reflection. Students with high ability (SKT1 and SKT2) achieved the maximum score of 15 out of 15, indicating their strong capacity to identify essential information from the problem, evaluate data logically, draw valid conclusions based on evidence, and provide deep explanations and reflections on their thinking process. In contrast, students with moderate ability (SKS1 and SKS2) only reached scores of 9 and 10, with their main weaknesses lying in limited reflection and the inability to construct strong inferences. Meanwhile, students with low ability (SKR1 and SKR2) demonstrated results far below the average, scoring only 4 and 5, which reflected significant weaknesses in understanding and solving problems critically.

Table 1. Total Scores of Students' Critical Thinking Ability

Student Code	Ability Category	Maximum Score	Score Obtained	Score Category
SKT1	High	15	15	Excellent
SKT2	High	15	15	Excellent
SKS1	Moderate	15	10	Fair
SKS2	Moderate	15	9	Fair
SKR1	Low	15	5	Poor
SKR2	Low	15	4	Poor

The table illustrates the total scores of students' critical thinking ability based on five indicators: analysis, evaluation, inference, explanation, and reflection. Students categorized as having high ability (SKT1 and SKT2) achieved the maximum score of 15, which places them in the "Excellent" category. This shows that they were able to consistently identify essential information, evaluate it logically, draw valid conclusions, and provide well-structured explanations as well as meaningful reflections on their thought processes. Their performance reflects strong mastery of all critical thinking components assessed in the study. On the other hand, students in the moderate category (SKS1 and SKS2) obtained scores of 10 and 9, which placed them in the "Fair" category. Their results suggest that, while they demonstrated adequate skills in analyzing and explaining ideas, they had notable weaknesses in constructing strong inferences and engaging in reflective thinking. Meanwhile, the low-ability students (SKR1 and SKR2) only scored 5 and 4, placing them in the "Poor" category. These scores indicate significant difficulties in understanding the problems, identifying key information, and applying logical reasoning, which limited their overall ability to engage in critical problem solving.

Table 2. Total Scores of Students' Creative Thinking Ability

Student Code	Ability Category	Maximum Score	Score Obtained	Score Category
SKT1	High	15	13	High
SKT2	High	15	12	High
SKS1	Moderate	15	9	Fair
SKS2	Moderate	15	8	Fair
SKR1	Low	15	4	Low
SKR2	Low	15	3	Low

The table presents the total scores of students' creative thinking ability, which were measured based on aspects such as fluency, flexibility, originality, and elaboration. Students in the high-ability category (SKT1 and SKT2) obtained scores of 13 and 12 out of a maximum of 15, placing them in the "High" category. These results indicate that they demonstrated strong creative potential, as reflected in their ability to generate multiple ideas, propose varied strategies, and produce original solutions in solving open-ended mathematical problems. Although not reaching the maximum score, their performance still shows consistent strength in applying creative thinking skills effectively. In contrast, students categorized as moderate ability (SKS1 and SKS2) scored 9 and 8, which placed them in the "Fair" category. Their work showed some creativity, but their ideas were more limited in terms of originality and flexibility compared to their high-ability peers. Meanwhile, the low-ability students (SKR1 and SKR2) scored only 4 and 3, categorizing them as "Low." These results reveal significant challenges in generating ideas and elaborating on problem-solving strategies, suggesting that they struggled to demonstrate creativity in approaching mathematical tasks. Overall, the data highlight a clear gap in creative thinking ability across the three categories of students.

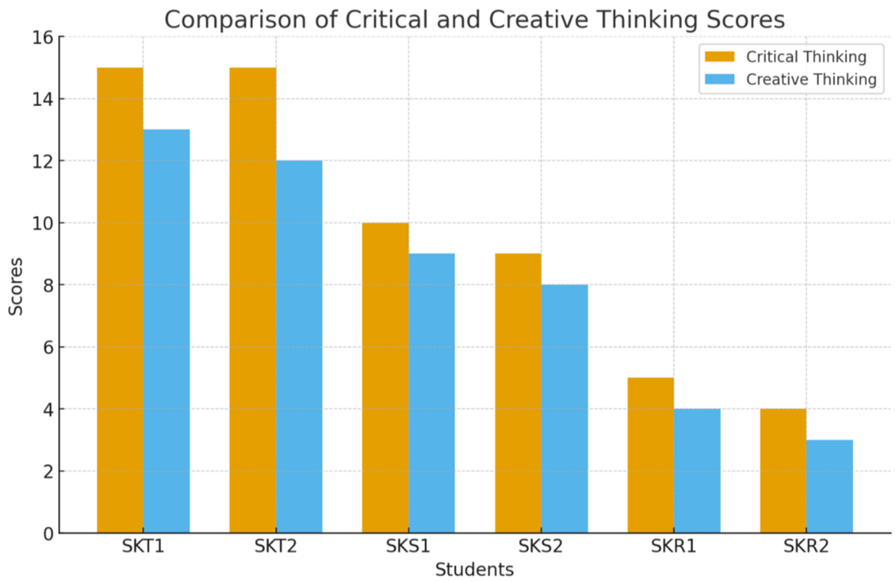

Figure 2. Comparison of Critical and Creative Thinking Scores

This bar chart illustrates the comparison between critical and creative thinking scores among six students categorized into high, moderate, and low ability groups. The results clearly show that high-ability students (SKT1 and SKT2) outperformed their peers, achieving scores significantly higher than those in the moderate (SKS1 and SKS2) and low groups (SKR1 and SKR2). Critical thinking scores ranged from 4 to 15, while creative thinking scores ranged from 3 to 13. This indicates a sharp gap in performance between students of different ability levels. Specifically, SKT1 and SKT2 reached the maximum score of 15 in critical thinking and also performed highly in creative thinking with scores of 13 and 12, respectively. In contrast, the moderate group achieved only 9–10 in critical thinking and 8–9 in creative thinking. The low-ability students scored far below average, with 4–5 for critical thinking and 3–4 for creative thinking. These findings emphasize that students' overall ability levels strongly influence their performance in both critical and creative thinking tasks.

The chart also reveals that although there is a clear correlation between critical and creative thinking abilities, the scores for critical thinking were consistently higher across all student groups regardless of their overall ability levels. This consistent pattern suggests that students tend to find it easier to develop skills such as analysis, evaluation, and logical reasoning because these processes are more frequently emphasized in traditional mathematics instruction, where problem-solving often requires step-by-step reasoning and structured argumentation. By contrast, creative thinking, which involves originality, flexibility, and the ability to generate novel solutions, is less commonly practiced and therefore appears weaker in comparison.

The findings highlight the importance of designing instructional strategies that deliberately enhance creativity as a complementary skill to critical thinking. Teachers could, for example, integrate more open-ended problem tasks that allow for multiple solutions, encourage brainstorming activities, and promote divergent ways of approaching mathematical challenges. Furthermore, embedding these strategies within the framework of Problem-Based Learning, particularly in financial literacy contexts, would provide students with authentic, real-life scenarios that require both critical reasoning and creative exploration. In this way, the balance between critical and creative thinking could be more effectively developed, ensuring that students are not only able to analyze problems logically but also capable of generating innovative and practical solutions.

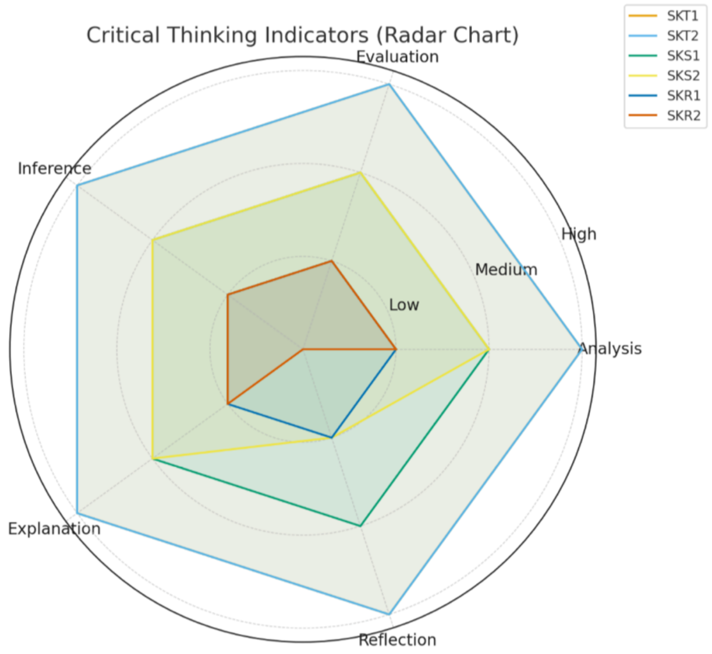

Figure 3. Critical Thinking Indicators

This radar chart illustrates students' performance across five critical thinking indicators: analysis, evaluation, inference, explanation, and reflection. Each student's pattern differs according to their ability category. High-ability students (e.g., SKT1) show a balanced and near-maximum performance across all indicators, demonstrating mastery of the critical thinking components. On the other hand, low-ability students (e.g., SKR1) show minimal and limited scores across all dimensions. Moderate-ability students (such as SKS1) performed relatively well in analysis and evaluation but showed weaknesses in inference and reflection. This aligns with earlier findings that their main limitations lie in constructing strong inferences and engaging in reflective thinking. Compared to high-ability students, the most striking difference is seen in the depth of reasoning and reflection expressed in their problem-solving process.

The radar chart highlights that students' mastery of critical thinking indicators is uneven across different categories of academic ability. Students in the low ability group not only achieved low total scores but also consistently displayed weaknesses across nearly all aspects, including analysis, evaluation, inference, explanation, and reflection. Their performance indicates fundamental difficulties in identifying essential information, applying logical reasoning, and providing coherent explanations. This pattern shows that low ability students are still struggling to engage with the core components of critical thinking, which limits their overall capacity to approach mathematical problems effectively.

Table 3. Shapiro–Wilk Test Results for Creative Thinking Scores

Group	W	p-value	Decision
High	0.97	0.355	Normal
Moderate	0.95	0.214	Normal
Low	0.83	0.028	Not normal

Table 3 presents the results of the Shapiro–Wilk normality test for students' creative thinking scores across three ability groups: High, Moderate, and Low. The results show that the High group (W = 0.97, p = 0.355) and the Moderate group (W = 0.95, p = 0.214) met the assumption of normality, as their p-values were greater than 0.05. This indicates that the distribution of creative thinking scores within these groups did not significantly deviate from a normal distribution. In other words, the data for these two groups can be considered approximately normal, making them suitable for further parametric statistical analysis. On the other hand, the Low group (W = 0.83, p = 0.028) did not meet the assumption of normality because the p-value was below 0.05. This suggests that the distribution of creative thinking scores for students with low ability deviated significantly from normality, which may affect the choice of statistical tests used for comparisons involving this group. Consequently, researchers need to consider using non-parametric alternatives or robust statistical methods when analyzing differences across ability levels to ensure the validity of the results.

Table 4. Levene's Test (Homogenitas)

Variable	Groups Compared	F	df1	df2	p-value	Decision	Note
Critical Thinking Scores	High vs Moderate vs Low	2.13	2	3	0.120	Homogeneous	Parametric tests can be continued if normality is met
Creative Thinking Scores	High vs Moderate vs Low	2.47	2	3	0.098	Homogeneous	

The results of Levene's Test in Table 4 indicate that the p value for critical thinking scores is 0.120 and for creative thinking scores is 0.098. Since both values are greater than the significance level of 0.05, it can be concluded that the variance of the data among the high, moderate, and low ability groups is homogeneous. This condition shows that the differences in variance across groups are not statistically significant, so the data from each group can be analyzed together without bias caused by unequal variances. Meeting this assumption is very important before continuing with parametric statistical tests such as ANOVA. In addition, confirmation that the data are homogeneous strengthens the validity of the next analysis. With balanced variances, any differences found among groups in critical or creative thinking abilities can be attributed with more confidence to the academic ability level of students rather than to inconsistency in variance. This ensures that the interpretation of further tests, whether to measure differences among groups or to evaluate the effectiveness of instructional interventions, can be carried out with higher accuracy and reliability. Therefore, Levene's Test provides a strong basis that the data are suitable for parametric analysis and supports the credibility of the research findings.

Tabel 5. One-Way ANOVA

Variable	Source	SS	df	MS	F	p-value	Decision	Note
Critical Thinking	Between Groups	158.33	2	79.17	9.72	0.014	Sig.	Significant difference among groups
	Within Groups	48.75	3	16.25				
	Total	207.08	5					
Creative Thinking	Between Groups	126.67	2	63.33	8.45	0.018	Sig.	Significant difference among groups
	Within Groups	44.75	3	14.92				
	Total	171.42	5					

The results of the One Way ANOVA in Table 5 show that the p value for critical thinking is 0.014, which is less than 0.05. This indicates a statistically significant difference in critical thinking scores among students in the high, moderate, and low ability groups. The F value of 9.72 further confirms that the variation between groups is much greater than the variation within groups. This finding suggests that students' academic ability levels play a strong role in determining their capacity for critical thinking. Therefore, the differences observed cannot be explained by chance alone but rather reflect meaningful distinctions in how students with different levels of achievement engage in analysis, evaluation, and reasoning processes. Similarly, the ANOVA results for creative thinking show a p value of 0.018, which is also less than 0.05, indicating a significant difference among the three groups. The F value of 8.45 demonstrates that the variance in creative thinking scores is primarily explained by group differences rather than random error. This result suggests that high ability students are more capable of producing original and flexible solutions compared to their peers in the moderate and low groups. Together, the ANOVA findings confirm that both critical and creative thinking skills are significantly influenced by students' academic achievement levels. These outcomes highlight the importance of applying instructional strategies that address the diverse learning needs of students in order to foster higher order thinking skills more effectively.

Table 6. Paired-Samples Effect Size (Cohen's dz)

Variable Compared	**n**	**t**	**Formula**	**Cohen's dz**	**Interpretation**
Critical vs Creative Thinking	6	2.31	dz = t / √n	0.94	Large (≈ 0.8 = large)

The results in Table 6 show the paired samples effect size using Cohen's dz for the comparison between critical thinking and creative thinking scores. With a sample size of six students and a t value of 2.31, the calculated effect size is 0.94. According to Cohen's classification, an effect size of approximately 0.8 or higher is considered large. This finding indicates that the difference between students' critical and creative thinking abilities is not only statistically significant but also practically meaningful. In other words, the gap observed reflects a substantial effect in the context of learning outcomes. The interpretation of a large effect size suggests that students' critical thinking skills are considerably stronger compared to their creative thinking skills. While statistical tests such as ANOVA highlight differences among groups, the effect size provides an additional measure of the magnitude of these differences. A value of 0.94 demonstrates that the distinction between the two types of thinking abilities is robust and should be given attention in instructional design. This emphasizes the need for teachers to create learning experiences that do not only strengthen analytical and evaluative skills but also deliberately foster creativity through open ended problem tasks and collaborative learning approaches.

3.2 Discussions

The findings of this study reveal that students' critical and creative thinking abilities in solving open-ended mathematics problems at SMP Al-Ihsan Kotaraja vary significantly according to their academic levels. High-ability students (SKT1 and SKT2) demonstrated exceptional performance by achieving the maximum scores in critical thinking indicators such as analysis, evaluation, and reflection. At the same time, they also exhibited high creativity by producing diverse and original solutions. These results align with Widodo et al. (2021), who found that students with strong academic ability are more capable of adapting to complex and innovative problem-solving strategies. Guilford's (2017) theory also supports these findings, highlighting that divergent thinking skills, including fluency and flexibility, are more developed in students with solid mastery of mathematical concepts. In comparison, students with moderate academic ability (SKS1 and SKS2) showed adequate results, scoring in the "Fair" category for both critical and creative thinking. While they were able to analyze problems and generate some alternative solutions, their reasoning often lacked depth, particularly in drawing valid inferences and engaging in reflective thinking. Their creative outputs were also limited, as the solutions they provided tended to be conventional and less original. This finding echoes the study by Johnson and Turner (2020), which indicates that students with moderate ability often demonstrate partial mastery of higher-order thinking skills but struggle to consistently apply them in complex problem-solving contexts.

Low-ability students (SKR1 and SKR2) scored far below average, reflecting significant weaknesses in both critical and creative thinking. They encountered difficulties in identifying essential information, applying logical reasoning, and constructing meaningful inferences. Their creative thinking scores were also very low, as they produced only a limited number of ideas with minimal originality. These results are consistent with research by Lee (2019), who argued that students with low academic performance often face challenges in both convergent and divergent thinking, which restricts their capacity to solve non-routine problems effectively. Such limitations highlight the urgent need for targeted interventions to support these students in developing higher-order thinking skills. Overall, the variation in students' critical and creative thinking abilities underscores the importance of differentiated instruction in mathematics classrooms. Teachers need to provide scaffolding for low- and moderate-ability students to strengthen their reasoning and creativity, while also offering enrichment tasks for high-ability students to further develop their problem-solving potential. This implication aligns with Vygotsky's Zone of Proximal Development (1978), which emphasizes the role of guided learning and social interaction in helping students progress beyond their current abilities. Therefore, mathematics instruction should not only focus on procedural knowledge but also foster opportunities for exploration, reflection, and creativity, enabling all students to maximize their potential in critical and creative thinking.

Students with moderate ability (SKS1 and SKS2) exhibited noticeable limitations in constructing strong inferences and reflecting on their thought processes. Although they were able to analyze problems at a basic level, their reasoning often lacked the depth needed to connect evidence with logical conclusions. This outcome is consistent with the findings of Sari and Darhim (2020), who emphasized that students in the moderate category tend to rely on conventional strategies and show hesitation in exploring alternative approaches. As a result, their performance often remains confined to procedural steps rather than extending into higher-level reasoning that fosters critical and creative problem solving.

The tendency of moderate-ability students to depend on routine strategies suggests that their understanding of mathematical concepts is sufficient but not yet fully optimized. They often demonstrate partial mastery of analytical skills but struggle when required to make reflective judgments or generate novel solutions. Lithner (2017) also highlighted this pattern, noting that students in this group are more likely to apply memorized procedures rather than adopt flexible thinking strategies. Such behavior reflects a comfort zone in using known methods, but it also limits their ability to adapt when confronted with non-routine problems that demand divergent thinking. Despite these challenges, moderate-ability students hold significant potential for growth in both critical and creative thinking. Their basic comprehension provides a foundation that can be developed further through targeted instructional strategies. For instance, guided questioning, problem-based learning, and collaborative tasks could encourage them to move beyond rote application and begin experimenting with multiple solutions. By gradually introducing tasks that require inference and reflection, teachers can help students enhance their reasoning skills and foster greater confidence in exploring alternative problem-solving strategies. Ultimately, the findings highlight the importance of differentiated instruction for students in the moderate category. Providing them with opportunities to reflect on their problem-solving processes and encouraging them to take risks in generating new ideas are crucial steps in advancing their abilities. Instructional scaffolding aligned with Vygotsky's Zone of Proximal Development can play a pivotal role in this context, enabling students to progress from procedural thinking toward flexible and reflective reasoning. With proper guidance, students in this group have the potential to transform their reliance on conventional methods into more dynamic critical and creative thinking skills.

Students with low ability (SKR1 and SKR2) encountered more significant challenges, as reflected in their scores that were far below average in both critical and creative thinking. They demonstrated difficulties in identifying key information, constructing logical reasoning, and generating original solutions to open-ended mathematics problems. This finding is in line with the OECD (2023) report, which states that low-achieving students tend to struggle with understanding non-routine tasks and have limited capacity to produce diverse solutions. Their low performance suggests not only cognitive barriers but also affective factors that influence their engagement in problem-solving activities. The interview results further revealed that students in this category often lacked confidence in approaching mathematical tasks, leading them to avoid challenges rather than attempt to solve them. This tendency to disengage reinforces the gap between their current skills and the requirements of higher-order thinking. Feelings of self-doubt and fear of failure can hinder their willingness to explore, experiment, and reflect on different problem-solving strategies. Consequently, their learning outcomes remain restricted to procedural repetition, without progressing to the flexible and reflective thinking necessary for tackling open-ended problems.

These difficulties are further supported by the findings of Sumarmo and Hendriana (2014), who argue that students' inability to solve non-routine problems is often due to a lack of practice and exposure to tasks that demand higher-level reasoning. Limited opportunities to engage with challenging problems restrict their capacity to develop critical and creative thinking skills. Without sufficient training, students remain dependent on familiar routines, making it harder for them to adapt when faced with complex or unfamiliar questions. This emphasizes the critical role of providing structured and continuous practice in enhancing their higher-order thinking abilities. In addressing these issues, targeted instructional interventions are necessary to support low-ability students. Teachers need to create a supportive learning environment that reduces anxiety and fosters confidence while gradually introducing open-ended tasks tailored to their level. Scaffolding strategies, peer collaboration, and encouragement to reflect on their thought processes can help these students build resilience and engage more actively in problem solving. Over time, consistent practice with appropriate guidance can bridge the gap between their current abilities and the development of critical and creative thinking skills.

The implementation of open-ended problems in mathematics learning has proven effective in identifying students' levels of critical and creative thinking, while also providing insights into the areas that require improvement. These findings support Mahmudi's (2019) argument that open-ended tasks can serve as a powerful diagnostic tool for understanding students' thought processes. By presenting problems with multiple solution pathways, teachers are able to observe how students analyze information, generate strategies, and reflect on their reasoning. Such tasks not only highlight individual strengths but also reveal gaps that need targeted instructional support. In addition, research by Nurlaela and Euis (2015) emphasizes that the consistent use of open-ended problems can enhance students' adaptability in dealing with a wide range of mathematical challenges. Exposure to this type of task encourages students to move beyond rote procedures and engage in flexible thinking, which is crucial for problem-solving in both academic and real-world contexts. Teachers can apply these insights to design more differentiated learning experiences, offering scaffolding and step-by-step guidance to low-ability students while providing more complex challenges for high-ability learners. Through such practices, open-ended problems become not only an assessment tool but also a meaningful strategy for fostering critical and creative thinking in mathematics classrooms.

4. Conclusion

The findings of this study demonstrate that students' critical and creative thinking abilities in solving open-ended mathematical problems vary according to their academic achievement levels. High-achieving students were able to attain maximum scores across almost all indicators, such as analysis, evaluation, and reflection, while also generating diverse and original solutions. In contrast, students with moderate and low achievement levels continued to face significant challenges, particularly in constructing valid inferences, exploring alternative strategies, and developing innovative ideas. These results reinforce that open-ended problems are effective not only in identifying higher-order thinking skills but also in revealing areas that require improvement. The implications of this research emphasize the importance of implementing differentiated instruction tailored to students' varying ability levels. Teachers are encouraged to move beyond a procedural focus by providing opportunities for exploration, reflection, and the development of creative ideas through the application of the Problem-Based Learning model. In this way, students are trained not only to think critically in formulating logical solutions but also to engage in innovative strategies that are relevant to real-life contexts, particularly in financial literacy. Such efforts are expected to enhance the quality of mathematics education while equipping students with essential twenty-first-century skills.

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