Linking emotional intelligence to mathematical critical thinking performance among high school students

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Abstract

This study investigates the relationship between emotional intelligence and students' mathematical critical thinking using a quantitative ex-post facto design. The sample consisted of 29 Grade XI Science students from SMA Negeri 1 Binjai District, Langkat Regency, selected through purposive sampling. Data were collected using two instruments: a mathematical critical thinking test and an emotional intelligence questionnaire. The Spearman correlation test indicated a coefficient of -0.127 with a significance value of 0.512, exceeding the 0.05 threshold. These results demonstrate that emotional intelligence does not have a significant correlation with mathematical critical thinking skills. Contrary to many previous studies that reported a positive association between emotional intelligence and higher-order cognitive abilities, this research presents a divergent finding. The lack of association suggests that emotional intelligence may not directly contribute to critical thinking in mathematical problem-solving, particularly within instructional environments that rely heavily on teacher-centered approaches. This outcome implies that cognitive enhancement in mathematics may depend more on external academic stimuli than on students' affective attributes. Future research is recommended to examine potential mediating variables, such as academic motivation, classroom engagement, peer interaction, or instructional design. Understanding these indirect pathways may provide a more comprehensive explanation of how emotional intelligence interacts with cognitive performance.

Keywords

Emotional intellingence, mathematical critical thingking

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Introduction

To prepare every Indonesian citizen for an increasingly complex and challenging future, the government undertakes systematic efforts through education (Sain et al., 2024). Education holds a vital position within a nation, particularly for the Indonesian society (Sukmayadi & Yahya, 2020). It is expected to help individuals reach their full potential, expand their knowledge, and enhance their critical thinking abilities (Kallet, 2014). This aligns with Law No. 20 of 2003 on the National Education System, which states that national education functions to develop competencies and foster an intelligent nation with dignified character. Its goal is to develop learners into individuals who are faithful to God Almighty, morally upright, healthy, knowledgeable, capable, creative, independent, and responsible citizens (Abolade, 2024).

However, recent concerns have emerged regarding the quality of education in Indonesia(Pramana et al., 2021). This is reflected in the 2022 Programme for International Student Assessment (PISA) results, where Indonesia ranked 68th out of 81 participating countries in mathematics (Golla & Reyes, 2022). A similar trend appears in the Trends in Mathematics and Science Study (TIMSS), where Indonesia ranked 44th out of 49 countries. According to TIMSS items are designed to assess higher-order thinking skills, particularly critical thinking (Dossey et al., 2006). Thus, Indonesia's low scores indicate students' weak critical thinking abilities (Fitriani et al., 2022), which hinders the nation's readiness to meet 21st-century demands (Joynes et al., 2019), where critical thinking is one of the most essential competencies (Indrašienė et al., 2019). This is consistent with the 2013 Curriculum, which emphasizes the 4Cs: collaboration, creativity, communication, and critical thinking (Maneen, 2016).

Critical thinking is important not only academically but also in navigating real-life situations that require sound judgment (Haber, 2020). Defines critical thinking as the ability to objectively evaluate information and make judgments based on sound reasoning and evidence (Heard et al., 2020). Similarly, describes it as a cognitive skill involving logical argumentation supported by empirical data (Stein & Miller, 2019). Therefore, in mathematics education, more attention must be given to strengthening students' critical thinking skills (Saputri et al., 2023).

Nonetheless, cognitive aspects alone do not fully determine critical thinking skills; non-cognitive factors also play a role, particularly emotional conditions. Emotional states, often referred to as emotional intelligence (Bru-Luna et al., 2021), encompass one's ability to manage stress, control impulses, maintain motivation, regulate mood, empathize with others, and build relationships (Antonopoulou, 2024).

Previous studies have consistently reported a positive relationship between emotional intelligence and students' mathematical critical thinking (Tanjung et al., 2025). However, based on preliminary observations conducted at SMA Negeri 1 Binjai District, Langkat Regency, not all students exhibited strong critical thinking skills. Many showed low initiative in questioning or exploring learning difficulties, while some easily gave up when faced with challenging mathematics problems. Only a few demonstrated curiosity by actively seeking clarification from teachers outside classroom sessions.

Methodology

Research design, site, and participants

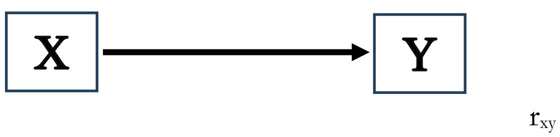
This study employed a quantitative research method with an ex-post facto approach. The population consisted of all Grade XI students at SMA Negeri 1 Binjai District, Langkat Regency. One class, XI Science 1, comprising 29 students, was selected as the sample. The sample was determined using purposive sampling based on the highest scores in the most recent midterm mathematics examination.

Data collection and analysis

The research instruments included a mathematical critical thinking test and an emotional intelligence questionnaire adapted from Satrianti (2015). The mathematical critical thinking test consisted of two essay items, both of which had been proven valid and reliable. Meanwhile, the emotional intelligence questionnaire consisted of 24 statements, including 12 positive and 12 negative items, which had also been validated and confirmed for reliability.

Data were analyzed using the Spearman correlation technique, selected due to the ordinal nature of the data and its non-normal distribution. The research design is illustrated in the following figure 1.

Figure 1. *Research design*



Description:
Variable X = Emotional Intelligence
Variable Y = Mathematical Critical Thinking
r_{xy} = The relationship between variable X and variable Y

The results of the emotional intelligence questionnaire were interpreted according to the categorization framework of (Thaibah & Saputri, 2025), which is presented in Table 1 below.

Table 1. *Categories of student emotional intelligence*

Score Interval	Category
Value < M – SD	Low
M – SD ≤ Value ≤ M + SD	Currently
Value > M + SD	High

Meanwhile, the mathematical critical thinking test scores were interpreted based on the criteria established by (Kanatovna & Jumakhmetovna, 2020), which are summarized in the following table 2.

Table 2. *Criteria for mathematical critical thinking*

Final Scores	Categories
80,0 < X ≤ 100,0	Very Good
60,0 < X ≤ 80,0	Good
40,0 < X ≤ 60,0	Fairly Good
20,0 < X ≤ 40,0	Not Good
00,0 < X ≤ 20,0	Very Poor

The data obtained from the emotional intelligence questionnaire and the mathematical critical thinking test were then analyzed using the Spearman correlation test to determine the strength of the relationship between the variables and to assess whether a significant correlation existed between them. The interpretation of the correlation coefficient was based on the classification of relationship strength adapted from Sugiyono (2016), as presented in the following table. To provide a clearer reference for interpreting the obtained correlation value, the classification of relationship strength is outlined in Table 3.

Table 3. *The power of relationships*

Coefficient Range	Relationship Level
0,000 – 0,199	Very Weak
0,200 – 0,399	Weak
0,400 – 0,599	Currently
0,600 – 0,799	Strong
0,800 – 1,000	Very Strong

Results

The results of the data analysis yielded information regarding the emotional intelligence variable (X) and the mathematical critical thinking variable (Y), which are displayed in the table below. A summary of the descriptive statistics for both variables is shown in Table 4.

Table 4. *Descriptive analysis of research data*

Statistics	Emotional Intelligence	Mathematical Critical Thinking
Minimum Score	58,00	16.67
Maximum Score	95,00	83.33
Mean	76.862	37.260
Standard deviation	8.6302	17.051

The descriptive analysis provides an overview of the students' emotional intelligence (X) and mathematical critical thinking (Y). As shown in Table 4, the emotional intelligence scores ranged from a minimum of 58.00 to a maximum of 95.00, with a mean score of 76.862 and a standard deviation of 8.6302. This indicates that, on average, students demonstrated a fairly high level of emotional intelligence with relatively low variability among participants. In contrast, the mathematical critical thinking scores showed a much wider distribution, ranging from 16.67 to 83.33. The mean score of 37.260 suggests that the overall critical thinking ability of the students was relatively low. Furthermore, the standard deviation of 17.051 indicates a higher level of dispersion compared to the emotional intelligence scores, implying considerable differences in students' critical thinking performance. These findings suggest that while most students possessed moderate to high emotional intelligence, their mathematical critical thinking varied substantially and tended to be weak overall. To facilitate a more meaningful analysis of the emotional intelligence variable, the raw scores were converted into categorical levels. The classification of students' emotional intelligence is presented in Table 5.

Table 5. *Classification of emotional intelligence*

Rentang Skor	f	%	Kategori
Score < 68	3	10, 35 %	Low
68 < Score < 85,48	24	82,76%	Currently
Score > 85,48	2	6,90%	High

Based on the classification of emotional intelligence scores, it was found that the majority of students were in the moderate category. A total of 3 students, or 10.35%, fell into the low category with scores below 68. Most students, amounting to 24 individuals or 82.76%, were classified as having moderate emotional intelligence, with scores ranging from 68 to 85.48. Meanwhile, only 2 students, or 6.90%, achieved high emotional intelligence scores above 85.48. These findings indicate that, overall, the students' emotional intelligence was at an adequate level, although a small proportion may require additional support to further develop their emotional regulation skills.

Subsequently, the results of the critical thinking skills test were converted into scores on a 0–100 scale. These converted scores were then used to classify students' mathematical critical thinking abilities. The classification of students' mathematical critical thinking is displayed in Table 6.

Table 6. *Mathematical critical thinking classification*

Final Score	f	%	Category
80,0 < X ≤ 100,0	1	3,45%	Very Good
60,0 < X ≤ 80,0	3	10,35%	Good
40,0 < X ≤ 60,0	5	17,24%	Fairly Good
20,0 < X ≤ 40,0	14	48,28%	Not Good
00,0 < X ≤ 20,0	6	20,69%	Very Poor

Based on the classification of students' mathematical critical thinking final scores, it was found that the majority of students fell into the lower performance categories. Nearly half of the participants (48.28%) were categorized as *Not Good*, with scores ranging between 20.0 and 40.0. Additionally, 20.69% of students were classified as *Very Poor*, scoring below 20.0. This indicates that more than two-thirds of the students (68.97%) demonstrated insufficient levels of mathematical critical thinking. Meanwhile, 17.24% of students were in the *Fairly Good* category with scores between 40.0 and 60.0, suggesting that only a small proportion had begun to develop moderate critical thinking abilities. Furthermore, 10.35% of students were categorized as *Good*, and only 3.45% reached the *Very Good* level. These findings show that high-level mathematical critical thinking were rare among the students. Overall, the data suggests that the majority of students struggle to apply higher-order thinking in mathematical contexts. This condition highlights the need for instructional strategies that explicitly foster reasoning, reflection, and problem-solving abilities in mathematics learning.

Before testing the hypothesis to examine the relationship between the two variables, a prerequisite test was conducted, namely the normality test. The purpose of this test was to determine whether the data obtained from the respondents were normally distributed. The normality analysis for each research variable was carried out using the Chi-Square test, processed with SPSS 21, as presented in Table 7.

Table 7. *Normality of the chi-square distribution*

	Emotional Intelligence	Mathematical Critical Thinking
Chi-Square	9.103[a]	11.862[b]
df	27	27
Asymp. Sig.	.909	.617

Based on the results of the Chi-Square normality test, the emotional intelligence variable obtained a Chi-Square value of 9.103 with a significance level of 0.909. Similarly, the mathematical critical thinking variable showed a Chi-Square value of 11.862 with a significance level of 0.617. Since both significance values are greater than 0.05, it can be concluded that the data for both variables are normally distributed. Therefore, the dataset meets the normality assumption and is considered appropriate for further hypothesis testing.

After the normality test was conducted, the data were confirmed to be normally distributed. The next step was hypothesis testing to determine whether there was a relationship between emotional intelligence and the mathematical critical thinking of students at SMA Negeri 1 Binjai District, Langkat Regency. The data were analyzed using the Spearman correlation method with the assistance of SPSS version 21. The results of the analysis are presented in Table 8 below:

Table 8. *Spearman correlation analysis results*

			Emotional Intelligence	Mathematical Critical Thinking
Spearman's rho	Emotional Intelligence	Correlation Coefficient	1.000	-.127
		Sig. (2-tailed)	.	.512
		N	29	29
	Mathematical Critical Thinking	Correlation Coefficient	-.127	1.000
		Sig. (2-tailed)	.512	.
		N	29	29

Based on the results of the Spearman correlation analysis, the correlation coefficient between emotional intelligence and mathematical critical thinking was found to be -0.127 with a significance value of 0.512. Since the significance value is greater than 0.05, it indicates that there is no statistically significant relationship between the two variables. The negative direction of the correlation coefficient suggests an inverse trend; however, the value is very close to zero, indicating a very weak and practically negligible association. Thus, the level of students' emotional intelligence does not appear to contribute meaningfully to their mathematical critical thinking performance in this context. These findings imply that other factors such as instructional strategies, learning motivation, or prior mathematical knowledge may play a more dominant role in influencing students' critical thinking abilities.

Based on the researcher's observations, several factors distracted students during the data collection process, particularly while completing the mathematical critical thinking test. Some students were disturbed by noise outside the classroom as the break bell rang, even though the test was conducted right after a free period when they had no scheduled lessons. As a result, many students submitted their answer sheets before completing all the questions. Several others expressed frustration upon seeing the length of the written problems, even though there were only two items. Their initial reaction was influenced by the perception that long questions must require long and difficult answers, while in reality, the solutions were relatively short. According to Amirian et al., (2023), two types of factors influence a person's critical thinking skills: internal and external. Internal factors include learner characteristics, experience, learning style, and self-efficacy, while external factors consist of instructional methods and learning strategies.

Based on the Spearman correlation analysis, the obtained significance value was 0.512. Since the value exceeds 0.05, it indicates that there is no significant relationship between emotional intelligence and students' mathematical critical thinking skills. This result aligns with the findings of Sk & Halder, (2020), who also reported no significant relationship between emotional intelligence and critical thinking skills. However, several studies reported contrasting results. For instance, Tanjung et al., (2025) found a positive correlation between emotional intelligence and mathematical critical thinking skills. Similarly, Wang & Abdullah, (2024) concluded that higher emotional intelligence leads to higher mathematical critical thinking performance, indirectly confirming a relationship between the two variables.

The questionnaire analysis revealed that students at SMA Negeri 1 Binjai District, Langkat Regency generally demonstrated a moderate level of emotional intelligence, while their mathematical critical thinking scores were categorized as low. Interestingly, there were cases in which students with low emotional intelligence displayed fairly strong critical thinking skills, while others with moderate or even high emotional intelligence showed weak critical thinking performance. This further reinforces that emotional intelligence does not significantly determine students' mathematical critical thinking abilities. After the critical thinking test was administered, the researcher evaluated students' responses based on the indicators proposed by Qurohman et al., (2025), namely: (1) problem understanding and problem solving; (2) synthesis; (3) analysis; (4) drawing conclusions; and (5) evaluation. Three students were selected for further examination based on their emotional intelligence categories: AP (high emotional intelligence), MR (moderate emotional intelligence), and F (low emotional intelligence). The analysis of their mathematical critical thinking performance according to their emotional intelligence level is presented below:

Responses of subject AP (Student with high emotional intelligence but critical) indicator: Understanding and solving problems

Figure 2. *AP's response on the understanding indicator*

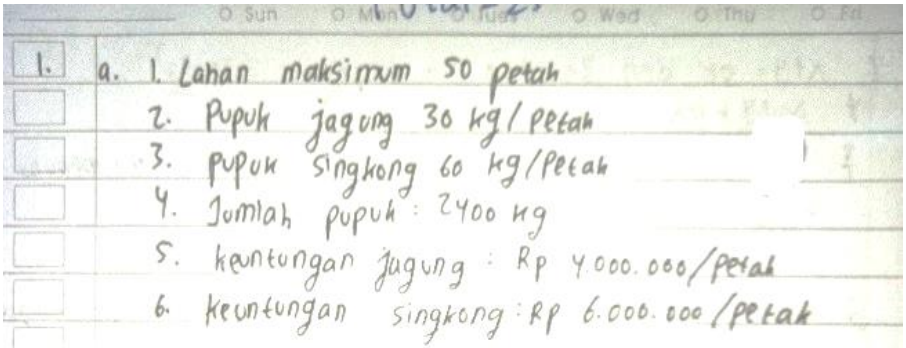
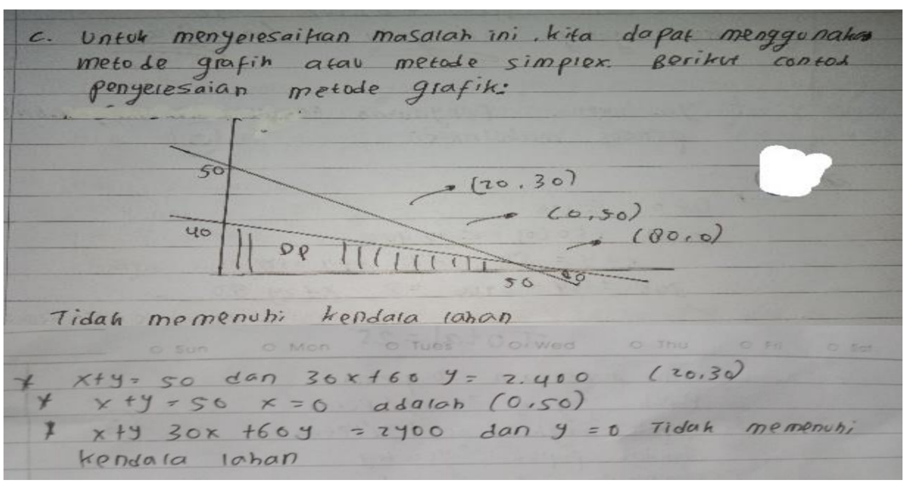


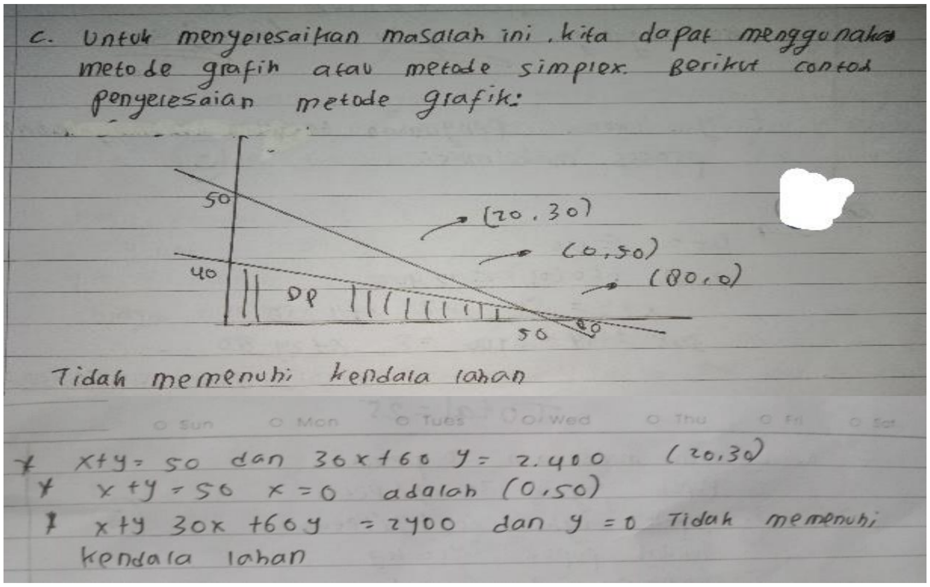
Figure 2 shows that AP successfully met the indicator of understanding the problem by identifying the known information and clearly writing down all relevant details obtained from the question.

Figure 3. *AP's response on the problem-solving indicator*



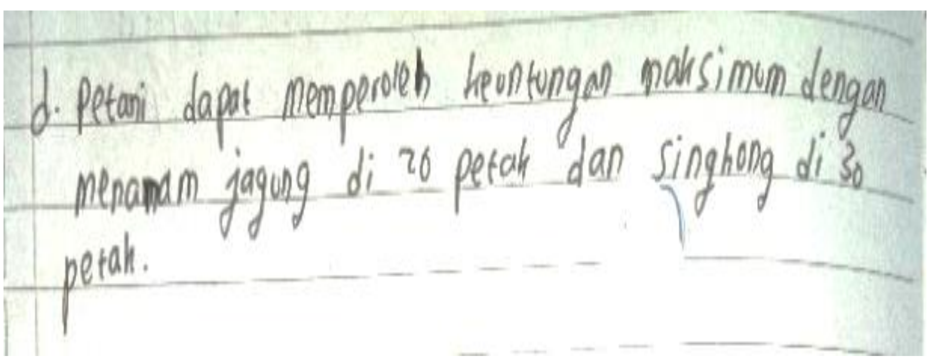
Based on AP's response in Figure 3, the student was unable to complete the problem accurately and thoroughly because several essential steps were omitted. AP skipped the process of explicitly determining the corner points of the constraint functions. The student merely wrote the constraint equations and the corner points. Furthermore, the final step of calculating the maximum profit by substituting the known values of corn and cassava into the objective function was not presented. This indicates that although AP understood the problem, they had not fully mastered the problem-solving process, as the method was not explicitly demonstrated.

Figure 4. *AP's response on the synthesizing indicator*



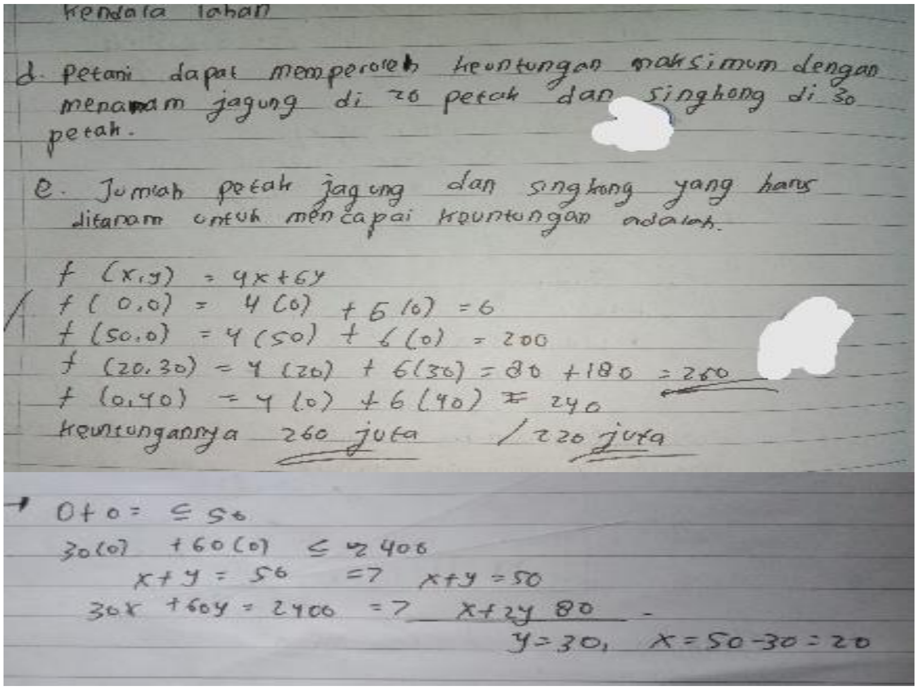
In Figure 4, AP demonstrated the ability to model the problem mathematically by defining the constraint variables, where x represents the number of corn plots and y the number of cassava plots. AP correctly wrote the constraint functions: $x + y \leq 50$, $30x + 60y \leq 2,400$, $x \geq 0$, $y \geq 0$. This indicates that AP successfully synthesized the problem, although the student did not explicitly label x and y as decision variables.

Figure 5. *AP's response on the conclusion indicator*



AP's written response shows that the student was unable to draw an appropriate conclusion. Instead of stating the maximum profit obtainable from planting corn and cassava, which is Rp. 220,000,000.00, AP wrote the number of corn and cassava plots required. This indicates that AP had not yet mastered the ability to properly conclude based on the solution process.

Figure 6. *AP's response on the analysis indicator*



From the response, AP correctly identified the optimal number of corn and cassava plots, namely 20 plots of corn and 30 plots of cassava. This demonstrates that AP had met the analysis indicator.

Figure 7. *AP's response on the evaluation indicator*

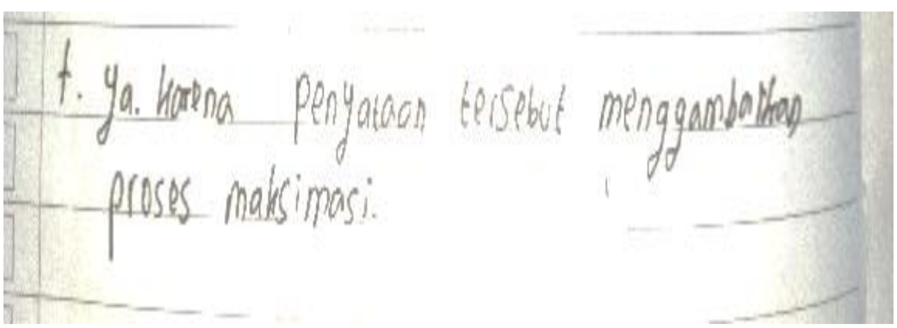


Figure 6 shows that AP did not fully meet the evaluation indicator. The student provided an answer but did not justify it with supporting reasoning.

Response of subject MR (student with moderate emotional intelligence but very uncritical)

Figure 4. *MR's response*

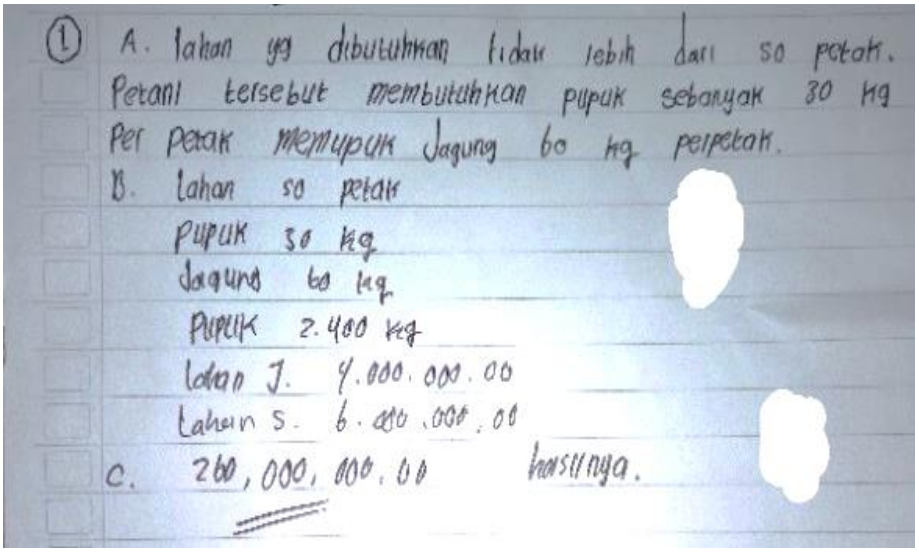


Figure 7 indicates that MR understood the given information and wrote down the data obtained from the problem. However, MR failed to solve the problem, as the student merely stated the maximum profit without considering the problem-solving process. Furthermore, MR was unable to analyze, synthesize, or draw conclusions. This is evident from the absence of mathematical modeling for the objective function, constraint functions, and decision variables. MR also left several steps unanswered, indicating incomplete problem-solving.

Response of subject F (student with low emotional intelligence but fairly critical)

Figure 5. *F's response on the understanding indicator*

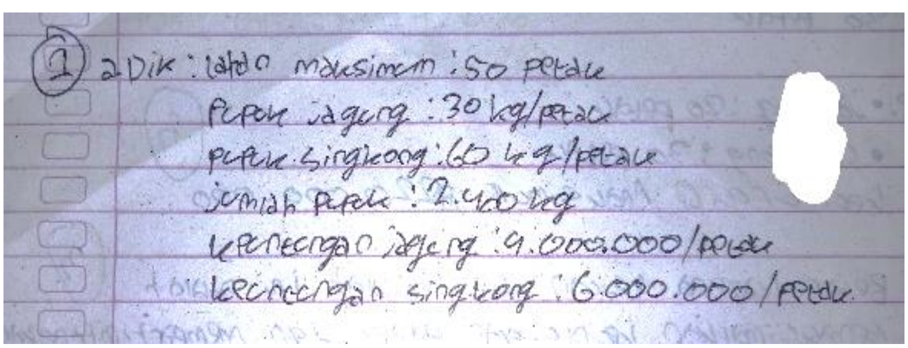
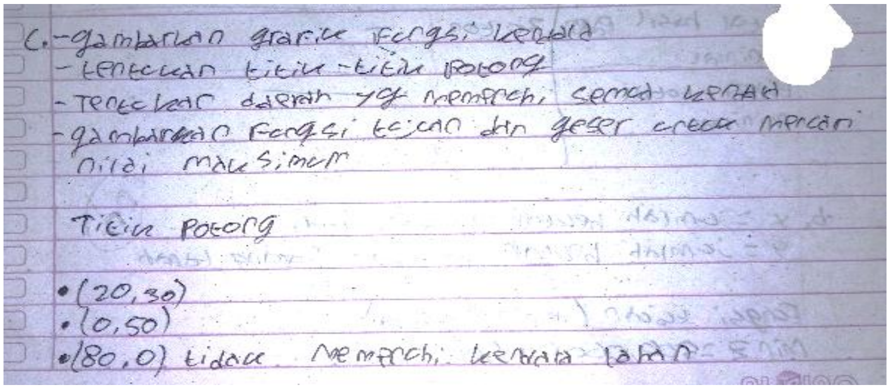


Figure 8 shows that F successfully identified and wrote down all relevant information from the question, fulfilling the understanding indicator.

Figure 6. F's *response on the problem-solving indicator*

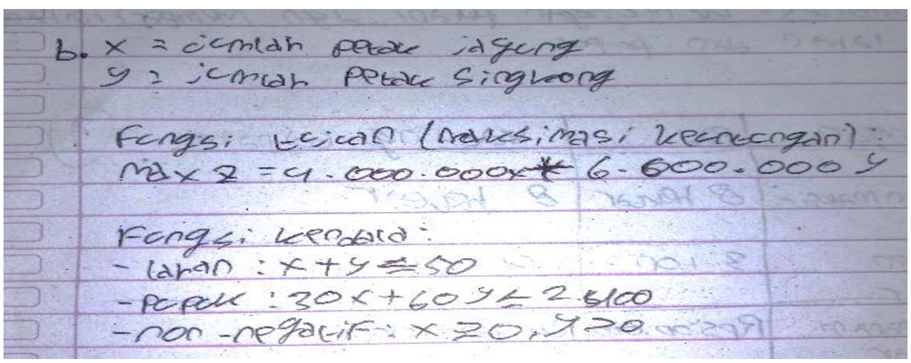


c. -gambarkan grafik fungsi kendala
- tentukan titik-titik potong
- tentukan daerah yg memenuhi semua kendala
- gambarkan fungsi tujuan dan geser untuk mencari nilai maksimum

Titik potong
•(20,30)
•(0,50)
•(80,0) tidak memenuhi kendala lahan

Figure 9 shows that F did not complete the problem accurately; several steps were skipped. F listed the corner points (20,30), (0,50), and (80,0) but did not continue to calculate the profit obtained. This indicates that F understood the problem but did not know how to solve it fully.

Figure 7. *F's response on the synthesizing indicator*



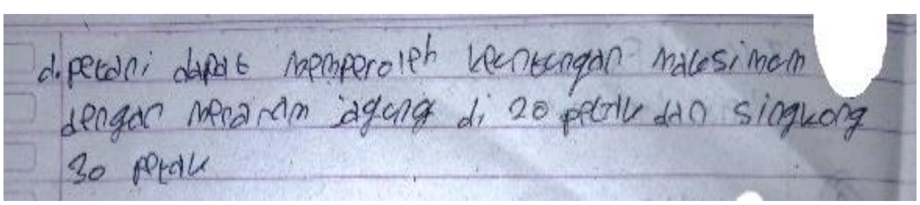
b. x = jumlah petak jagung
y = jumlah petak singkong

Fungsi tujuan (maksimasi keuntungan):
Max Z = 4.000.000x + 6.000.000y

Fungsi kendala:
- lahan : x + y ≤ 50
- pupuk : 30x + 60y ≤ 2.400
- non-negatif : x ≥ 0, y ≥ 0

F demonstrated the ability to model the problem mathematically by defining x as the number of corn plots and y as the number of cassava plots. F correctly wrote the constraint functions, which indicates mastery in synthesizing the problem, though the decision variable labels were not explicitly stated.

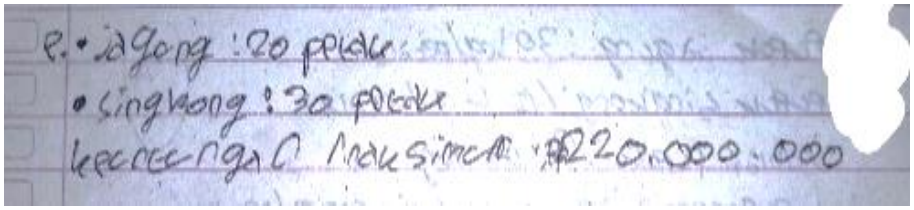
Figure 8. F's response on the conclusion indicator



d. petani dapat memperoleh keuntungan maksimum dengan menanam jagung di 20 petak dan singkong 30 petak

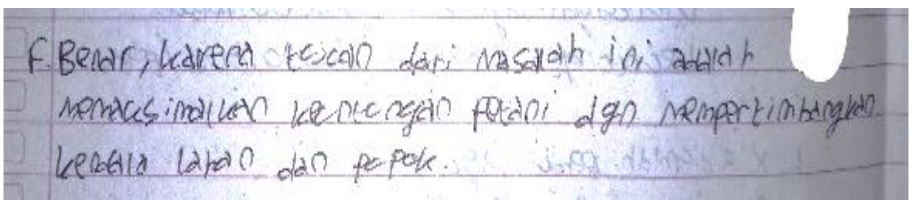
F did not provide the correct conclusion and instead wrote the number of plots needed for optimal income. The correct conclusion should be the maximum profit of Rp. 220,000,000.00. This shows that F had not mastered the conclusion indicator.

Figure 9. *F's response on the analysis indicator*



F correctly identified that 20 plots of corn and 30 plots of cassava were needed to achieve maximum income, meeting the analysis indicator.

Figure 10. *F's response on the evaluation indicator*



In Figure 13, F successfully answered the question and provided justification, demonstrating the ability to distinguish between maximization and minimization cases. This indicates that F met the evaluation indicator.

The analysis of the three subjects shows that AP, with high emotional intelligence, was able to understand and analyze problems but struggled with solving, concluding, and evaluating. Therefore, AP can be categorized as critical. According to Johnson & Njoku, (2024), emotional intelligence plays an important role in learning activities, as emotionally intelligent students tend to show empathy, initiative, responsibility, stress resilience, optimism, and problem-solving ability all of which support academic success. In contrast, MR, with moderate emotional intelligence, was only able to understand problems but failed in all other indicators, thus classified as highly uncritical. Meanwhile, F, with low emotional intelligence, demonstrated understanding, synthesizing, analyzing, and evaluating skills but was not accurate in drawing conclusions, making F fairly critical. These findings are consistent with (Buşu, 2020), who argues that academic intelligence is only slightly related to emotional life. Individuals may possess strong intellectual ability but lack self-awareness, which suggests that both emotional and intellectual intelligence are influenced by environmental factors (Antonopoulou, 2024). During the test, some students became anxious when others submitted their papers early, leading to unfinished responses further proving the environmental influence. Overall, the findings confirm that emotional intelligence does not significantly determine mathematical critical thinking ability, as students with low, moderate, and high emotional intelligence displayed varying levels of critical thinking performance.

Discussion

The findings indicate that while most students demonstrated a moderate level of emotional intelligence, their mathematical critical thinking were predominantly classified as low. This discrepancy suggests that emotional intelligence does not directly translate into higher-order mathematical reasoning. The Spearman correlation test further confirmed this assumption, showing no significant relationship between the two variables. Thus, students' emotional intelligence whether high, moderate, or low did not meaningfully influence their mathematical critical thinking performance. This aligns with the results of Sk & Halder, (2020), although it contrasts with previous studies such as Tanjung et al., (2025) and Wang & (Abdullah, 2024), which reported a positive correlation between emotional intelligence and mathematical critical thinking. Such inconsistencies imply that mathematical critical thinking is likely shaped more strongly by other factors, including instructional approaches, learning motivation, and students' prior problem-solving experience. Observations during data collection further support this interpretation, as environmental distractions and test-related anxiety caused several students to complete the tasks prematurely or carelessly. The qualitative analysis of individual responses also revealed that students with high emotional intelligence were not always capable of solving problems critically, whereas some students with lower emotional intelligence were able to perform adequately on several critical thinking indicators. Therefore, improving mathematical critical thinking cannot rely solely on strengthening emotional intelligence; rather, it requires intentional pedagogical interventions that explicitly cultivate reasoning, reflection, and structured problem-solving processes.

Conclusion and Recommendations

In summary, the findings indicate that emotional intelligence does not serve as a determining factor in the development of students' mathematical critical thinking. Variations in critical thinking performance were observed across students with low, moderate, and high emotional intelligence, suggesting that affective traits alone are insufficient to explain cognitive achievement in mathematical problem-solving. Instead, the results imply that external academic conditions such as instructional models, classroom atmosphere, task interpretation, and test-taking behavior may exert a more dominant influence. Therefore, efforts to improve mathematical critical thinking should not rely solely on fostering emotional attributes but should be supported by intentional pedagogical strategies that explicitly cultivate reasoning, reflection, and structured problem-solving processes. Future investigations are encouraged to examine mediating variables such as academic motivation, learning engagement, and instructional design to better understand the indirect mechanisms linking emotional functioning and higher-order thinking.

Disclosure Statement

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References

Abolade, G. O. (2024). Humanism in education philosophy and its implication to Christian education and practice. *International Council for Education Research and Training*, *2*(1), 290–300.

Amirian, S. M. R., Ghaniabadi, S., Heydarnejad, T., & Abbasi, S. (2023). The contribution of critical thinking and self-efficacy beliefs to teaching style preferences in higher education. *Journal of Applied Research in Higher Education*, *15*(3), 745–761. https://doi.org/10.1108/JARHE-11-2021-0441

Antonopoulou, H. (2024). The value of emotional intelligence: Self-awareness, self-regulation, motivation, and empathy as key components. *Technium Education and Humanities*, *8*, 78–92.

Bru-Luna, L. M., Martí-Vilar, M., Merino-Soto, C., & Cervera-Santiago, J. L. (2021). Emotional Intelligence Measures: A Systematic Review. *Healthcare*, *9*(12), 1696. https://doi.org/10.3390/healthcare9121696

Buşu, A.-F. (2020). Emotional intelligence as a type of cognitive ability. *Revista de Ştiinţe Politice. Revue Des Sciences Politiques*, *66*, 204–215.

Dossey, J. A., McCrone, S., & Christine, Y. (2006). Problem Solving in the PISA and TIMSS 2003 Assessments Technical Report. *Yeskisti.Net*. http://www.yeskisti.net/yesKISTI/InfoSearch/ReadDB02.jsp?CNO=TRFO200700046241%5Cnpapers3://publication/uuid/65C76465-C287-4396-B83F-DFFCC8B4AFA6

Fitriani, A., Zubaidah, S., & Hidayati, N. (2022). The quality of student critical thinking: A survey of high schools in Bengkulu, Indonesia. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *8*(2), 142–149. https://doi.org/10.22219/jpbi.v8i2.18129

Golla, E., & Reyes, A. (2022). Pisa 2022 Mathematics Framework (Draft). *OECD Publishing*, *November 2018*, 32–39. https://pisa2022-maths.oecd.org/files/PISA 2022 Mathematics Framework Draft.pdf

Haber, J. (2020). *Critical thinking*. MIT Press.

Heard, J., Scoular, C., Duckworth, D., Ramalingam, D., & Teo, I. (2020). *Critical thinking: Definition and structure*.

Indrašienė, V., Jegelevičienė, V., Merfeldaitė, O., Penkauskienė, D., Pivorienė, J., Railienė, A., Sadauskas, J., & Valavičienė, N. (2019). What critical thinking and for what? *Social Welfare: Interdisciplinary Approach*, *9*(1), 24–38.

Johnson, C., & Njoku, J. (2024). Impact Of Emotional Intelligence On Problem-Solving Skills Among Undergraduate Students In University Of Port Harcourt. *International Journal of*

Innovative Psychology & Social Development, *12*(3), 109–124. http://www.seahipublications.org/

Joynes, C., Rossignoli, S., & Amonoo-Kuofi, E. F. (2019). *21st Century Skills: evidence of issues in definition, demand and delivery for development contexts*.

Kallet, M. (2014). *Think smarter: critical thinking to improve problem-solving and decision-making skills*. John Wiley & Sons.

Kanatovna, S. Z., & Jumakhmetovna, N. Z. (2020). The role of criteria-based assessment while development of critical thinking. *Вестник Науки и Образования*, *7-1 (85)*, 68–72.

Maneen, C. A. (2016). *A case study of arts integration practices in developing the 21st century skills of critical thinking, creativity, communication, and collaboration*. Gardner-Webb University.

Pramana, C., Chamidah, D., Suyatno, S., & Renadi, F. (2021). Strategies to Improved Education Quality in Indonesia: A Review. *Turkish Online Journal of Qualitative Inquiry*, *12*(3).

Qurohman, M. T., Wijayanto, Z., & Suwarto, S. (2025). Investigating Critical Thinking Indicators in the Context of Algebra Problem Solving: A Study in Indonesia. *Utamax : Journal of Ultimate Research and Trends in Education*, *7*(2), 99–110. https://doi.org/10.31849/3psjs798

Sain, Z. H., Aulia Luqman AZIZ, & Moses Adeolu AGOI. (2024). Navigating Educational Challenges in Indonesia: Policy Recommendations for Future Success. *JOURNAL OF DIGITAL LEARNING AND DISTANCE EDUCATION*, *3*(4), 1038–1046. https://doi.org/10.56778/jdlde.v3i4.339

Saputri, L., Rahmadona, I., Aulia, N., & Sinulingga, S. P. B. (2023). Pengaruh Model Pembelajaran Problem Based Learning terhadap Kemampuan Berpikir Kritis dan Komunikasi Matematis Peserta didik SMP. *Jurnal Serunai Matematika*, *15*(1), 15–20.

Sk, S., & Halder, S. (2020). Critical thinking disposition of undergraduate students in relation to emotional intelligence: Gender as a moderator. *Heliyon*, *6*(11), e05477. https://doi.org/10.1016/j.heliyon.2020.e05477

Stein, N. L., & Miller, C. A. (2019). The development of memory and reasoning skill in argumentative contexts: Evaluating, explaining, and generating evidence. In *Advances in instructional psychology* (pp. 285–335). Routledge.

Sukmayadi, V., & Yahya, A. (2020). Indonesian education landscape and the 21st century challenges. *Journal of Social Studies Education Research*, *11*(4), 219–234. https://www.learntechlib.org/p/218538/

Tanjung, W. K. A., Jupri, A., & Usdiyana, D. (2025). The Role of Emotional Intelligence in Mathematical Critical Thinking: A Systematic Literature Review. *Jurnal Pendidikan MIPA*, *26*(1), 381–393. https://doi.org/10.23960/jpmipa.v26i1.pp381-393

Thaibah, A., & Saputri, L. (2025). Analisis Kemampuan Komunikasi Matematis Siswa Dalam Mengerjakan Soal Lingkaran Berbasis Etnomatematika Ditinjau Dari Self Confidence. *Jurnal Serunai Matematika*, *17*(1).

Wang, Q., & Abdullah, A. H. (2024). Enhancing Students' Critical Thinking Through Mathematics in Higher Education: A Systemic Review. *Sage Open*, *14*(3), 21582440241275652. https://doi.org/10.1177/21582440241275651