



## Mathematical critical thinking in ethno-controversial problems: A logical-mathematical intelligence perspective

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### Article Info

#### Article history:

Received February 09, 2026

Revised March 13, 2026

Accepted April 19, 2026

Available online May 20, 2026

**Keywords:** Ethno-controversial problems, Logical-mathematical intelligence, Mathematical critical thinking

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**Abstract.** Mathematical critical thinking ability is a crucial skill that should be developed in mathematics education, particularly in addressing complex and contextual problems. This study aims to describe the mathematical critical thinking skills of Grade 10 senior high school students in solving ethno-controversial mathematical problems viewed from the level of logical-mathematical intelligence. This study employed a descriptive qualitative approach, with 6 grade 10 students from SMA Negeri 2 Singaraja as subjects, selected based on high, medium, and low levels of logical-mathematical intelligence. Data were collected through a written test based on ethno-controversial problems, a logical-mathematical intelligence questionnaire, semi-structured interviews, and documentation of students' work. Data analysis was conducted through the stages of data reduction, data display, and conclusion drawing, referring to the indicators of mathematical critical thinking, namely interpretation, analysis,

evaluation, and inference. The results of the study indicate that students with high logical-mathematical intelligence consistently meet most indicators of mathematical critical thinking, although they still show shortcomings in systematically presenting conclusions. Students with moderate logical-mathematical intelligence demonstrate fairly good mathematical critical thinking abilities in the indicators of interpretation and analysis; however, they still experience difficulties in the indicators of evaluation and inference. Meanwhile, students with low logical-mathematical intelligence show limitations in almost all indicators of mathematical critical thinking. These findings suggest the need for differentiated instructional strategies tailored to students' levels of logical-mathematical intelligence.

## Introduction

In recent years, mathematical critical thinking ability has become one of the main focuses in mathematics education research, as this skill is considered to be related to students' ability to analyze information, construct arguments, and make rational decisions free from cognitive bias (Agus & Purnama, 2022; Susilowati & Sumaji, 2021; Syafruddin & Pujiastuti, 2020). In the 21st century and the Society 5.0 era, students must not only master procedures but also evaluate situations, formulate solutions, and apply mathematics to real-life contexts. Studies show that

mathematical critical thinking supports success in solving non-routine problems and adapting to everyday uncertainties (Fahrudin et al., 2021; Mudita et al., 2019). However, empirical findings reveal a gap between these demands and students' actual abilities. Previous studies indicate that many students still fall into the low category of mathematical critical thinking ability, particularly in identifying, generalizing, formulating, and drawing conclusions, with 54% in the low category, 26% in the moderate category, and only 20% in the high category, which includes the abilities to identify, generalize, formulate, and deduce (Lestari et al., 2019). This fact reflects a common problem in mathematics education, namely, students' weak skills in understanding information, processing arguments, and connecting mathematical concepts with applicative contexts

Mathematical critical thinking is a logical reasoning process used to evaluate information, assess arguments, consider alternative solutions, and draw evidence-based conclusions (Widana & Umam, 2023). It involves not only understanding symbols and procedures but also reflection, interpretation, and generalization. In mathematics education, it is closely related to open-ended problem-solving, mathematical communication, and inferential reasoning, which integrate conceptual knowledge with higher-order thinking skills. Therefore, the literature suggests the need for instructional strategies that encourage students' active engagement in analyzing information and independently evaluating solutions in order to strengthen critical thinking ability as an essential competence in modern mathematics learning (Hikmah & Kartika, 2022; Susilowati & Sumaji, 2021).

Studies on mathematical critical thinking ability have been conducted from various perspectives. A number of studies attempt to map students' ability levels, identify factors influencing these skills, or examine the effectiveness of particular instructional approaches (Hapudin, 2021; Tae et al., 2021). The study by Zebua et al. (2024) indicates that one factor frequently associated with low critical thinking ability is students' limited understanding of the structure of complex mathematical problems, as well as their lack of experience in solving non-routine tasks. In addition, instructional approaches that place excessive emphasis on procedures and final outcomes tend to provide limited opportunities for students to explore critical thinking processes optimally. Although previous studies have made important contributions in mapping conditions and supporting factors, most have not yet offered concrete interventions that systematically develop mathematical critical thinking abilities in both abstract and contextual problem settings. Consequently, a research gap exists in the development of instructional strategies that integrate cognitive training processes with mathematical situations that require in-depth analysis.

In the study of cognitive abilities, higher-order thinking skills play an important role in mathematics learning because they require students to analyze and evaluate, as well as generate new ideas or solutions (Haryanto et al., 2026). Ethnomathematics refers to mathematical practices that are embedded in cultural contexts, including local traditions, values, and community activities (Yanti, 2025; Widana et al., 2023). It emphasizes how mathematical ideas are developed and applied in real-life situations within specific cultural settings. Meanwhile, controversial problems involve differing viewpoints, debates, or conflicts in interpretation, often requiring individuals to evaluate arguments, consider multiple perspectives, and make reasoned judgments (Tjosvold, 2014). Based on these two concepts, ethno-controversial problems can be defined as mathematical problems that integrate cultural contexts with elements of controversy or conflicting perspectives. These problems not only require students to apply mathematical concepts but also to analyze information critically, evaluate differing viewpoints, and construct logical arguments in order to reach well-reasoned conclusions. Such problems are designed to promote higher-order thinking skills, particularly in developing students' mathematical critical thinking in meaningful, context-rich situations. Ethno-controversial mathematical problems fall into the category of tasks with high

cognitive demands, as they require students to elaborate information, construct mathematical arguments, and consider multiple perspectives within complex contexts.

However, various research findings indicate that students still experience difficulties in solving mathematical problems with high levels of complexity, particularly when the problems are non-routine, open-ended, or involve contextual conflicts (Nursyifa et al., 2020; Yuaidah et al., 2022). Previous studies highlight skills like creative thinking, problem-solving, mathematical argumentation, and decision-making. However, most research focuses on describing abilities rather than exploring instructional strategies that develop these skills alongside affective factors. This shows the need to view higher-order thinking as shaped by both cognitive and non-cognitive traits. Self-confidence and logical–mathematical intelligence also influence success, with higher intelligence linked to more effective problem-solving and stronger critical thinking (Firdaus & Wilujeng, 2018). Low self-confidence can cause anxiety, doubt, negative self-perceptions, and poor decision-making. Although research has found that differences in logical–mathematical intelligence influence students' mathematical critical thinking abilities, most studies classify students into high, moderate, and low groups without examining their performance on complex and challenging tasks in depth. Therefore, a gap remains in integrating cognitive aspects, especially mathematical critical thinking, with affective factors such as self-confidence and logical–mathematical intelligence in complex mathematics learning contexts.

Unlike previous studies that primarily categorize students by performance levels, this research reveals detailed cognitive patterns in students' mathematical critical thinking in ethno-controversial problem contexts. It provides deeper insights into how logical–mathematical intelligence influences each stage of thinking, particularly in complex and culturally contextualized mathematical situations. In summary, several research gaps remain. First, there is a mismatch between the demands of 21st-century mathematics learning and students' actual critical thinking and complex problem-solving abilities. Second, studies on mathematical critical thinking often overlook affective factors such as self-confidence and logical–mathematical intelligence, limiting integrated cognitive–affective approaches. Third, interventions addressing these aspects are still limited, particularly in Indonesia. Therefore, this study aims to describe students' mathematical critical thinking abilities in solving ethno-controversial mathematical problems, as a function of their levels of logical–mathematical intelligence.

## Method

### *Research Design*

This study used a descriptive qualitative approach to examine tenth-grade students' mathematical critical thinking in solving ethno-controversial problems from the perspective of logical–mathematical intelligence. The approach enabled in-depth exploration of students' reasoning processes, including how they analyze, evaluate, and draw conclusions in contextual problem situations (Darmayanti et al., 2024). Data from written responses and interviews were analyzed thematically to identify patterns and characteristics of students' critical thinking based on their levels of logical–mathematical intelligence (Darmayanti et al., 2024).

### *Sample and Data Collection*

This study involved tenth-grade students of SMA Negeri 2 Singaraja selected through purposive sampling from the Grade 10 population. This research was conducted over a four-week period, from the first week to the fourth week of November 2025. The participants were chosen based on variations in logical–mathematical intelligence, categorized as high, moderate, and low, to represent different subject characteristics. Data were collected through several techniques. Students

completed a mathematical critical-thinking test comprising ethno-controversial problems to assess their ability to interpret problems, analyze solution strategies, evaluate results, and draw logical conclusions. Their levels of logical–mathematical intelligence were assessed using a questionnaire and structured interviews to ensure accurate classification. In-depth interviews and observations during the problem-solving process were also conducted to gain deeper insight into students' thinking processes. All data, including written responses, interview transcripts, and observational notes, were analyzed qualitatively to identify patterns and characteristics of students' mathematical critical thinking abilities in relation to their levels of logical mathematical intelligence.

The study employed a descriptive, qualitative procedure to explore students' mathematical critical thinking processes in depth. The research procedures were carried out in several stages. First, the researcher selected participants using purposive sampling based on their levels of logical–mathematical intelligence, categorized as high, moderate, and low. Second, students were administered a mathematical critical thinking test consisting of ethno-controversial problems to assess their abilities in interpretation, analysis, evaluation, and inference. Third, semi-structured interviews were conducted to gain deeper insights into students' reasoning processes and to clarify their written responses. In addition, observations and documentation of students' work were collected to support data triangulation. Finally, the collected data were analyzed through the stages of data reduction, data display, and conclusion drawing to identify patterns of students' mathematical critical thinking based on their levels of logical–mathematical intelligence.

### ***Research Instruments***

The research instruments in this study were designed to support a descriptive qualitative approach, with the aim of deeply exploring students' mathematical critical thinking abilities in solving ethno-controversial mathematical problems in terms of their levels of logical–mathematical intelligence. The instruments used included a written test, semi-structured interview guidelines, and documentation of students' work. The primary instrument of this study was a mathematical critical thinking ability test presented as essay questions based on ethno-controversial mathematical problems. The aspects of mathematical critical thinking assessed in this study include: (1) interpretation, which refers to the ability to understand and identify given information; (2) analysis, which involves determining appropriate strategies and mathematical relationships; (3) evaluation, which refers to the ability to assess the accuracy of procedures and results; and (4) inference, which involves drawing logical and contextually appropriate conclusions.

These questions were designed to elicit cognitive and metacognitive conflict and to require students to engage in in-depth mathematical reasoning (Ismaimuza, 2025; Mustika, 2024). The test was used to explore students' mathematical critical thinking abilities across four indicators: interpretation, analysis, evaluation, and inference.

In addition to the written test, semi-structured interview guidelines were used to explore students' thinking processes in depth as they solved each problem. The interviews focused on how students understood the given information, determined solution strategies, evaluated calculation results, and drew conclusions. These interviews served as a triangulation technique to strengthen and validate the findings obtained from the written test results (Roesadhi et al., 2025; Susanto et al., 2023). Students' work documents were analyzed to identify answer patterns, solution strategies, errors, and misconceptions for each mathematical critical thinking indicator, providing supporting data for a comprehensive analysis. All instruments were validated by mathematics education experts to ensure content relevance, construct clarity, and linguistic appropriateness. Revisions were made in response to feedback to ensure their suitability for in-depth qualitative analysis.

### ***Instrument Validation***

The research instruments were validated using the Gregory content validity formula involving two experts from the Mathematics Education Department. The validation aimed to ensure that the instruments met the criteria of content relevance, construct clarity, and linguistic appropriateness in measuring students' mathematical critical thinking abilities. Each expert assessed the instrument items based on their relevance to the indicators of mathematical critical thinking (interpretation, analysis, evaluation, and inference). The assessment results were then categorized into a 2×2 cross-tabulation matrix, consisting of:

- A: items considered irrelevant by both experts
- B: items considered relevant by expert 1 but irrelevant by expert 2
- C: items considered irrelevant by expert 1 but relevant by expert 2
- D: items considered relevant by both experts

The content validity coefficient was calculated using the Gregory formula as follows:

$$V = \frac{D}{A+B+C+D}$$

The validation results indicated that the instrument achieved a high level of content validity, as most items were classified in category D (agreed relevant by both experts). Based on the experts' suggestions, several revisions were made, particularly to improve the clarity of problem statements and to align the questions more closely with the indicators of mathematical critical thinking. Thus, the instrument was considered valid and appropriate for use in this study.

### ***Data Analysis Techniques***

Data were analyzed descriptively and qualitatively to examine students' mathematical critical thinking in solving ethno-controversial problems, with attention to their levels of logical–mathematical intelligence. The data included written tests, interviews, and students' work. Analysis followed the stages of data reduction, data display, and conclusion drawing, beginning with selecting and simplifying data from test results and interview transcripts (Firnanda et al., 2025). The data were then classified based on the indicators of mathematical critical thinking ability, namely interpretation, analysis, evaluation, and inference, and grouped according to students' levels of logical mathematical intelligence (high, moderate, and low). At the data display stage, the analysis results were presented as descriptive narrative accounts that describe the characteristics of each research subject's mathematical critical thinking abilities. Data presentation was also supported by excerpts from relevant written responses and interview results, which strengthened the description of the research findings. The subsequent stage was conclusion-drawing, which involved interpreting the patterns of mathematical critical thinking abilities that emerged within each logical–mathematical intelligence group. Conclusions were drawn gradually and continuously verified throughout the analysis process to ensure the consistency and accuracy of the findings (Evi et al., 2025). Data validity was ensured through technique triangulation by comparing results from written tests, interviews, and students' work. This approach enhanced the credibility and depth of the findings on students' mathematical critical thinking in solving ethno-controversial problems.

### ***Researchers' Role***

In this study, the researcher acted as the primary instrument in collecting and analyzing the data. The researcher was directly involved in administering the written test based on ethno-controversial mathematical problems, conducting semi-structured interviews, and observing students' problem-solving processes. In this context, the researcher functioned both as an observer and an interviewer,

systematically documenting students' responses, behaviors, and reasoning during the problem-solving activities. Furthermore, the researcher played a crucial role in interpreting the data by identifying patterns in students' mathematical critical thinking, using indicators of interpretation, analysis, evaluation, and inference. During data collection, the researcher ensured that all procedures were conducted systematically and objectively to maintain the credibility of the findings.

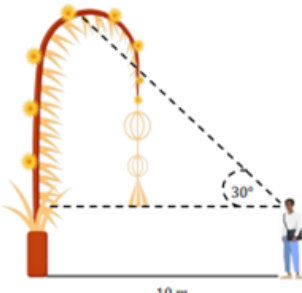
In addition, the researcher served as a facilitator, creating a supportive environment that allowed students to express their reasoning freely during interviews and problem-solving sessions. To ensure data validity, triangulation techniques were applied by comparing data obtained from written tests, interviews, and documentation of students' work. Through these roles, the researcher gained an in-depth understanding of students' mathematical critical thinking skills in relation to their levels of logical–mathematical intelligence.

## Results and Discussion

### Results

The ethno-controversial mathematical problems are presented in Image 1 to illustrate the context and structure of the tasks given to students. These problems integrate cultural situations with differing perspectives, requiring students to apply mathematical concepts and engage in critical thinking. Each problem is aligned with the indicators of interpretation, analysis, evaluation, and inference, enabling a clearer understanding of students' responses and thinking processes.

SMA Harapan Bangsa sedang melakukan *study tour* ke Bali. Saat tiba di tempat wisata, guru meminta siswa untuk mencatat setiap adat dan kebudayaan yang mereka temui selama di Bali sebagai bahan laporan. Pelaksanaan *study tour* ini bertepatan dengan hari raya Galungan dan Kuningan, dimana masyarakat Bali memasang penjor. Beberapa siswa tertarik untuk melihat penjor lebih dekat. Kemudian, Adi ingin mencari tahu berapakah tinggi penjor yang ada di hadapan mereka. Adi meminta Dodi, yang memiliki tinggi badan 180 cm, untuk berdiri di sekitar penjor tersebut. Adi memperkirakan sudut yang terbentuk antara kepala Dodi dan ujung tiang penjor (sudut elevasi) adalah  $30^\circ$ . Adi juga memperkirakan jarak antara Dodi dan penjor adalah 10 m.



Selanjutnya, Adi menyimpulkan bahwa tinggi penjor tersebut adalah 5,7 m dengan perhitungan sebagai berikut.

$$\tan \theta = \frac{\text{sisi depan}}{\text{sisi samping}}$$

$$\tan 30^\circ = \frac{x}{10}$$

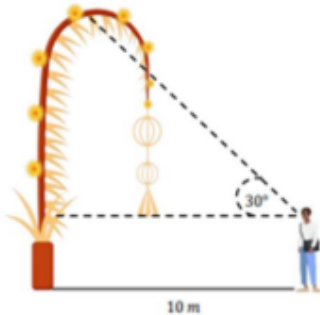
$$\frac{1}{3}\sqrt{3} = \frac{x}{10}$$

$$x = \frac{1}{3}\sqrt{3} \cdot 10$$

$$x = 5,7 \text{ m}$$

Saat Adi bertanya kepada petugas tempat wisata, petugas tersebut menjawab bahwa tinggi penjor adalah 7,5 m. Menurut Anda, jawaban manakah yang benar? Berikan pendapat kalian beserta penjelasan yang logis dan masuk akal!

Harapan Bangsa High School was conducting a study tour to Bali. Upon arriving at the tourist destination, the teacher asked the students to take notes on every custom and cultural aspect they encountered in Bali as material for their reports. This study tour coincided with the Galungan and Kuningan festivals, during which the Balinese people erect penjor (decorative bamboo poles). Some students were curious to take a closer look at the penjor. Adi wanted to find out the height of the penjor in front of them. He asked Dodi, who is 180 cm tall, to stand near the penjor. Adi estimated that the angle formed between Dodi's head and the tip of the penjor (the angle of elevation) was 30 degrees. He also estimated that the distance between Dodi and the penjor was 10 meters



Next, Adi concluded that the height of the penjor was 5.7 meters, based on the following calculation:

$$\tan \theta = \frac{\textit{opposite}}{\textit{adjacent}}$$

$$\tan 30^\circ = \frac{x}{10}$$

$$\frac{1}{3} \sqrt{3} = \frac{x}{10}$$

$$x = \frac{1}{3} \sqrt{3} \cdot 10$$

$$x = 5,7 \text{ m}$$

When Adi asked the staff at the tourist site, the staff replied that the height of the penjor was 7.5 meters. In your opinion, which answer is correct? Provide your reasoning along with a logical and reasonable explanation

**Image 1.** An Ethno-Controversial Mathematical Problem.

Based on the problem presented in Image 1, students' responses were analyzed to identify their mathematical critical thinking processes in solving ethno-controversial problems. The analysis focuses on how students interpret the given information, select and apply appropriate strategies, evaluate the accuracy of their solutions, and formulate conclusions. Furthermore, differences in students' responses are examined based on their levels of logical–mathematical intelligence to reveal distinct patterns of thinking. The following section provides a detailed discussion of each subject's responses, highlighting the strengths and difficulties encountered in each indicator of mathematical critical thinking.

The results of this study were obtained through an in-depth analysis of written test data and semi-structured interviews with six research subjects (S1–S6) on the solution of ethno-controversial mathematical problems. The analysis focused on students' mathematical critical thinking abilities based on four indicators, namely interpretation, analysis, evaluation, and inference, by examining differences in students' ability characteristics according to their levels of logical–mathematical intelligence. The following presentation of the research results provides a detailed description of each subject's ability to solve the given problems. The test results of subject S1 in solving an ethno-controversial mathematical problem are shown in Image 2.

Diketahui :  
 tinggi dodi = 180 cm = 1,8 m  
 jarak dodi ke penjor = 10 m  
 sudut evaluasi = 30°

Ditanya :  
 tinggi penjor sebenarnya = ?

Interpretasi

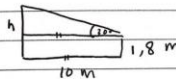
$\tan 30^\circ = \frac{h}{10}$   
 $\frac{1}{3}\sqrt{3} = \frac{h}{10}$   
 $\frac{10}{3}\sqrt{3} = h$   
 $h = \frac{10}{3}\sqrt{3} = 5,7 \text{ meter}$

Hasil 5,7 m merupakan selisih tinggi antara dodi dan puncak penjor, karena tinggi dodi adalah 1,8 m, maka tinggi penjor yaitu

$5,7 + 1,8 = 7,5 \text{ m}$

Evaluasi

Jawab :



Menggunakan perbandingan trigonometri tan untuk menghitung tinggi mata dodi ke puncak penjor, yaitu :

Analisis

\* Petugas tempat wisata yang benar, tinggi penjor adalah 7,5 m

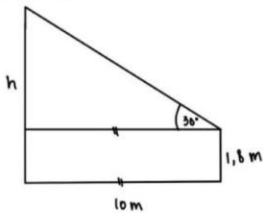
Inferensi

**It is known:**  
 Dodi's height = 180 cm = 1,8 m  
 The distance from Dodi to the penjor = 10 m  
 Angle of elevation = 30 degrees

**Questions:**  
 The actual height of the penjor?

Interpretation

**Solution:**



Using the tangent trigonometric ratio to calculate the height from Dodi's eyes to the top of the penjor, which is:

Analysis

$\tan 30^\circ = \frac{h}{10}$   
 $\frac{1}{3}\sqrt{3} = \frac{h}{10}$   
 $\frac{10}{3}\sqrt{3} = h$   
 $h = \frac{10}{3}\sqrt{3} = 5,7 \text{ m}$

The result of 5.7 m represents the height difference between Dodi and the top of the penjor. Since Dodi's height is 1.8 m, the height of the penjor is  $5.7 + 1.8 = 7.5 \text{ m}$ .

Evaluation

The tourist site staff stated that the correct height of the penjor is 7.5 meters

Inference

**Image 2.** Test Results of Subject S1 in Solving Ethno-Controversial Mathematical Problems

The analysis of Subject S1, who possesses a high level of logical–mathematical intelligence, indicates a notably strong ability in mathematical critical thinking compared to the other subjects. In most problems, Subject S1 performed interpretation effectively, accurately identifying the given information and what was being asked. Subject S1 also showed a good understanding of the ethno-controversial problem context and was able to relate it to relevant mathematical concepts.

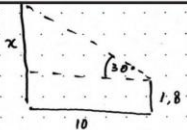
For the analysis indicator, Subject S1 was generally able to determine the appropriate mathematical formulas and explain the solution steps to be used. However, in several cases, these formulas were not always written explicitly on the answer sheet, although interview results indicated that the

subject understood their application. Regarding the evaluation indicator, Subject S1 was able to perform calculations logically and to recheck the obtained results. Nevertheless, in one of the problems, the subject was found to be less meticulous in presenting the final result. For the inference indicator, Subject S1 generally drew appropriate conclusions, though in some questions, the conclusions were not fully developed.

"I understand the intended conclusion; however, I do not always present it explicitly in detail at the end of my response," the student stated.

These findings indicate that Subject S1 demonstrates strong mathematical critical thinking; however, there remains a need to present solutions and conclusions in a more systematic manner.

Subject S2 showed consistent mathematical critical thinking. For interpretation, they clearly identified and restated the information and explained its meaning in the interview. In the analysis, they selected and applied relevant formulas correctly, demonstrating strong conceptual understanding. For evaluation, they performed accurate calculations and assessed the results' suitability to the problem, as shown in Image 3.

<p>Diketahui: sudut elevasi = <math>30^\circ</math>            jarak dodi dan penjor = 10 m            tinggi dodi = 180 cm = 1,8 m</p> <p>Ditanya: Tinggi penjor = ?</p>	Interpretasi	<p><b>It is known:</b>            Angle of elevation = 30 degrees            The distance from Dodi to the penjor = 10 m            Dodi's height = 180 cm = 1,8 m</p> <p><b>Question:</b>            The height of the penjor?</p>	Interpretation
<p>Jawab:</p> 		Analisis	
$\tan 30^\circ = \frac{x}{10}$ $\frac{1}{3}\sqrt{3} = \frac{x}{10}$ $x = \frac{10}{3}\sqrt{3} = 5,7 \text{ m}$ <p>tinggi penjor = <math>5,7 + 1,8</math>  <math>= 7,5</math></p>	Evaluasi		$\tan 30^\circ = \frac{x}{10}$ $\frac{1}{3}\sqrt{3} = \frac{x}{10}$ $x = \frac{10}{3}\sqrt{3} = 5,7 \text{ m}$ <p>The height of the penjor = <math>5,7 + 1,8</math>  <math>= 7,5</math></p>

**Image 3.** Test Results of Subject S2 in Solving an Ethno-Controversial Mathematical Problem

However, for the inference indicator, Subject S2 was not yet fully able to construct complete and explicit conclusions. The student stated

"I usually present the final result directly; however, I may not have fully connected the conclusion to the context of the problem."

The conclusions were brief and did not fully relate the calculation results to the problem context. This indicates that although Subject S2 has good analytical ability, the ability to formulate conclusions still needs further development.

Subject S3 exhibited varying levels of mathematical critical thinking ability across the given problems. In several questions, Subject S3 performed interpretation fairly well, as indicated by their ability to identify the given information and what was being asked. However, for the analysis indicator, Subject S3 was not always able to apply mathematical formulas accurately, even though the formulas used were relevant.

*"I understand which formula should be applied; however, I am sometimes confused about how to implement it in the calculation steps," the student stated.*

Errors in formula use affected S3's evaluation accuracy. In one problem, S3 improved, calculating correctly and drawing a proper conclusion, but inconsistencies remained in other tasks, showing ongoing difficulties in evaluation and inference. The student expressed,

*"In this problem, I made an error during the calculation process, which resulted in an incorrect final answer. However, in another problem, I felt more confident in the answer provided because the solution steps were clearer and easier to understand."*

These findings suggest that Subject S3 demonstrates a basic understanding; however, reinforcement is needed to consistently apply formulas and maintain accuracy in calculations. Subject S4 demonstrated good interpretation skills in understanding ethno-controversial mathematical problems. The subject was able to identify the given information and what was being asked quite clearly in each question. For the analysis indicator, Subject S4 also determined the relevant mathematical formulas and applied them in the solution process.

However, the evaluation indicator showed that Subject S4 still had weaknesses, particularly in calculation accuracy. The errors in calculations affected the correctness of the final results. The student expressed,

*"I actually understand the concepts and formulas that need to be used to solve the problems, but when performing the calculations, I am not meticulous enough, which results in errors affecting the final outcome. In addition, I still have difficulty formulating conclusions that correspond to the obtained results, especially in relating them to the context of the problem presented in the question."*

Moreover, for the inference indicator, Subject S4 was not yet fully able to formulate conclusions that aligned with the calculation results and the problem context. These findings indicate that although Subject S4 has a fairly good conceptual understanding, the ability to evaluate results and formulate conclusions still needs improvement.

Subject S5, who has low logical–mathematical intelligence, demonstrated considerable limitations in mathematical critical thinking ability. For the interpretation indicator, Subject S5 identified the given information and what was being asked in some questions; however, this understanding was not accompanied by the use of appropriate solution strategies. The student expressed,

*"I am not very sure which formula should be used, so I wrote the answer as best as I could."*

For analysis, S5 often omitted or misapplied formulas, leading to incorrect calculations and conclusions. For inference, they struggled to draw any accurate conclusions. These results show S5 needs intensive guidance to link problem understanding with appropriate solution strategies.

Subject S6 demonstrated uneven mathematical critical thinking ability across the indicators. For the interpretation and analysis indicators, Subject S6 tended to have difficulty fully identifying the given information and what was being asked, as well as determining the appropriate mathematical formulas, resulting in an inability to demonstrate accurate analysis. This affected the correctness of the solution steps, as shown in Image 4.

<p>Diketahui: Sudut = <math>30^\circ</math> tinggi badan = 180 cm Jarak = 10 cm Ditanya: tinggi penjor adalah 5.7 atau 7.5?</p>	Interpretasi	<p><b>It is known:</b> Angle = 30 degrees Height = 180 cm Distance = 10 cm</p> <p><b>Question:</b> The height of the penjor: 5.7 or 7.5 meters?</p>	Interpretation
<p>Jawab: <math>\tan 30^\circ = \frac{1}{3}\sqrt{3}</math> <math>\frac{1}{3}\sqrt{3} = \frac{10}{x}</math> <math>x = 30\sqrt{3}</math></p>	Evaluasi	<p><b>Answer:</b> <math>\tan 30^\circ = \frac{1}{3}\sqrt{3}</math> <math>\frac{1}{3}\sqrt{3} = \frac{10}{x}</math> <math>x = 30\sqrt{3}</math></p>	Evaluation
<p>Maka tinggi penjor yang benar adalah <math>30\sqrt{3}</math> meter</p>	Inferensi	<p>Therefore, the correct height of the penjor is <math>30\sqrt{3}</math> meters</p>	Inference

**Image 4.** Test Results of Subject S6 in Solving an Ethno-Controversial Mathematical Problem

However, for the evaluation and inference indicators, Subject S6 showed efforts to evaluate solutions and draw conclusions, although the results were not entirely accurate. Subject S6 was able to explain the reasoning behind their answers during the interview, although there were still discrepancies between the calculation results and the conclusions.

*"I still have difficulty determining the given information and what is being asked, so I feel unsure about selecting the formulas and solution steps. However, I still try to evaluate the answers and draw conclusions, even though the calculations and conclusions I make are not entirely accurate," the student stated.*

These findings indicate that Subject S6 has potential for development, but still requires more structured guidance in understanding and analyzing mathematical problems.

To provide a clearer overview of students' mathematical critical thinking abilities across different levels of logical–mathematical intelligence, Table 1 presents a summary.

**Table 1.** Summary of Students' Mathematical Critical Thinking Based on Logical–Mathematical Intelligence Levels

Intelligence Level	Interpretation	Analysis	Evaluation	Inference
High	Accurate & complete	Appropriate strategy	Logical & reflective	Mostly correct but less systematic
Moderate	Fairly accurate	Partially appropriate	Less accurate	Incomplete conclusions
Low	Limited understanding	Incorrect strategy	Inaccurate	Unable to conclude

### ***Discussion***

The findings of this study indicate that the level of logical–mathematical intelligence plays an important role in shaping students' mathematical critical thinking abilities in solving ethno-controversial mathematical problems. Differences in mathematical critical thinking abilities were clearly observed across each logical–mathematical intelligence group, including in the indicators of interpretation, analysis, evaluation, and inference. These findings reinforce the view that mathematical critical thinking ability does not exist in isolation, but is strongly influenced by students' logical reasoning skills and their understanding of mathematical concepts (Zebua et al., 2024; Fatra et al., 2020; Hafsa et al., 2026). The differences in students' performance can be explained through cognitive perspectives. Students with high logical–mathematical intelligence tend to manage cognitive load more effectively, allowing them to process complex information more efficiently without overloading their working memory. In contrast, students with lower intelligence levels may experience cognitive overload when dealing with ethno-controversial problems, which are inherently complex and require multi-step reasoning. Furthermore, metacognitive regulation plays a crucial role in mathematical critical thinking. High-ability students demonstrate better planning, monitoring, and evaluation during problem solving, which supports their performance in the evaluation and inference stages. Meanwhile, students with moderate and low abilities often lack reflective thinking habits, leading to calculation errors and incomplete conclusions.

Students with high logical–mathematical intelligence showed the strongest mathematical critical thinking, accurately interpreting problems, identifying key information, and connecting them to relevant concepts (Syam, 2020; Purnadewi & Widana, 2023). Moreover, students in this group were able to analyze solution strategies and evaluate the steps taken, although, in some cases, the presentation of formulas and conclusions was not fully systematic. These findings are in line with the studies of Julimah et al. (2020) and Mudita et al. (2019), which state that logical–mathematical intelligence supports students' ability to understand problem structures, reason about relationships between concepts, and make rational mathematical decisions (Julimah et al. 2020; Mudita et al. 2019; Citrawan et al., 2024).

These findings also reinforce Risna's (2021) conclusion that logical–mathematical intelligence is positively correlated with mathematical critical thinking ability, particularly in the context of solving contextual problems with socio-cultural nuances. Students with high logical–mathematical intelligence tend to have better cognitive control in processing information, evaluating solutions, and drawing logical conclusions (Firdaus & Wilujeng, 2018; Septiana & Kurniawan, 2018). Similar findings have been reported in recent studies, which indicate that mathematical critical thinking develops optimally when students possess strong logical reasoning skills and a deep conceptual understanding (Rahmawati et al., 2021).

These findings are consistent with research indicating that students with moderate logical–mathematical intelligence have the potential for critical thinking, but often face difficulties in accuracy and consistency when evaluating solutions and formulating conclusions (Yuaidah et al., 2022). Nurpaisa (2025) found that students' inability to draw conclusions is often not due to a lack of conceptual understanding, but rather to unsystematic thinking habits and limited reflection on problem-solving outcomes.

Meanwhile, students with low logical–mathematical intelligence demonstrated considerable limitations across almost all indicators of mathematical critical thinking. Students in this group experienced difficulties from the interpretation stage onward, which affected their ability to analyze strategies, evaluate calculation results, and draw accurate conclusions. Although in some cases students were able to write down the given and asked information, misunderstandings led to the use of inappropriate formulas and errors in calculations. These findings support previous studies, which indicate that students with low logical–mathematical intelligence tend to have low perseverance, give up easily, and lack confidence in solving mathematical problems that require reasoning (Fransisca et al., 2020; Suratmi et al., 2020). Several studies also show that the limitations in mathematical critical thinking in this group are associated with low information organization skills and weak metacognitive control during problem-solving processes (Tresnawati et al., 2020; Wulandari, 2020; Zahra et al., 2018).

Based on the review of each mathematical critical thinking indicator, the interpretation indicator was the most mastered by students with high and moderate logical–mathematical intelligence. In contrast, students with low logical–mathematical intelligence still had difficulty identifying relevant information. These findings align with research stating that interpretation ability heavily depends on students' prior understanding of problem structure and mathematical literacy skills (Cahyanti et al., 2025). However, these results contradict the findings of Setianingsih et al. (2021), who reported that students with low logical–mathematical intelligence still met the interpretation indicator satisfactorily. For the analysis and evaluation indicators, only students with high logical–mathematical intelligence demonstrated relatively good and consistent mastery. Students with moderate and low logical–mathematical intelligence tended to have difficulty selecting and applying appropriate strategies and accurately evaluating solutions. Meanwhile, the inference indicator was the most challenging for all student groups, particularly those with moderate and low logical–mathematical intelligence. These findings reinforce recent research suggesting that the ability to draw mathematical conclusions requires the integration of conceptual understanding, calculation accuracy, and reflective thinking skills, which are not easily mastered by students (Wijiasih & Awalludin, 2022; Hasanah, 2023).

Based on the results of the logical–mathematical intelligence questionnaire, most students fell into the moderate category, while the proportion of students with high logical–mathematical intelligence remained relatively small. This condition indicates the need for special attention in mathematics instruction to continuously enhance students' logical–mathematical intelligence. Improving logical–mathematical intelligence is believed to positively impact students' mathematical critical thinking skills, particularly in solving contextual and ethno-controversial mathematical problems. Nevertheless, this study has several limitations.

First, the problems used in this study were limited to certain types and thus did not fully represent the variation in students' mathematical critical thinking abilities. Second, the small number of research subjects and the specific school context mean that the findings cannot be widely generalized. Therefore, further research with a larger sample size, more diverse contexts, and a wider range of mathematical problems is necessary to obtain a more comprehensive understanding.

Overall, this study confirms that logical–mathematical intelligence significantly impacts students' mathematical critical thinking when solving ethno-controversial mathematical problems. The findings highlight the importance of teachers' roles in designing instruction that focuses not only on final results but also on developing students' logical reasoning, accuracy, and reflective abilities. With an appropriate instructional approach, students' mathematical critical thinking skills are expected to develop optimally and contribute to the overall improvement in the quality of mathematics learning.

The findings of this study have important implications for mathematics instruction. Teachers are encouraged to implement scaffolding strategies to support students with lower logical–mathematical intelligence, particularly in understanding problem structures and selecting appropriate solution strategies. In addition, the use of reflective questioning can help students develop metacognitive awareness, especially in evaluating their problem-solving processes and identifying errors. Moreover, teachers should emphasize structured conclusion writing, as the inference stage was the most challenging for all student groups. Providing guided practice in formulating clear and contextually relevant conclusions can significantly improve students' mathematical critical thinking skills.

## Conclusion

This study concludes that students' mathematical critical thinking abilities in solving ethno-controversial problems vary according to their levels of logical–mathematical intelligence. Students with higher levels demonstrate stronger performance across interpretation, analysis, evaluation, and inference, while those with moderate and low levels experience increasing difficulties, particularly in evaluation and drawing conclusions. These findings highlight the important role of logical–mathematical intelligence in supporting the development of critical thinking in mathematics learning. Therefore, teachers are encouraged to implement differentiated and context-based instructional strategies that emphasize not only procedural understanding but also reasoning, reflection, and the construction of conclusions. Future studies should explore intervention-based approaches to specifically strengthen students' inference skills and involve larger, more diverse samples to enhance the generalizability of findings.

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