

# ISRG Journal of Multidisciplinary Studies (ISRGJMS)



**ISRG PUBLISHERS**

Abbreviated Key Title: isrg j. multidiscip. Stud.

ISSN: 2584-0452 (Online)

Journal homepage: <https://isrgpublishers.com/isrgjms/>

Volume – IV, Issue - VI (June) 2026

Frequency: Monthly



## Analysis Of Students' Mathematical Critical Thinking Abilities And Processes On Pythagoras Material Based On Ethnomathematics

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| Received: 02.06.2026 | Accepted: 06.06.2026 | Published: 08.06.2026

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### Abstract

*This study aims to analyze the mathematical critical thinking skills and processes of junior high school students on the Pythagorean Theorem material based on ethnomathematics of traditional Tongkonan houses in Tana Toraja. This study uses a descriptive qualitative approach with 28 eighth-grade students of Dende' Christian Junior High School as research subjects. The research instrument is a descriptive essay test based on Higher Order Thinking Skills (HOTS) contextualized with local culture and supporting interviews to explore students' thinking processes. The analysis of mathematical critical thinking skills is based on four indicators, namely interpretation, analysis, evaluation, and inference. The results show that students' mathematical critical thinking skills are generally in the sufficient to good category. The analysis and inference indicators show higher achievements, indicating that students are able to identify important information, model problems mathematically, and draw conclusions based on the Pythagorean Theorem concept. However, the evaluation and explanation indicators are still in the low category, especially in assessing the logic of results and conveying mathematical arguments systematically. Ethnomathematics-based learning in the Tongkonan traditional house helps students understand mathematical concepts more concretely and meaningfully because it is linked to a cultural context close to their lives. Therefore, ethnomathematics can be used as an alternative learning approach to support the development of critical mathematical thinking skills in junior high school students.*

**Keywords:** *critical mathematical thinking, Pythagorean Theorem, ethnomathematics, Tongkonan traditional house*

### INTRODUCTION

Mathematics learning at the level *Junior High School (SMP)* Mathematical critical thinking plays a crucial role in developing students' higher-order thinking skills, particularly mathematical critical thinking skills. Students need mathematical critical thinking

skills to identify problems, analyze information, formulate problem-solving strategies, and evaluate the results logically and systematically (Pratiwi & Sumarmo, 2021). However, several studies have shown that junior high school students' mathematical

critical thinking skills are still relatively low, especially when faced with non-routine problems or math problems that require in-depth conceptual understanding (Gusmayenti, 2025; Putra & Akbar, 2025).

However, various studies have shown that junior high school students' critical mathematical thinking skills are still relatively low. Students tend to struggle when faced with non-routine problems or word problems that require conceptual understanding and logical reasoning. The learning process, which is still oriented towards formulas and routine practice problems, results in students being less accustomed to critical and reflective thinking when solving mathematical problems (Rahmawati et al., 2022).

One mathematical concept that demands critical thinking from students is the Pythagorean Theorem. This material requires not only calculation skills but also an understanding of the relationships between the sides of a right triangle and their application in various contextual problems. The reality of classroom learning shows that students often simply memorize formulas without truly understanding the concepts behind them. Therefore, when faced with story problems or contextual situations, they struggle to develop appropriate solution strategies. As a result, students often make mistakes in determining the hypotenuse, perpendicular, or in interpreting problems presented in story form (Sari & Hidayat, 2021).

Students' low critical mathematical thinking skills in Pythagoras are also influenced by abstract and poorly contextualized learning. Mathematics learning that is disconnected from students' real-life experiences makes concepts difficult to understand and less meaningful. Therefore, a learning approach that connects mathematical concepts to students' everyday lives is needed to make the learning process more meaningful and encourage critical thinking (Nugraha et al., 2023).

Abstract learning without real contextualization is often highlighted as one of the causes of students' low critical thinking skills in mathematics. To address this, a learning approach that connects mathematical concepts with Students' real-life experiences are essential. Ethnomathematics is one such approach because it links local cultural elements with mathematical concepts in the learning process, making learning more meaningful and contextual. This approach has the potential to increase students' cognitive engagement and support the development of critical mathematical thinking skills. This approach allows students to learn mathematics through contexts close to their lives, thereby improving conceptual understanding and active student engagement in the learning process (D'Ambrosio, 2021; Putri & Siregar, 2022).

One relevant approach to addressing these issues is ethnomathematics. Ethnomathematics is a learning approach that links mathematical concepts to local culture. This approach allows students to learn mathematics through contexts close to their lives, thereby enhancing conceptual understanding and active student engagement in the learning process (D'Ambrosio, 2021; Putri & Siregar, 2022). Various studies have shown that the integration of ethnomathematics in learning, ethnomathematics can improve students' critical thinking skills in mathematics. For example, the development of ethnomathematics-based teaching modules has been shown to be effective in improving junior high school students' critical thinking skills in the context of the independent curriculum (Lase et al., 2025). Furthermore, exploring cultural

contexts in ethnomathematics can also foster critical thinking indicators such as the ability to identify problems, develop strategies, provide logical reasoning, and draw conclusions (Darulfalah et al., 2025).

Torajan culture, particularly the Tongkonan traditional house, contains many mathematical elements that can be utilized as a learning context. The structure of Tongkonan buildings demonstrates geometric concepts, such as right-angled triangles, rectangles, similarity, and symmetrical patterns in the carvings and roof shapes. These elements can be linked to the Pythagorean Theorem, for example, in determining the length of a building's side or the slope of a traditional house's roof. Recent research shows that utilizing traditional houses as a context for ethnomathematics can help students understand geometric concepts more concretely and meaningfully (Lomboan & Rante, 2023; Kadir et al., 2024). The application of STEM-based learning media and ethnomathematics, such as *asdigital book* It has also been proven to improve the critical thinking skills of junior high school students in mathematics. *Pythagorean theorem*, thus demonstrating that the integration of technology and local culture in learning can strengthen students' conceptual understanding (Pramasdyasari et al., 2025). Other research also shows that the development of a mathematical critical thinking test instrument based on ethnomathematics is valid for evaluating students' critical thinking abilities in a mathematical context (Aini et al., 2025).

Several studies have also shown that ethnomathematics-based mathematics learning can improve students' critical mathematical thinking skills. Through the cultural context, students are encouraged to interpret problems, analyze information, evaluate problem-solving strategies, and draw logical conclusions. Thus, Ethnomathematics not only plays a role in preserving local culture but also supports the achievement of 21st-century mathematics learning goals (Yuliani et al., 2022; Saputra & Fitriani, 2024). Furthermore, a study analyzing students' critical thinking in solving ethnomathematics-themed problems also shows that some students still tend to memorize without critically examining the problem, thus requiring learning efforts that provide real-world context related to students' culture and daily lives. Theoretically, the ethnomathematics approach is also seen as an effective strategy in facilitating critical thinking processes through identification, construction, reflection, and decision-making in the face of uncertainty when solving mathematical problems (Nuryadi, 2024).

The Tongkonan traditional house of the Torajan culture displays a rich variety of geometric patterns and shapes, such as right-angled triangles, lines of symmetry, and complex roof structures. These elements have the potential to become relevant and meaningful contexts for mathematics learning, including in the material *Pythagorean theorem*. Exploring geometry in local cultures such as traditional house architecture can help students understand mathematical concepts more concretely and increase their critical thinking engagement in problem solving.

Research over the past five years has shown that ethnomathematics-based mathematics learning has a positive impact on students' critical mathematical thinking skills. Integrating local cultural context into learning helps students understand concepts more meaningfully, improves analytical skills, and encourages connections between mathematics and everyday life. Several studies have also reported that applying ethnomathematics to geometry can improve students' higher-order thinking skills.

However, most previous studies have focused on quantitatively measuring learning outcomes or improving critical thinking skills, and have not examined students' mathematical critical thinking processes in depth. Therefore, this study offers novelty by qualitatively analyzing students' mathematical critical thinking abilities and processes based on indicators of interpretation, analysis, evaluation, and inference, and integrating the context of the Tongkonan (Toraja) traditional house into the Pythagorean Theorem material at the junior high school level.

With this background, this research is important to conduct in-depth studies on the mathematical critical thinking abilities and processes of junior high school students on the material *Pythagorean theorem* based on ethnomathematics of Toraja traditional houses. The results of this study are expected to provide an overview of students' levels of mathematical critical thinking and support efforts to improve mathematics learning that is more meaningful, contextual, and rooted in the local culture of junior high school students in Indonesia.

## METHOD

This study uses a descriptive qualitative approach. This qualitative approach was chosen because this study aims to describe in-depth students' mathematical critical thinking abilities and processes, specifically in solving Pythagorean Theorem problems based on ethnomathematics of Toraja traditional houses. This approach allows researchers to analyzing how students understand problems, develop strategies, perform calculations, and evaluate the results of the solution as a whole (Nuryadi, 2024; Gusmayenti, 2025). The subjects of this study were students of class VIII B of Dende' Christian Middle School who had studied the Pythagorean Theorem material. The selection of class VIII was based on the junior high school curriculum that places Pythagoras material at that level. The subjects of this study were selected using a purposive sampling technique, taking into account the diverse academic abilities of students (high, medium, and low). The object of this study is the ability to think critically mathematically and the process of students' mathematical critical thinking in solving Pythagorean Theorem problems based on ethnomathematics of Toraja traditional houses (Tongkonan).

This research was conducted at Dende' Christian Junior High School in North Toraja, South Sulawesi. The location was chosen based on the students' familiarity with the local culture of the Tongkonan traditional house, ensuring the ethnomathematics context was relevant to their lives. The research was conducted in the even semester of the current academic year.

The researchers applied a data collection technique by administering a descriptive test on Pythagoras related to the Torajan cultural context. Students' answers were then scored for each ability indicator, which was assessed based on a percentage. The percentages for each indicator on each question were then averaged to determine the students' level of mathematical critical thinking ability. Furthermore, the researchers also used a non-test instrument, namely unstructured interviews.

Students' mathematical critical thinking skills can be analyzed through indicators of interpretation, analysis, evaluation, and inference that describe students' thinking processes comprehensively in solving mathematical problems (Anggraini, Siagian & Agustinsa, 2022). The questions are in the form of a mathematical context of Pythagoras material. Each question item is

given a scoring rubric of 0 – 4. The following are guidelines for assessing students' mathematical critical thinking skills:

**Table 1. Assessment Rubric for Mathematical Critical Thinking Skills**

| Indicators Ability Critical thinking  | Response  | Score |
|---|---|-------|
| <b>Analysis;</b><br>ability identify important information in a problem.                  | <ul style="list-style-type: none"> <li>Understand the problem completely; write down all the information that is known and asked accurately and sing the correct representation (image/model).</li> <li>Understand the problem well; most of the information is written correctly, there are minor omissions.</li> <li>Write down information that is known or asked but is incomplete or inaccurate.</li> <li>The information written does not match the problem.</li> <li>Not writing relevant information and not understanding the problem.</li> </ul>  | 4     |
|   |   | 3     |
|   |   | 2     |
|   |   | 1     |
|   |   | 0     |
| <b>Inference;</b><br>pull the knot based on data and relationships between concepts.      | <ul style="list-style-type: none"> <li>Writing important information correctly (height 7 m, base 5 m), applying Pythagoras' formula correctly, calculations complete and neat, the final result is correct (<math>\approx 8.6</math> m)</li> <li>Important information is written quite completely, the calculation steps are correct but not neat or incomplete, the final result is still correct</li> <li>Identifies information but it is incorrect or incomplete; there is a small calculation error but the Pythagorean step is still visible.</li> <li>Using incorrect information, applying formulas incorrectly, answers far from correct but it looks like an effort to understand the question.</li> <li>No answer or answer does not show any use of Pythagoras at all</li> </ul> | 4     |
|   |   | 3     |
|   |   | 2     |
|   |   | 1     |
|   |   | 0     |
| <b>Evaluation;</b><br>ability evaluate truth, accuracy, or logicity step solution problem | <ul style="list-style-type: none"> <li>Assess the feasibility based on the calculation results of question 1, provide logical reasons (<math>8\text{ m} &lt; 8.6\text{ m} \rightarrow \text{unsafe}</math>), and include an explanation of the construction consequences.</li> <li>Provides correct decision but the reason is incomplete or does not mention the numerical relationship in detail.</li> <li>The decision answer is correct but the reason is still general, or the decision is wrong but the reason shows a logical thinking process.</li> </ul>   | 4     |
|   |   | 3     |
|   |   | 2     |
|   |   | 1     |
|   |   | 0     |

|   |  |   |
|---|--|---|
|   | <ul style="list-style-type: none"> <li>• Giving answers but without clear reasons or illogical reasons.</li> <li>• The answer is irrelevant or does not answer.</li> </ul> | 0 |
| <b>Explanation;</b><br>ability<br>give<br>logical and<br>precise<br>reasons,<br>descriptions,<br>or arguments | • Full explanation: linking measurement errors with impacts on stability, asymmetrical slopes, risk of structural damage, aesthetics of the Tongkonan, and safety.         | 4 |
|   | • Explains at least 2 important impacts (stability & slope), but not in depth.   | 3 |
|   | • Mention 1 impact with a general explanation (e.g.: "the house may not be sturdy").   | 2 |
|   | • Answered very briefly, did not explain the cause and effect properly.  | 1 |
|   | • Irrelevant or empty answers  | 0 |

Source: (Angraini, Siagian & Agustinsa, 2022)

The data analysis method is carried out through several processes, namely:

#### 1. Analysis of Average Mathematical Critical Thinking Ability

To calculate the average student score, the following formula is used:

$$\bar{x} = \frac{\sum x_i}{n}$$

Keterangan:

$\bar{x}$  = rate-rate

$\sum x_i$  = Total marks obtained by students

$n$  = Number of students

To obtain the average in percentage form, use the formula:

$$\text{Average Percentage} = \frac{\text{Average Score}}{\text{Maximum Score}} \times 100\%$$

#### 2. Classification of Students' Levels of Mathematical Critical Thinking Ability

**Table 2 Classification of Students' Levels of Mathematical Critical Thinking Ability**

| Classification of Critical Thinking Skills | Information |
|--|-------------|
| $84 < N \leq 100$                          | Very high   |
| $69 < N \leq 84$                           | High        |
| $54 < N \leq 69$                           | Currently   |
| $39 < N \leq 54$                           | Low         |
| $0 < N \leq 39$                            | Very Low    |

Source: Sutarni & Gatnigsih (2022)

Description: N = Student score

#### 3. Analysis of Students' Level of Mathematical Critical Thinking Ability

The percentage of each indicator for each question was then averaged to determine the students' problem-solving ability. Researchers used a formula adapted from Sutarni & Gatnigsih (2022), as follows:

$$P = \frac{f}{N} \times 100\%$$

Where P is the percentage of students' mathematical Critical Thinking Ability Indicator,  $f$  is the student's achievement score, and  $N$  is the maximum score (total score).

**Table 3 Percentage Criteria for Mathematical Critical Thinking Ability**

| Percentage (%) | Ability Category |
|----------------|------------------|
| 85%-100%       | Very good        |
| 70%-84%        | Good             |
| 55%-69%        | Enough           |
| 40%-54%        | Not enough       |
| < 40%          | Very less        |

Sutarni & Gatnigsih (2022)

The instruments used in this study (descriptive test):

Tongkonan roofs have a distinctive curved slope, but when initially designed, the carpenters used a right-angled triangular framework as the basis for the slope. If the roof height from the ground to the peak is 7 meters, and the horizontal distance from the base of the roof to the center of the building is 5 meters:

1. Make the triangular frame
2. Determine the length of the slanted wooden frame (as the hypotenuse).
3. If the available wooden frame is 8 meters long, is it safe to use? Explain your decision.
4. Explain how errors in measuring slope can affect the structure of a traditional Toraja house.

## RESULTS AND DISCUSSION

The average achievement of mathematical critical thinking skills of 28 class VIII B students of Dende' Christian Middle School is 8.35. The results of mathematical critical thinking skills (MCTS) of 28 class VIII B students based on category levels can be seen in Table 5 below:

**Table 4. Data from the results of the Students' Critical Thinking Ability Test**

| No | Interval MCTS student | Number of Students | Percentage (%) | Student MCTS categories |
|----|-----------------------|--------------------|----------------|-------------------------|
| 1  | $84 < N \leq 100$     | 1                  | 3,6%           | Very good               |
| 2  | $69 < N \leq 84$      | 4                  | 14,3%          | Good                    |
| 3  | $54 < N \leq 69$      | 14                 | 50%            | Enough                  |
| 4  | $39 < N \leq 54$      | 5                  | 17,9%          | Not enough              |

|   |                 |           |             |           |
|---|-----------------|-----------|-------------|-----------|
| 5 | $0 < N \leq 39$ | 3         | 10,8%       | Very less |
|   | <b>Amount</b>   | <b>28</b> | <b>100%</b> |           |

Based on Table 4, the researcher obtained data regarding students' mathematical critical thinking skills through a question designed according to four indicators of critical thinking skills based on Ethnomathematics of class VIIIB students of Dende' Christian Middle School. Of the 28 students tested, variations in the level of students' mathematical critical thinking skills were divided into five categories, namely very good, good, sufficient, less, and very less. For the category with the highest percentage, namely 50%, it is in the sufficient category, where out of 28 students, 14 students are in the sufficient category. This shows that the overall level of mastery of HOTS Pythagoras questions based on Ethnomathematics of class VIIIB students of Dende' Christian Middle School is in the sufficient criteria. In the very good category, only 1 student can achieve it with a percentage of 3.6%. The good category of student achievement is still very small, namely 4 students with a percentage of 14.3%, so there is a need to improve mathematical critical thinking skills in solving HOTS Pythagoras questions based on Ethnomathematics

The following are the percentage results for each category based on the facione theory.

**Table 5. Data on the results of critical thinking skills for each indicator**

| Indicators  | Percentage | KPM Level |
|---|------------|-----------|
| <b>Analysis;</b> the ability to identify important information in a problem                       | 86%        | Very good |
| <b>Inference;</b> draw conclusions based on data and relationships between concepts               | 78%        | Good      |
| <b>Evaluation;</b> the ability to evaluate the truth, accuracy, or logic of problem-solving steps | 53%        | Enough    |
| <b>Explanation;</b> the ability to provide logical and precise reasons, descriptions or arguments | 19%        | Very less |

Based on Table 5. regarding the results of Critical Thinking skills of each Indicator of the results of the analysis of students' critical thinking skills on HOTS Pythagoras questions based on ethnomathematics, the analysis indicator shows very good results (86%), which indicates that students are able to identify important information in the problem correctly. The inference indicator is in the good category (78%), indicating that most students are able to draw conclusions based on data and relationships between concepts. However, the evaluation indicator results are still sufficient (53%), which indicates that students are not optimal in assessing the truth and logic of the solution steps. The explanation indicator obtained the lowest percentage (19%) with a very poor category, indicating that students still have difficulty in expressing

reasons and logical arguments for the answers given. Therefore, a learning strategy is needed that emphasizes more on reflection exercises, discussions, and written or oral explanations, so that students' critical thinking skills can develop more balanced in each indicator.

## DISCUSSION

Critical thinking is a skill necessary for problem solving. Furthermore, critical thinking skills are important for helping students practice their skills, generating innovative questions to devise appropriate solutions, actively constructing arguments by presenting accurate and logical evidence, and minimizing errors in problem solving (Sulistiani and Masrukhan, 2016). There are four core skills in critical thinking: interpretation, analysis, evaluation, and inference. These core skills can be used to measure mathematical critical thinking skills.

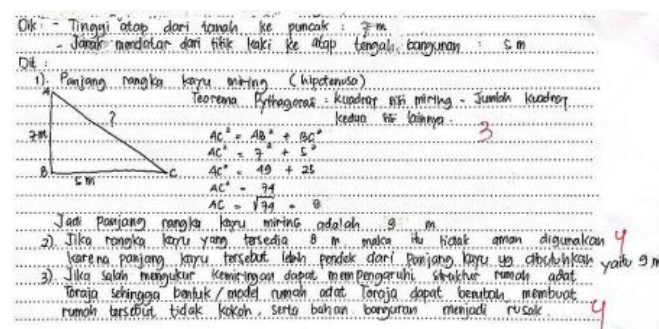
In this study, after analyzing the level of mathematical critical thinking ability in solving HOTS problems based on ethnomathematics, it was found that students' mathematical critical thinking ability met the low criteria. The average mathematical critical thinking ability of class VIIIB students of Dende' Christian Middle School on the Pythagorean Theorem material based on ethnomathematics was 8.35 out of a maximum score of 16, or equivalent to 52.19%, which is in the sufficient category. It can be seen from the results of the analysis of the mathematical critical thinking ability test of class VIIIB students of Dende' Christian Middle School in the 2025/2026 academic year, the odd semester, the calculation results obtained from the 28 students were 1 student (3.6%) who had very good abilities, there were 4 students (14.3%) who had good abilities, there were 14 students (50%) who had sufficient abilities, there were 5 students (17.9%) who had less abilities, and there were 3 students (10.8%) who had very less abilities. Critical mathematical thinking ability of eighth grade students of Dende' Christian Middle School in 2019

The 2025/2026 academic year as a whole meets the sufficient category because students are not yet accustomed to solving mathematical critical thinking problems and students' lack of ability to implement each indicator of critical thinking ability based on Facione.

The following is an analysis of mathematical critical thinking skills in solving HOTS problems based on ethnomathematics of VIIIB students of Dende' Christian Middle School based on Facione:

### Students' Mathematical Critical Thinking Process Ability in the High Category

This study found that only one student had excellent mathematical critical thinking skills, namely the MSA subject. The MSA subject answer sheet is presented in Figure 1 below.



**Figure 1. MSA Subject Answer Sheet**

The following are the results of the researcher's interview with the MSA subject on the inference indicator;

Researcher: "How do you recheck the calculation results  $\sqrt{74} = 9$ ?"

Subject MSA: "Sorry, ma'am, I'm having difficulty determining the results here.  $\sqrt{74}$  with that's right, ma'am, because when I used  $8 \times 8$  the result was only 64, so I just estimated the result.  $\sqrt{74}$  is 9".

Based on the answer sheets and interview results of the MSA subjects, it was found that the analysis indicators of the MSA subjects' abilities were very good. In the analysis stage, students were able to correctly identify known and requested information, namely a roof height of 7 meters and a horizontal distance of 5 meters. Students were also able to represent the problem in the form of a right triangle and select a relevant mathematical concept, namely the Pythagorean Theorem. This indicates that students have excellent analytical skills in modeling contextual problems into mathematical forms.

At the inference stage, the student concluded that the length of the slanted wooden frame was 9 meters. Conceptually, this conclusion was derived from the calculation of  $\sqrt{74}$ , but the student made an inaccurate rounding, because the value of  $\sqrt{74}$  should be around 8.6 meters.

However, students' inferences still show an understanding of the relationships between concepts and the ability to draw conclusions from the calculation process, although the numerical accuracy is not yet completely accurate.

During the evaluation phase, the student stated that the 8-meter-long wooden frame was unsafe to use because it was shorter than the required length. Although the student's value for the wooden frame length was rounded to 9 meters, the decision was still logical and consistent with the student's calculations. This demonstrates that the student was able to evaluate the solution based on mathematical arguments he understood, despite minor errors in the final calculation.

Meanwhile, during the explanation stage, students were able to explain the impact of errors in roof slope measurements on the structure of a traditional Tongkonan house. Students stated that measurement errors can cause changes in the building's shape, reduce the house's sturdiness, and potentially damage building materials. This explanation demonstrated students' ability to connect mathematical concepts to real-world and cultural contexts, a characteristic of high-level critical thinking.

Based on the four indicators of critical mathematical thinking, students are categorized as having very good critical mathematical thinking skills. They are able to analyze problems accurately, draw inferences, evaluate decisions, and provide contextual explanations. However, minor errors were still found in the accuracy of calculations and rounding of root results, which shows the need for strengthening the aspect of numerical accuracy even though critical thinking skills conceptually have developed very well.

### Students' Mathematical Critical Thinking Process Ability in the Medium Category

In this study, students with moderate mathematical critical thinking skills were selected for the YLSP subjects. These students were selected because they were highly communicative. The YLSP subject's answer sheet is presented in Figure 2 below:

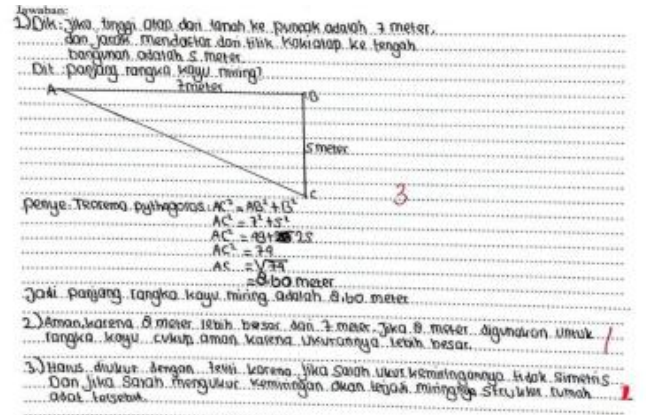


Figure 2. YLSP Subject Answer Sheet

The following are the results of the researcher's interview with the YLSP subject on the Evaluation indicator;

Researcher: "Which do you think is longer, 8 meters or 8.6 meters?"

Subject MSA: "The longer one is 8.6 meters, ma'am."

Researcher: "Well, if only 8 meters are available, does that mean the wood is shorter or longer?"

Subject MSA: "Shorter than mother".

Researcher: "Okay, then are you sure that if the available wood is shorter, namely only 8m, it is safe to use?"

MSA Subject: "Oh yes, ma'am, I was wrong. It should not be safe to use because the wood needed is 8.6m while the available length is only 8m, so the wood is not long enough, ma'am."

Based on the answer sheets and the results of the YLSP subject interviews, it was found that in the analysis stage, students demonstrated a good understanding of the given problem. This was evident from the students' ability to write down known information, namely the height of the roof from the ground to the peak of 7 meters and the horizontal distance of 5 meters. In addition, students also drew a sketch of a right triangle that represents the slope of the Tongkonan roof frame. The sketch created has reflected the relationship between the vertical side, the horizontal side, and the hypotenuse, although there were still minor errors in writing the units and naming the sides.

At the inference stage, students are able to identify the concept of the Pythagorean Theorem as a problem-solving strategy. Students write the Pythagorean formula and make the correct substitution of the height and horizontal distance values, namely:  $AC^2 = 7^2 + 5^2$ . The calculation results obtained are the length of the slanted wooden frame of  $\pm 8.60$  meters, which indicates that students have carried out the mathematical analysis process correctly and systematically. This indicates that students are able to connect known data with relevant mathematical concepts appropriately. In general, students' interpretation skills are good because they are able to link the cultural context of Toraja traditional houses with the mathematical form of a right triangle.

During the evaluation stage, students still made mistakes in assessing the feasibility of the calculation results. Students had tried to evaluate the feasibility of using 8 meters of wood, but the reasoning given was still inaccurate and not fully based on correct mathematical calculations. Based on the results of the length of the slanted wooden frame being greater than 8 meters, students

concluded that 8 meters of wood was safe to use because its size was larger than the actual needs, which led to the student making the wrong decision.

In the explanation stage, students were able to provide contextual explanations regarding the impact of errors in measuring roof slope. Students stated that if the slope is not measured accurately and is not symmetrical, the structure of the Tongkonan traditional house can become tilted and unbalanced. This answer demonstrates students' ability to connect mathematical concepts.

with real conditions and cultural context, although the explanations given are still general and not yet in-depth.

Overall, students have demonstrated a fairly good understanding of basic concepts and procedures, but their evaluation and logical explanation skills still need to be improved, especially in the accuracy of calculations and the delivery of more systematic and mathematically concept-based reasons. However, students still experience difficulties in the accuracy of mathematical analysis and calculations, especially in applying the Pythagorean Theorem correctly. Therefore, learning is needed that places more emphasis on understanding concepts and accuracy in the process of mathematical critical thinking.

### Students' Mathematical Critical Thinking Process Ability in the Low Category

For this study, the students with low mathematical critical thinking skills were subject RB. Subject RB was chosen because they received the lowest scores. Subject RB's answer sheet is presented in Figure 3 below:

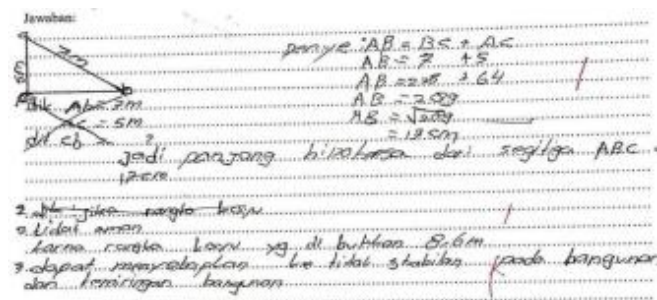


Figure 3. RB Subject Answer Sheet

The following are the results of the researcher's interview with the MSA subject on the inference indicator;

Researcher: "Are you having difficulty working on this question?"  
 Subject RB: "Yes, ma'am, this is very difficult for me. I don't understand what the question means. "That's it. I've also forgotten the correct Pythagorean theorem. I'm having a really hard time learning math. I hate counting."

Based on the answer sheets and the results of interviews with RB subjects, it was found that at the analysis stage, students demonstrated a low understanding of the given problem. This was evident in the writing of known data that was not written. Although students drew a sketch of a right-angled triangle representing the roof frame of a Tongkonan, information regarding the height of the roof and the horizontal distance were not clearly identified as the vertical side and the base side of the triangle. The sketches also did not fully reflect the relationship between the sides of the right-angled triangle accurately. This condition indicates that students have not been able to correctly interpret the problem context into a mathematical model.

At the inference stage, students demonstrated an inability to correctly apply the Pythagorean Theorem. Students wrote the relationship between the sides of a triangle using direct addition, that is, adding the lengths of the perpendicular and base sides without performing the exponentiation process as required by the Pythagorean Theorem. This error indicates that students do not yet understand the basic concept of the Pythagorean Theorem, particularly

the quadratic relationship between the sides of a right triangle. As a result, the calculated length of the hypotenuse does not conform to the correct mathematical concept.

During the evaluation phase, the student stated that the 8-meter-long wooden frame was safe to use, but the reasoning provided was not based on valid calculations. The student's evaluation was not supported by a valid mathematical analysis process. This indicates that the student was unable to evaluate the correctness of the solution and could not accurately compare the calculation results with the conditions given in the problem. Therefore, the student's evaluation ability fell into the low category.

During the explanation stage, the student provided a brief answer that measurement errors could cause the building to become unstable and its slope to be affected. Although this answer was still very simple, the student demonstrated an attempt to link the measurement errors to the impact on the structure of a traditional Torajan house. However, the explanation provided was not accompanied by clear and in-depth reasoning, so that students' inference abilities are still relatively low and do not reflect a mature critical thinking process.

Based on the four indicators of mathematical critical thinking, it can be concluded that students' mathematical critical thinking processes are in the low category. Students are unable to interpret problems accurately, cannot analyze and apply the Pythagorean Theorem correctly, and cannot evaluate calculation results logically, demonstrating very limited inference abilities. These results indicate the need for a more contextual, gradual, and conceptually-oriented learning approach, especially through ethnomathematics-based learning so that students can more easily relate mathematical concepts to real experiences.

Based on the discussion above, learning the Pythagorean Theorem based on ethnomathematics of Tongkonan traditional houses has a positive influence on junior high school students' critical mathematical thinking skills. In general, students' critical thinking skills are in the fair to good category, as seen from their ability to interpret contextual problems and relate them to mathematical concepts. The cultural context close to students' lives helps them understand problems more concretely and not merely abstractly.

For the critical mathematical thinking indicator, students demonstrated good skills in the analysis and inference indicators. This indicates that most students were able to identify important information, model problems mathematically, and draw conclusions based on relationships between concepts. Using the context of the Tongkonan traditional house helped students visualize the concept of right triangles and the application of the Pythagorean Theorem more meaningfully.

However, students' abilities in the evaluation and explanation indicators are still relatively low, especially in providing logical reasons and accurately assessing the feasibility of calculation results. Some students still make errors in calculations and in

presenting mathematical arguments, which indicates that their understanding of mathematics is still low.

Conceptual and thinking accuracy still need to be improved. This also indicates that students are not yet fully accustomed to HOTS-based critical thinking problems. Overall, ethnomathematics-based learning has proven effective in supporting the development of students' mathematical critical thinking skills, particularly in understanding and analyzing contextual problems. However, for students' critical thinking skills to develop more optimally and evenly across all indicators, a learning strategy that emphasizes reflection, discussion, and ongoing mathematical argumentation practice is needed. The integration of ethnomathematics accompanied by strengthening concepts and fostering higher-order thinking habits is expected to improve the quality of mathematics learning in junior high schools.

## CONCLUSION

Based on the results of research and discussion regarding the analysis of junior high school students' mathematical critical thinking abilities and processes on the Pythagorean Theorem material based on ethnomathematics of traditional Tongkonan houses, it can be concluded that students' mathematical critical thinking abilities are generally in the sufficient to good category. Most students are able to interpret contextual problems, identify known and asked information, and model problems into mathematical forms that are in accordance with the concept of the Pythagorean Theorem.

Based on the critical thinking indicators for mathematics, students' analytical skills demonstrated the highest achievement, indicating that students were able to recognize important elements in problems and select relevant mathematical concepts. The inference indicator was also in the good category, indicating that students were quite capable of drawing conclusions based on the relationships between concepts and calculation results. However, the evaluation and explanation indicators still showed relatively low achievement, especially in assessing the logic of the solution results and in expressing mathematical reasons and arguments systematically and in depth.

Analysis of the mathematical critical thinking process shows variations in student abilities in each category. Students with high abilities were able to fulfill all four indicators of mathematical critical thinking relatively completely, although minor errors in calculation accuracy were still found. Meanwhile, students with medium and low abilities experienced difficulties in understanding the basic concept of the Pythagorean Theorem, applying formulas correctly, and evaluating calculation results logically, which resulted in low-quality inferences and explanations.

Overall, ethnomathematics-based mathematics learning in traditional Tongkonan houses has been shown to positively contribute to the development of students' mathematical critical thinking skills and processes. The local cultural context helps students understand concepts more concretely and meaningfully, and fosters connections between mathematics and real life. However, to achieve this, critical thinking skills development requires which is more evenly distributed across all indicators, it is necessary to strengthen conceptual understanding, get used to high-level thinking questions, and learning strategies that emphasize reflection, evaluation, and continuous mathematical communication.

## SUGGESTION

Based on the research findings, mathematics teachers are advised to continuously integrate ethnomathematics approaches into their learning, particularly for abstract materials such as the Pythagorean Theorem. Teachers should also familiarize students with Higher Order Thinking Skills (HOTS)-based problems and encourage discussion, reflection, and oral and written explanations to further develop students' mathematical evaluation and argumentation skills.

Students are expected to be more active in understanding basic mathematical concepts and practicing explaining reasons and solving problems logically and systematically. Meanwhile, future researchers are advised to expand ethnomathematics studies to other mathematical materials or cultural contexts, and combine them with innovative learning models to gain a broader understanding of the development of students' critical mathematical thinking skills.

This completes the entire process required for widespread of research work on open front. Generally all International Journals are governed by an Intellectual body and they select the most suitable paper for publishing after a thorough analysis of submitted paper. Selected paper get published (online and printed) in their periodicals and get indexed by number of sources.

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