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ANALYSIS OF HIGH SCHOOL STUDENTS' CRITICAL THINKING SKILLS IN TRIGONOMETRY MATERIAL VIEWED FROM A MATHEMATICAL GROWTH MINDSET

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ABSTRACT. *This study aims to describe students' critical thinking skills in solving trigonometry problems in terms of their Mathematical Growth Mindset level. This study uses a descriptive qualitative approach with high school students from a school in Palembang as subjects. These students are classified into high, medium, and low growth mindset categories. Data were collected through questionnaires, context-based critical thinking tests on trigonometry, and in-depth interviews. Data analysis was conducted based on critical thinking ability indicators, namely interpretation, analysis, evaluation, and inference. The results showed that students with a high mathematical growth mindset were able to consistently meet all critical thinking indicators. Students with a moderate growth mindset were able to meet the indicators of interpretation, analysis, and inference, but were not yet optimal in the evaluation indicator because they still relied on intuitive reasoning and did not perform explicit mathematical checks. Meanwhile, students with a low growth mindset showed limitations in almost all critical thinking indicators. These findings indicate that Mathematical Growth Mindset plays an important role in the quality of students' critical thinking in trigonometry. Therefore, mathematics learning needs to be designed to foster a growth mindset in order to continuously improve students' critical thinking skills.*

Keywords*: critical thinking, mathematical growth mindset.*

ABSTRAK. Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir kritis siswa dalam menyelesaikan masalah trigonometri ditinjau dari tingkat Mathematical Growth Mindset. Penelitian ini menggunakan pendekatan kualitatif deskriptif dengan

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subjek siswa sekolah menengah atas yang ada di salah satu sekolah Palembang, siswa tersebut diklasifikasikan ke dalam kategori growth mindset tinggi, sedang, dan rendah. Data dikumpulkan melalui angket, tes berpikir kritis berbasis konteks trigonometri dan wawancara mendalam. Analisis data dilakukan berdasarkan indikator kemampuan berpikir kritis, yaitu interpretasi, analisis, evaluasi, dan inferensi. Hasil penelitian menunjukkan bahwa siswa dengan Mathematical Growth Mindset tinggi mampu memenuhi seluruh indikator berpikir kritis secara konsisten. Siswa dengan growth mindset sedang mampu memenuhi indikator interpretasi, analisis, dan inferensi, namun belum optimal pada indikator evaluasi karena masih mengandalkan penalaran intuitif dan belum melakukan pengecekan matematis secara eksplisit. Sementara itu, siswa dengan growth mindset rendah menunjukkan keterbatasan pada hampir seluruh indikator berpikir kritis. Temuan ini menunjukkan bahwa Mathematical Growth Mindset berperan penting dalam kualitas berpikir kritis siswa pada materi trigonometri. Oleh karena itu, pembelajaran matematika perlu dirancang untuk menumbuhkan growth mindset guna meningkatkan kemampuan berpikir kritis siswa secara berkelanjutan.

Kata Kunci: berpikir kritis, mathematical growth mindset.

1. INTRODUCTION

Critical thinking is a process aimed at helping and minimizing errors in making reasonable decisions (Sofiyati, 2022). Critical thinking skills are one of the high-level thinking skills that are very important in 21st-century learning (Gunartha, 2024). Critical thinking not only requires students to remember and understand concepts, but also to analyze information, evaluate arguments, and make logical and evidence-based decisions (Puling et al., 2024). In the context of education, this ability serves as an indicator that students are not merely performing procedures, but are capable of assessing the truth of a concept and using reasoning to solve problems independently (Situmorang & Laksono, 2025).

However, the reality is that the critical thinking skills of high school students in Indonesia are still considered low (Hulu et al, 2024). One of the main causes is the strong fixed mindset or fixed pattern of thinking within students (Sastradinata, 2023). Mathematical critical thinking skills have not been optimally empowered by teachers in schools, leading to negative impacts on students, such as difficulty in improving their learning outcomes (Aziz et al., 2022). Many students believe that mathematical ability is an innate talent and cannot be developed. Beliefs like "Math is difficult" or "I'm just not good at math" cause students to give up quickly when faced with abstract and challenging math problems. These negative beliefs reduce motivation, hinder effort, and make students reluctant to try deeper problem-solving

strategies (Abu & Susetyarini, 2025). As a result, higher-order thinking processes such as analyzing, connecting concepts, and making generalizations do not develop optimally (Winarso, 2014). Additionally, students also experience problems related to critical thinking skills in trigonometry material (Yulia & Ferdianto, 2023).

Trigonometry is one of the important topics in high school mathematics because it forms the foundation for learning calculus, physics, analytical geometry, and various real-world applications such as navigation, digital technology, and wave modeling (Dodi, 2025). According to NCTM (2020), trigonometry demands a high level of abstraction because students must understand the relationships between angles, side lengths, periodic functions, and representations on the unit circle. However, various studies show that trigonometry is one of the most challenging topics for students because many students find it difficult due to its complex concepts (Kasmawati & Mulbar, 2025), relationships between angles, and the application of trigonometric identities that require conceptual understanding, not just procedural (Dodi, 2025).

Students' difficulty in understanding this material impacts their weak ability to identify problems, provide logical reasoning, and make appropriate mathematical decisions (Hakiki et al., 2025). Sari & Widodo's (2021) research revealed that high school students tend to have difficulty understanding trigonometric identities and the application of tangent because learning still focuses on memorizing formulas. Additionally, learning trigonometry is often considered abstract and out of context, which affects students' motivation and interest in learning (Aulia et al., 2021). This aligns with the OECD's (2023) statement that mathematical material irrelevant to students' life contexts leads to low engagement and conceptual understanding. Therefore, improving critical thinking skills in trigonometry is an urgent need for students to be able to connect concepts with their application in various life and scientific contexts.

On the other hand, critical thinking ability is not only influenced by cognitive aspects, but also by affective aspects, one of which is the Mathematical Growth Mindset (Rohim, 2025). A growth mindset refers to the belief that mathematical abilities can develop thru effort, appropriate strategies, and perseverance (Akbar &

Hidayati, 2025). Students with a growth mindset are less likely to give up easily when facing difficulties, are more open to challenges, and are motivated to correct mistakes (Suniah & Mulyanti, 2025). Conversely, students with a fixed mindset are more likely to feel incapable and avoid problems they perceive as difficult (Putri, 2023). Therefore, a mathematical mindset has the potential to be an important factor influencing how students think critically, especially when facing challenging material like trigonometry (Sastradinata, 2023).

Trigonometry was selected as the focus of this study because it is one of the most important and challenging topics in secondary school mathematics. The researcher chose trigonometry as the focus of this study because it plays a fundamental role in supporting students' understanding of advanced mathematical topics, such as calculus, analytical geometry, and various real-world applications. Understanding trigonometry is essential because it connects algebraic, geometric, and graphical reasoning and supports students' learning of pre-calculus and calculus (Weber, 2005). Trigonometry requires students to understand abstract concepts, such as the relationships among angles, side lengths, trigonometric functions, and multiple mathematical representations. Solving trigonometric problems often involves analyzing information, evaluating mathematical relationships, and drawing logical conclusions, all of which are essential components of critical thinking skills.

Previous studies have also reported that many students experience difficulties in understanding trigonometric concepts, applying trigonometric identities, and connecting trigonometry to real-life situations (Kasmawati & Mulbar, 2025). These difficulties may hinder students' ability to engage in critical thinking when solving mathematical problems. Furthermore, previous studies have shown that students' critical thinking skills in solving trigonometric problems remain inadequate, particularly in the aspects of interpretation, analysis, inference, and evaluation (Ramadhan & Jatisunda, 2025). Therefore, trigonometry provides an appropriate context for investigating students' critical thinking skills and examining how these skills may differ according to variations in their mathematical growth mindset.

Several previous studies have investigated factors related to students' mathematical critical thinking skills. Sari, Destiniar, and Octaria (2022) examined high school students' critical thinking skills in trigonometry based on gender differences. Their findings revealed that female students demonstrated better critical thinking performance than male students, particularly in the indicators of analysis and inference. The study indicates that students' critical thinking skills in trigonometry vary according to individual characteristics. However, the study focused only on gender differences and did not examine psychological factors that may influence students' critical thinking processes.

Furthermore, Yudha, Pujawan, and Sugiarta (2022) analyzed students' critical thinking skills in relation to growth mindset, self-efficacy, and self-regulated learning using path analysis. The results showed that growth mindset contributes positively to the development of students' critical thinking skills, both directly and indirectly through other psychological variables. This finding suggests that students' beliefs about the developability of their abilities play an important role in fostering higher-order thinking skills. Nevertheless, the study investigated critical thinking in a general educational context and did not specifically explore mathematics learning or particular mathematical topics.

In addition, Yulia and Ferdianto (2023) analyzed students' mathematical critical thinking skills in trigonometry based on learning motivation. Their study found that students with higher learning motivation tended to demonstrate better performance in interpreting problems, analyzing information, evaluating solutions, and drawing conclusions. The findings emphasize the importance of affective factors in supporting students' critical thinking skills in trigonometry. However, the study focused on learning motivation and did not consider mathematical growth mindset as an influencing factor.

Based on these previous studies, it can be seen that research on critical thinking skills in trigonometry has been conducted from the perspectives of gender and learning motivation, while research on growth mindset has generally examined its relationship with critical thinking skills in broader educational contexts. However, studies that specifically analyze students' critical thinking skills in

trigonometry based on variations in mathematical growth mindset are still limited. Therefore, this study aims to fill this gap by providing an in-depth analysis of senior high school students' critical thinking skills in solving trigonometric problems according to their levels of mathematical growth mindset.

This study aims to analyze senior high school students' critical thinking skills in solving trigonometry problems based on variations in their levels of mathematical growth mindset. The results of this study are expected to provide a comprehensive description of students' abilities, serve as a reference for the development of instructional strategies, and assist teachers in designing interventions that not only enhance cognitive aspects but also foster a positive mindset toward learning mathematics.

2. METHODS

This research uses a descriptive qualitative approach because it aims to deeply describe and understand students' mathematical thinking abilities in trigonometry material based on their mathematical growth mindset category. A qualitative approach is suitable for exploring the processes, learning experiences, and mindsets of students within the natural context of mathematics learning. This aligns with Moleong's (2021) opinion that qualitative research is used to understand phenomena holistically in a natural context, utilizing the researcher as the key instrument. Additionally, this research is descriptive because it is focused on describing the conditions and findings of the study as they are, as explained by Sugiarto (2020) that descriptive research is used to systematically, factually, and accurately describe phenomena.

The subjects in this study were 15 tenth-grade students from a high school in Palembang, selected using the purposive sampling technique, which involves choosing subjects based on specific criteria. Samsu (2022) explains that purposive sampling is used when researchers need informants who are considered to know and understand the phenomenon being studied the most. Thus, the selected students are those who have studied trigonometry and represent high, medium, and low mindset categories based on the questionnaire results.

The research instruments consist of a mathematical growth mindset questionnaire, a mathematical thinking ability test, and a semi-structured interview guide. Data analysis techniques include three main steps: data reduction, data presentation, and drawing conclusions. Rahardjo (2021) explains that data reduction is done to select and focus on relevant data, data presentation is done to organize data in the form of narratives, tables, or diagrams so that it is easy to understand, while drawing conclusions is done continuously throughout the research process to find patterns, relationships, and meaning from the data. The validity of the data was obtained thru technique triangulation, which involves comparing data from questionnaires, tests, and interviews. Rukin (2020) states that triangulation is necessary to increase the credibility and trustworthiness of qualitative research findings.

Data analysis began by assessing the results of the students' test answers, which were then categorized into the Growth Mindset questionnaire results grouping, divided into three categories: high, medium, and low. Here is the categorization of score percentages.

Table 1. Category Percentage Questionnaire Score Result.

Percentage Score	Category
$75\% - 100\%$	High
$\leq 51\% - 75\%$	Medium
$\leq 50\%$	Low

After the values were categorized, 6 students were selected as a sample to be examined based on critical thinking ability indicators. The critical thinking ability indicators used in this study are as follows, according to Hesti et al. (2021):

Table 2. Critical Thinking Skills Indicators

Indicator	Description
Interpretation	Understanding the problem by accurately writing down what is known and what is being asked in the question.
Analysis	Identifying the relationships between the statements, concepts, and questions provided in the problem, as indicated by accurately creating a mathematical model and providing appropriate explanations.
Evaluation	Using the right strategy to solve the problem, and being complete and correct in the calculations.
Inference	Drawing conclusions accurately according to the context of the problem.

3. RESULTS AND DISCUSSION

A growth mindset is the belief that a person's abilities, including mathematical abilities, can be developed through effort, appropriate strategies, and continuous learning experiences. Unlike a fixed mindset, which considers intelligence to be innate and static, a growth mindset encourages students to view mistakes as part of the learning process, challenges as opportunities for growth, and failures as feedback for improvement.

In the context of mathematics, especially trigonometry, a mathematical growth mindset plays an important role because this subject requires an understanding of concepts, reasoning, and flexibility of thought, not just memorization of formulas. Students with a growth mindset tend not to give up easily when faced with complex trigonometry problems, try various strategies, and reflect on the mistakes they make. This attitude is closely related to the development of critical thinking skills, which include the ability to analyze, evaluate, and conclude logically.

Based on the results of data analysis, students can be grouped into three categories of mathematical growth mindset, namely high, medium, and low. The differences in growth mindset levels show clear variations in students' critical thinking skills in solving trigonometry problems. The results of the student questionnaire are as follows.

Table 3. Table of Growth Mindset Categories

Percentage Score	Category	Amount
$75\% - 100\%$	High	10
$\leq 51\% - 75\%$	Medium	4
$\leq 50\%$	Low	1

The results of the mathematical growth mindset questionnaire analysis show that students have varying degrees of growth mindset. Most students fall into the high growth mindset category, which is characterized by a willingness to try various strategies in solving math problems, not giving up easily when faced with difficulties, and being able to accept and utilize feedback from teachers and peers. Meanwhile, students with a low growth mindset tend to give up quickly, avoid math

problems that are considered difficult, and view mistakes as an indicator of inability to learn mathematics.

These variations in mathematical growth mindset levels form the basis for further analysis of students' critical thinking skills in trigonometry. This analysis aims to examine the extent to which variations in mathematical growth mindset levels affect students' ability to understand, analyze, evaluate, and draw conclusions in solving trigonometry problems.

3.1 Students with a High Mathematical Growth Mindset

Students with a high level of Mathematical Growth Mindset show a very positive attitude toward learning mathematics. They believe that mathematical ability can be improved through effort and practice, and they continue to try when facing difficult problems. Students in this category do not give up easily and view difficulties as part of the learning process. The students' responses illustrate how they answered the given trigonometry problems.

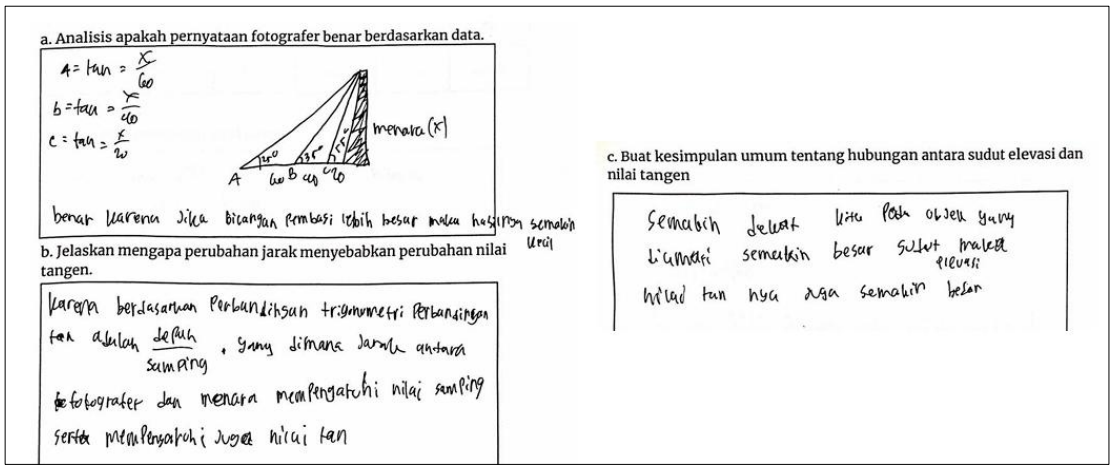

Figure 1. Student responses: High Mathematical Growth Mindset.

Interpretation

At the interpretation stage, the students' responses demonstrate a deep conceptual understanding of the given contextual problem. The students can identify important information in the problem, such as the observer's distance, the height of the tower, and the angle of elevation, and then accurately model the situation in the form of a right triangle. The situation is represented through trigonometric ratios using the tangent function, namely

$$\tan\ \theta = \frac{\text{opposite side}}{\text{adjacent side}}.$$

Specifically in Question b, the students not only understand the formula procedurally but also successfully interpret the horizontal distance as a mathematical variable representing the adjacent side. This accuracy in linking real-world context to the components of the trigonometric formula indicates that the students have strongly met the interpretation indicator, providing a solid foundation for proceeding to the subsequent stage of mathematical analysis.

Analysis

The quality of analysis demonstrated by the students is at a high level, as indicated using formal quantitative evidence in explaining the relationships among variables. In Question a, the students explicitly present three comparison cases, namely $A = \frac{X}{60}$, $B = \frac{X}{40}$, and $C = \frac{X}{20}$, and analyze that the relationship between distance and the angle of elevation is inversely proportional. The students explain that when the denominator (distance) increases, the value of the ratio (the tangent value or the magnitude of the angle) decreases, in accordance with algebraic principles. Furthermore, in Question b, the students analyse changes in the tangent value by directly referring to the definition of trigonometric ratios, namely that changes in horizontal distance represent changes in the adjacent side, which directly affect the value of the tangent. This analysis demonstrates the students' ability to systematically relate changes in variables based on relevant mathematical concepts, rather than relying solely on intuitive observations.

Evaluation

The students' evaluation ability is categorized as very strong because it is based on credible and objective mathematical principles. In Question a, the students evaluate the correctness of the photographer's statement by using algebraic principles and fraction comparisons as standards for argument validity. This approach indicates that the students do not merely evaluate qualitatively but employ formal mathematical reasoning to determine the truth of a statement. In Question b, the evaluation is conducted by referring to the fundamental definition of the tangent function, namely the ratio of the opposite side to the adjacent side, rather than

relying solely on logical consequences such as changes in the angle. This strategic choice to use mathematical definitions as the basis for evaluation reflects the maturity of the students' critical thinking in assessing the strength and validity of an argument.

Inference

The students can draw logical, consistent, and comprehensive inferences across all parts of the problem. In Questions a and b, conclusions are drawn as direct consequences of evidence in the form of formulas and definitions of trigonometric ratios that have been analysed previously. The peak of inferential ability is evident in Question c, where the students present a synthesized inference that integrates the results of the analyses in Questions a and b, stating that *"semakin dekat jarak pengamat ke objek, semakin besar sudut elevasi, dan nilai tangennya juga semakin besar."* This inference summarizes the functional relationship among distance, angle, and tangent value in a coherent manner and demonstrates an understanding that the relationship between the angle of elevation and the tangent value is direct (monotonically increasing). Such a conclusion reflects the students' ability to perform mathematical generalization based on the entire analytical process undertaken.

The students' responses based on the indicators of critical thinking skills are reinforced by the interview results.

Teacher	:	Why did you draw a triangle in this problem?
Student	:	Because problems involving angles of elevation and towers can be modelled using a right triangle, which makes it easier to determine the tangent value.
Teacher	:	In your opinion, does the observer's distance affect the angle of elevation?
Student	:	Yes. When the distance is closer, the angle becomes larger, so the tangent value also changes.
Teacher	:	How did you determine that the photographer's statement was correct?
Student	:	I looked at the comparison between the height of the tower and the observer's distance. If the distance changes, the ratio also changes, so the statement makes sense.
Teacher	:	What conclusion can you draw from this problem?

Student : The conclusion is that the closer the observer is to the object, the larger the angle of elevation and the greater the tangent value.

Based on the four indicators, the students demonstrate good critical thinking skills, as they can understand the problem, analyze relationships among concepts, evaluate statements based on mathematical reasoning, and draw appropriate conclusions.

3.2 Students with a Medium Mathematical Growth Mindset

Students with a Mathematical Growth Mindset are showing a positive attitude toward learning mathematics, but are not yet fully consistent in facing challenges. Students in this category generally believe that mathematical ability can be improved through effort and practice, but this belief is still easily shaken when faced with problems that are considered difficult or unfamiliar.

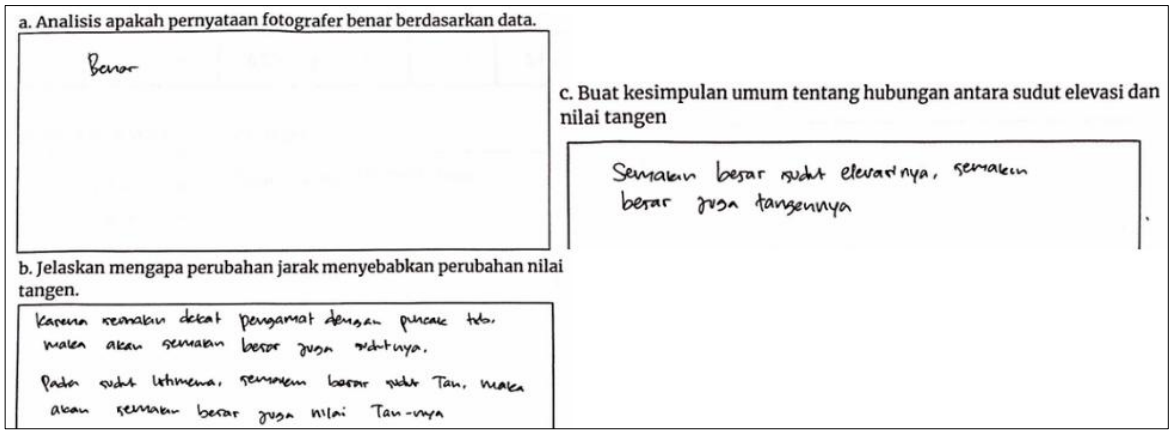

Figure 2. Student responses: Medium Mathematical Growth Mindset.

Interpretation

At the interpretation stage, students can understand the context of the problem given. This can be seen from the students' answers in part (a), which state that the photographer's statement is correct. Students can grasp the meaning of the real situation, namely the relationship between the distance to the tower, the angle of elevation, and the tangent value. Students also understand that the data in the table shows a pattern: the closer the distance, the greater the angle of elevation. This indicates that students can identify important information and the purpose of the question quite well. However, students' interpretations are still general and are not

accompanied by mathematical representations (for example, directly relating to the side ratio in a right triangle). This can be seen from the following interview.

Teacher : In part (a), you wrote that the photographer's statement is correct. Can you explain your reasoning?

Student : I think that's correct, because the table shows that the angle is getting bigger.

Teacher : Why does a larger angle make the photographer's statement true?

Student : Because if the distance gets closer, the angle will increase.

Teacher : Did you relate your answer to the tangent value?

Student : Not really, I'm just looking at it from his perspective.

Teacher : So, when you answered "correct," you hadn't thought about the relationship between the angle and the tangent value in detail?

Student : Yes, I haven't thought that far ahead.

Students recognize patterns visually, but are not yet able to articulate mathematical reasons and have not linked their answers to the formal concept of tangents. This indicates that initial interpretation exists, but critical reasoning is not yet fully developed, in line with a medium level of Mathematical Growth Mindset.

Analysis

In the analysis indicator, students begin to connect the concepts of distance, angle, and tangent value. In part (b), students explain that the closer the observer is to the top of the tower, the greater the angle of elevation and the greater the tangent value. This shows that students can relate changes in one variable (distance) to changes in other variables (angle and tangent value) and are also able to use logical cause-and-effect reasoning. However, students' analysis is still descriptive and intuitive and does not fully use the formal definition of tangent as the ratio of the front side to the side.

Evaluation

On the evaluation indicator, students have not demonstrated strong abilities. Students accept the photographer's statement as true without explicitly comparing the tangent values of angles 25°, 35°, and 55°, and without providing comparative arguments or alternative checks (e.g., using the properties of the tangent function graph in quadrant I). This indicates that students have not yet fully evaluated the accuracy of arguments critically, but still rely on intuitive logic and everyday experience. This can be seen from the following interview.

Teacher	:	In your opinion, is the photographer's statement in the previous question correct?
Student	:	Yes, I think that's right.
Teacher	:	Can you explain the reason?
Student	:	Because as we get closer to the tower, the angle becomes larger, so the tangent also becomes larger.
Teacher	:	Have you ever compared the tangent values of angles 25°, 35°, and 55° directly?
Student	:	I'm not comparing their values one by one, ma'am. I'm just seeing that the angle is getting bigger.
Teacher	:	If, for example, we check the graph of the tangent function in quadrant I, have you considered that?
Student	:	Not yet, ma'am. I haven't thought about looking at the graph. I just concluded from the size of the angle.
Teacher	:	Do you think there is a possibility that the photographer's statement is wrong?
Student	:	It seems unlikely, because from everyday experience, if the angle increases, it seems that the tangent also increases.
Teacher	:	So, your conclusion is based more on everyday logic than mathematical verification?
Student	:	Yes, ma'am. I haven't checked using other mathematical methods.

The dialogue above shows that students only accept arguments without evaluating alternatives, do not explicitly compare tangent values, and do not use graphs or formal definitions of tangents as evaluation tools. Students also still rely on intuition and contextual experience, which are characteristics of a growth mindset in evaluation indicators.

Inference

On the inference indicator, students were able to draw a general conclusion in part (c), namely: “Semakin besar sudut elevasinya, semakin besar juga tangennya.” This conclusion is in line with the concept of trigonometry in quadrant I and shows that students can generalize patterns from several data points and accurately conclude the relationship between variables. However, the conclusion is not accompanied by any conditions (e.g., only applicable in quadrant I), so the inference is still simple.

Students with a mathematical growth mindset demonstrate good critical thinking skills in interpretation, analysis, and inference, but are still weak in evaluation.

3.3 Students with a Low Mathematical Growth Mindset

Students with a Low Mathematical Growth Mindset are not yet able to demonstrate several indicators of critical thinking ability. They are not yet able to analyze and perform formal calculations correctly. They also don't yet fully understand how to construct sentences based on their understanding of the relationship between changes in angle and changes in the tangent value. Here are the answers from students with a Low Mathematical Growth Mindset.

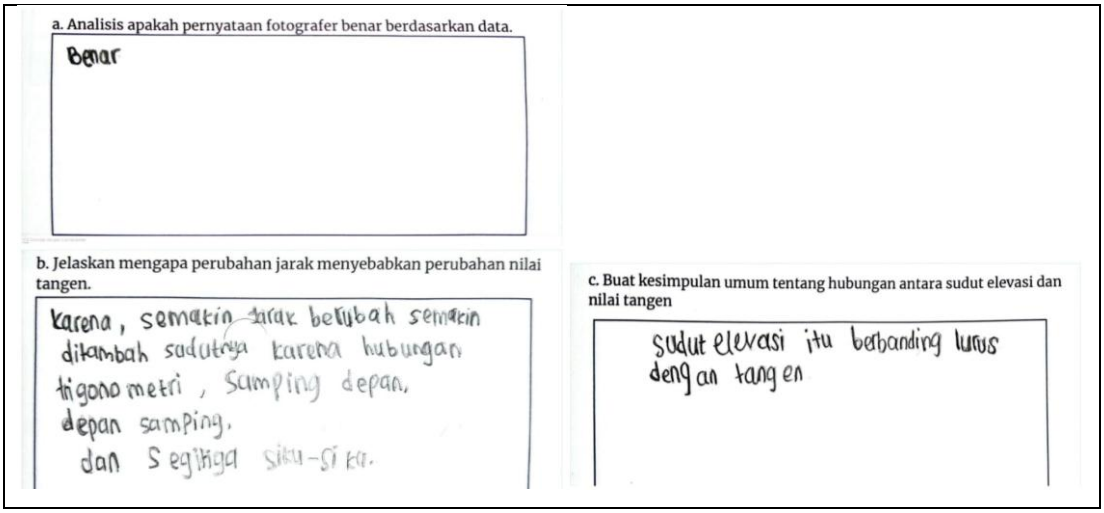

Figure 3. Student responses: Low Mathematical Growth Mindset.

Interpretation

At the interpretation stage, the student answers did not yet demonstrate the interpretation indicators. This can be seen in Figure 3 student did not write down what was known or what was asked. Student only wrote the answers without any explanation of why they answered that way.

Analysis

At the analysis stage, the student demonstrated the ability to analyze the relationship between changes in distance and changes in the tangent value, but from the written answers, the student was not yet able to use the correct words to explain what was meant. The student also did not perform the analysis using an explicit formula $an\theta = \frac{opposite\ side}{adjacent\ side}$.

Evaluation

At the evaluation stage, student answers indicate that they have not yet been able to demonstrate the evaluation indicators. This is because students have not used the appropriate strategy to solve the problem regarding the relationship between changes in distance and changes in the tangent value. Student only explained their reasoning without explicit calculations to support those reasons.

Inference

At the inference stage, student answers indicate that they can demonstrate inference indicators. Student can draw conclusions from what they have worked on. Student wrote that the angle of elevation is directly proportional to the tangent, meaning that the larger the angle of elevation, the larger the value of its tangent. Therefore, student wrote this as "directly proportional." This can be seen from the following interview

Teacher : In part (a) of the question, why did you answer correctly?

Student : Because I see from the table in the question that the closer the photographer is to the tower, the greater the angle of elevation.

Teacher : Did you just look at the table, or did you do any formal calculations?

Student : Yes, ma'am, I only looked at the table. If there's any formal calculation, I don't understand it, ma'am.

Teacher : In question (b), what do you mean by the trigonometric relationships of opposite/adjacent, adjacent/opposite, and right-

Student : angled triangle that you wrote?

What I mean is, as far as I remember, in a right-angled triangle there are values for sine, cosine, and tangent. The tangent value represents the opposite side and the adjacent side of a right-angled triangle. Therefore, I wrote down the trigonometric relationships for adjacent

Teacher : over opposite, opposite over adjacent, and a right-angled triangle.

Student : In question (c), what is the meaning of the conclusion you wrote?

The angle of elevation is directly proportional to the tangent, which means that as the value of the angle of elevation increases, the value

Teacher : of its tangent also increases, ma'am. That's why I wrote it as directly proportional.

Student : Why don't you write it like that so it's easy to understand, instead of having to write it in a directly proportional sentence?
At that time, the only phrase that came to mind was "directly proportional," because I was in a hurry to finish the problem.

Based on the interview results, students with a Low Mathematical Growth Mindset are not yet able to demonstrate the four indicators of critical thinking ability because they are not yet able to interpret, analyze, evaluate, and draw conclusions well and correctly.

The results of the study show that students' critical thinking skills in solving trigonometry problems are greatly influenced by their level of Mathematical Growth Mindset. This difference is clearly evident in each critical thinking indicator, namely interpretation, analysis, evaluation, and inference. These findings confirm that critical thinking does not only depend on mastery of cognitive concepts, but is also influenced by students' beliefs about their own mathematical abilities.

Students with a high Mathematical Growth Mindset demonstrate the most complete and consistent critical thinking skills. At the interpretation stage, students can identify important information from contextual problems and represent it in appropriate mathematical models. This ability provides a strong foundation for the analysis stage, where students explicitly relate changes in distance, elevation angle, and trigonometric ratio values using the formal definition of the tangent function. In the evaluation indicator, students do not accept the statements in the questions directly, but examine them through ratio comparisons and relevant mathematical principles. This shows that students have been able to critically evaluate arguments based on mathematical evidence, not just intuition. This finding is in line with the opinion of Hannan, et al (2025), who stated that students with a high growth mindset tend to use reflective and concept-based strategies in solving complex problems.

In contrast to the previous group, students with a moderate level of Mathematical Growth Mindset demonstrated good critical thinking skills in the

indicators of interpretation, analysis, and inference, but remained weak in the evaluation indicator. The students were able to identify patterns in the relationship between angle measures and the values of the tangent function and to draw a general conclusion that the value of the tangent increases as the angle increases in the first quadrant. However, the students did not fully evaluate the mathematical validity of the statement. They tended to accept the argument as true without conducting further verification, such as explicitly comparing the tangent values at angles of 25°, 35°, and 55°, or using alternative representations, such as the graph of the tangent function, as a means of validation.

In fact, evaluation in critical thinking requires the ability to assess the validity of a statement based on mathematical evidence, alternative representations, and systematic reasoning procedures, rather than relying solely on intuition or initial experiences (OECD, 2019). This condition indicates that students' evaluation processes are still dominated by intuitive reasoning and have not yet fully developed toward formal mathematical reasoning. Furthermore, although students with a growth mindset believe that mathematical abilities can be developed through effort and appropriate learning strategies, research has shown that growth mindset alone is not sufficient to produce strong evaluative skills without explicit instructional support and scaffolding (Yeager et al., 2019; Sisk et al., 2018). Therefore, students still require pedagogical support that emphasizes the systematic and evidence-based evaluation of mathematical arguments.

Meanwhile, students with a low Mathematical Growth Mindset show limitations in almost all critical thinking indicators. Students are not yet able to interpret problems completely, do not construct clear mathematical models, and do not use formal definitions of trigonometric ratios in the analysis and evaluation process. However, students are still able to draw simple conclusions based on observed patterns, even without a strong basis for calculation. This shows that the inferences made are superficial and not supported by a complete critical thinking process. These findings reinforce Hasanah & Idris (2025), opinion that students with a low mindset tend to avoid analytical strategies and feel unable to use formal mathematical approaches. Overall, the results of this study show a strong qualitative

correlation between Mathematical Growth Mindset and the quality of students' critical thinking in trigonometry. The higher the level of students' growth mindset, the completer and more in-depth the critical thinking process shown. This finding expands on previous research results which stated that growth mindset influences problem solving Yunus & Nasiruddin (2022) and mathematical connections Yulianti (2024) by emphasizing that growth mindset also plays an important role in evaluation and critical reasoning abilities in abstract trigonometry material.

The implication of this study is that mathematics teachers need to not only focus on mastery of trigonometry concepts and procedures, but also consciously foster a Mathematical Growth Mindset through learning that emphasizes the thinking process, provides constructive feedback, and uses contextual questions that require analysis and evaluation. Thus, the development of students' critical thinking skills can take place more optimally and sustainably.

4. CONCLUTION AND SUGGESTIONS

This study concludes that a mathematical growth mindset plays an important role in shaping the quality of students' critical thinking skills in trigonometry. Differences in growth mindset levels result in clear differences in students' abilities to interpret problems, analyze relationships between concepts, evaluate mathematical arguments, and draw logical inferences.

Students with a high Mathematical Growth Mindset demonstrate the most optimal critical thinking skills, characterized by a good understanding of the context of the problem, the use of formal trigonometric definitions and concepts, the ability to evaluate the truth of statements through proof or alternative checks, and drawing conclusions supported by strong mathematical arguments. Conversely, students with a moderate Mathematical Growth Mindset are able to interpret, analyze, and infer quite well, but still show weaknesses in evaluation, as they tend to accept arguments intuitively without in-depth mathematical comparison or verification. Students with a low Mathematical Growth Mindset show limitations in almost all indicators of critical thinking, particularly in the use of formal concepts and reasoning. These findings confirm that the development of critical thinking skills cannot be separated from efforts to foster students' Mathematical Growth Mindset.

Therefore, trigonometry learning needs to be designed not only to master concepts and procedures, but also to encourage reflection, evaluation of arguments, and students' courage in exploring solution strategies. With the right learning approach, students' Mathematical Growth Mindset can be improved, thereby positively impacting the strengthening of critical thinking skills in mathematics.

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