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Students' Pseudo-Thinking in Solving the Area of Obtuse Triangles: A Mindset-Based Perspective

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Abstract

The research aims to describe the different characteristics of students' pseudo-thinking in solving areas of obtuse triangles based on their mindset. The categorization of pseudo-thinking is based on the Vinner and Subanji frameworks, while the mindset is categorized according to the Dweck framework. The research was conducted in one of the Junior High Schools in the Kebumen district with 111 students. The study employs a qualitative, grounded theory design. Data were collected through the math test, the mindset questionnaire, and the interview. The data were analyzed using a process that consists of open, axial, and selective coding to identify patterns of reasoning among students. The study found that students with a growth mindset exhibit both true and false pseudo-thinking, whereas students with a fixed mindset exhibit only true pseudo-thinking. Students with a growth mindset tend to engage in pseudo-thinking by misapplying the Pythagorean Theorem. On the other hand, fixed-mindset students often perform pseudo-thinking by using the incorrect formula. GMS is often overconfident in its old knowledge, leading to incorrect decisions, while FMS tends to focus solely on memorizing formulas and settings without reflection. This study is significant because it highlights how students' mindsets influence their problem-solving abilities, particularly in geometric problems. Educators can use the insight gained from the study to develop effective learning strategies and help students grasp mathematics more deeply.

Keywords: Pseudo-thinking, Geometry, Pythagorean, Growth Mindset, Fixed Mindset

Introduction

Understanding how students think when solving mathematical problems is crucial. A phenomenon that gets more attention in this context is pseudo-thinking. Many main theories underpin the concept of pseudo-thinking, such as (Vinner, 1997) and Subanji & Nusantara (2016). According to Vinner (1997), pseudo-thinking occurs when there is a gap between the student's concept image and the concept definition. The gap is referred to as a pseudo-process involving both pseudo in concept and analysis. For example, when a student does not fully absorb new ideas to think about, leading them to assemble incomplete substructures based on their old cognitive schemes, which can also create cognitive disequilibrium (Nizaruddin & Kusmaryono, 2023). Based on Piaget's theories of assimilation and accommodation, pseudo-thinking can be interpreted as an inadequate assimilation, leading to errors in problem-solving (Nizaruddin & Kusmaryono, 2023).

Ultimately, students' thinking conditions will be reflected in their correct or incorrect answers. This condition is further elaborated and divided into two, namely true pseudo-thinking and false pseudo-thinking (Subanji, 2021; Subanji & Nusantara, 2016). True pseudo-thinking occurs when a student provides a correct answer, but the reasoning process is not entirely logical or meaningful. For example, students can apply a formula without understanding why it is necessary, leading to correct answers for the wrong reasons (Muslim et al., 2021). Meanwhile, false pseudo-thinking occurs when a student answers incorrectly but can reflect on their answer, with or without assistance, so that they can improve it (Anggraini et al., 2018a; Subanji & Nusantara, 2016). Teachers need to understand the fundamental differences between these two pseudo-concepts, as they can serve as a source for identifying students' mistakes and determining the appropriate actions (Adhitya & Prabawanto, 2019).

Research on pseudo-thinking has been widely conducted, particularly in the field of mathematics. The topic often studied is a specific subject, such as number operations. (Adhitya & Prabawanto, 2019; Setyaningrum et al., 2024), a system of two linear equations system (Syahraini et al., 2023), geometry (Sulistyorini, 2018), exponential equations (Muslim et al., 2021). Besides the topic, pseudo-thinking studies are also used to examine mathematical abilities, such as mathematical logic (Cahdriyana et al., 2019), mathematical reasoning (Adhitya & Prabawanto, 2019), mathematical connections (Lesmana et al., 2022) and mathematical problem solving (Nizaruddin & Kusmaryono, 2023).

From the various studies above, geometry emerges as an intriguing area of study. This is because geometry is a topic that many students struggle with, and it often encourages pseudo-thinking (Lesmana et al., 2022; Taamneh et al., 2024). This tendency is evident when students struggle to mentally manipulate shapes or visualize how changes in one aspect of a triangle impact its properties, leading to misconceptions that reflect pseudo-thinking (Subanji & Nusantara, 2016). Although several studies have examined pseudo-thinking within the context of geometry, they are limited to real or complex problems, leaving simpler problems that have yet to be explored. For example, the obtuse triangle is unique among other triangles, making it more challenging (Simon et al., 2021). Students often fail to recognize them correctly (Casanova et al., 2021). Students also struggle to define angles and triangles correctly, often failing to interpret concept images and reasoning. It is not good because it could hinder their understanding of more advanced geometric principles during later stages (Ximena Díaz Pinzón & Enrique González, 2025).

The lack of students' ability that makes pseudo-thinking is often related to psychological aspects, one of which is mindset. This is because a positive mindset can either enhance or hinder their performance in mathematical tasks (Repuya & Esterninos, 2022). Much research emphasizes the close link between students' achievement in mathematics and their cognitive processes (Boaler, 2021, 2022; Daly et al., 2019; Degol et al., 2018; Maskar, 2023; Samuel & Warner, 2021). Mindsets are categorized into two types: a growth mindset and a fixed mindset (Dweck, 2006). A growth mindset views challenges as opportunities for learning, whereas a fixed mindset may perceive them as impossible barriers (Guttin et al., 2022; Huffman et al., 2021). Students who believe in their abilities will perform better academically and persist in the face of challenges (Limeri et al., 2020).

Previous studies on pseudo-thinking and mindset have been conducted separately, providing insights into students' thinking skills and learning behaviors. However, research that combines both perspectives remains scarce. This study also emphasizes geometry, a topic that is still underexplored. The combination is essential because mindset affects students' willingness to correct their mistakes, while pseudo-thinking reflects the cognitive expression of misconceptions during problem-solving. Investigating their interaction offers a deeper understanding of how students reason errors and why they continue to make them. Therefore, this research makes a valuable contribution by connecting these two theoretical areas to improve teaching methods and foster genuine mathematical understanding.

Methods

Research Design

The study aims to describe the different characteristics of students' pseudo-thinking in solving areas of obtuse triangles based on their mindset. To explain these aims, this study used two research questions.

1. What kind of pseudo-thinking do students use when solving the problem of the obtuse triangle area from each type of mindset?
2. What are the characteristics of pseudo-thinking that students use to solve the problem of the obtuse triangle area from each type of mindset?

Due to the aims, this study employs a qualitative method with a grounded theory design. Grounded theory is a qualitative research procedure that systematically produces a theory explaining an educational event or interaction at a particular time (Creswell & Cresswell, 2018). The choice of grounded theory is due to the relationship between pseudo-thinking and mindset remaining underexplored, necessitating an inductive approach to develop a conceptual understanding based on empirical data. Grounded theory enables patterns and relationships to emerge naturally through systematic coding (open, axial, and selective), making it well-suited to reveal how students' cognitive processes and mindsets interact in shaping pseudo-thinking during mathematical problem-solving (Creswell & Cresswell, 2018; Gupta & Malodia, 2023).

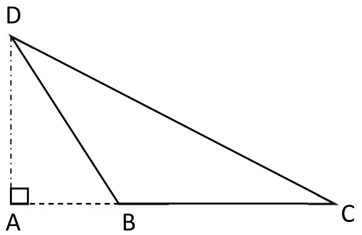
Participant

The subjects are 111 ninth-grade students (around 14-15 years old) from the same school, which is one of the public junior high schools in Kebumen Regency, Central Java, located in a rural area. The subjects were chosen from four different classes, with 29 students, 31 students, 31 students, and 20 students, respectively. Since this study does not focus on gender, gender information is not included. The students were selected based on the assumption that they were familiar with the material, having studied it in the previous grade. Besides the main participants, this study also included additional participants chosen from the main group for the in-depth interview stage. The procedures and selection criteria are explained in detail in the data analysis section.

Data Collection

Data was collected through a mindset questionnaire, mathematics tests, and interview guidelines. The mindset questionnaire was adapted from the Dweck Mindset Questionnaire to categorize students into either a growth or fixed mindset. The questionnaire has 15 statements representing four aspects: 1) beliefs in recognizing intelligence, talents, and personalities; 2) beliefs in challenges, difficulties, and failures; 3) beliefs about the impact of effort on self-development; and 4) confidence in criticism and feedback from others (Dweck, 2006).

The second tool is a mathematics test that involves calculating the area of an obtuse triangle, as shown in Figure 1 below.



Area $\Delta\boldsymbol{DBC}$ is $\mathbf{16\ cm^2}$. If $\overline{\boldsymbol{BC}} = \mathbf{8}\ \boldsymbol{cm}$ and $\overline{\boldsymbol{AB}} = \mathbf{3}$ cm, determine the area of $\Delta\boldsymbol{DAB}$!

Figure 1. The Problem in Solving the Area of an Obtuse Triangle

Based on the problem, the researcher developed a concept definition, known as Hypothetical Student Thinking (HST), to address it. The HST is illustrated in Figure 2 below.

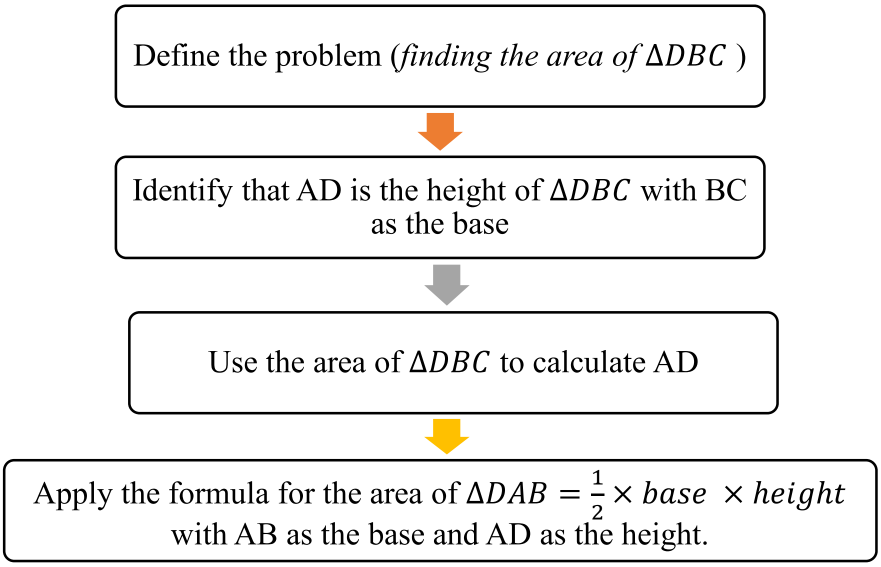


Figure 2. Hypothetical Student Thinking

Data Analysis

First, the researcher categorized the participants into two categories based on their mindset. For each mindset, a separate analysis process was conducted. The pseudo-thinking categories from the combination of the Vinner and Subanji & Nusantara frameworks are used to determine whether there is a mistake in thinking (Subanji & Nusantara, 2016; Vinner, 1997). Framework Vinner emphasizes the pseudo process, while Subanji focuses on the pseudo aspect of the final result. In this study, the outcome serves as the primary comparison, but it will be further explored through the thought process to illustrate the student's thinking categories, as shown in Table 1.

Table 1
The Condition of Student Thinking

Condition	Description
Fully True (FT)	Students can answer correctly and for the right reasons.
True Pseudo (TP)	Students can give/guess the answer correctly, but they cannot explain it.
False Pseudo (FP)	Students answer incorrectly, but the process is carried out according to the concept and procedure, allowing for correction of the answer.
Fully False (FF)	Students answer, and their reason is wrong, or they do not answer.

The research only used data from true pseudo-thinking and false pseudo-thinking conditions. Other thinking conditions were excluded because their answers and processes are already straightforward, correct, or incorrect, and do not involve pseudo-thinking. Then, pseudo-thinking data was analyzed in three phases: open, axial, and selective coding. In the first phase, open coding, researchers created an initial category of observed phenomena, focusing on the possibility of thinking errors in pseudo-thinking. In the axial coding stage, codes that had conceptual similarities regarding errors were grouped into the same category. Selective coding involved choosing categories formed in axial coding based on the type of pseudo-thinking that emerged. Finally, the entire analysis process was summarized in a table and triangulated by confirming data from interviews to define the characteristics of pseudo-thinking coding (Creswell & Cresswell, 2018; Gupta & Malodia, 2023). In the confirmation part of selective coding, one participant from each category was chosen to represent that category based on the completeness and clarity of their response process, which was used as interview informants. The entire data analysis flow is illustrated in Figure 3.

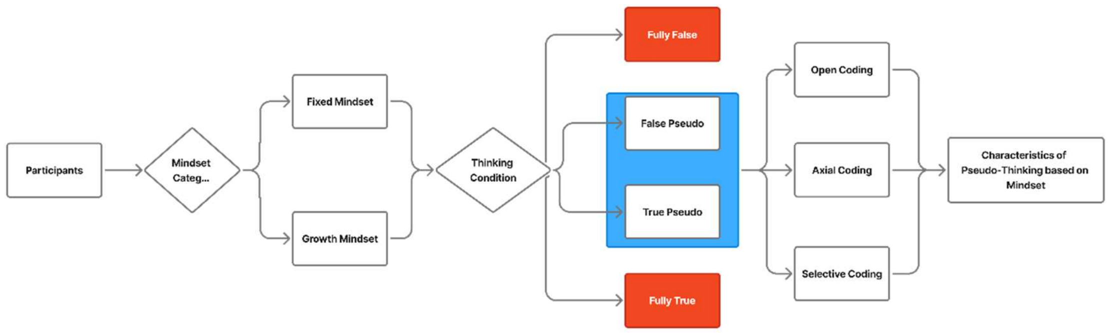


Figure 3. Data Analysis Flowchart

Results and Discussion

This section presents the results of the mindset questionnaire, the conditions of student thinking in solving areas of obtuse triangles, and the characteristics of pseudo-thinking based on their mindset. Based on the data analysis, the obtained data is as follows.

Student's Mindset

According to the mindset questionnaire, most ninth-grade students possess a growth mindset (see Figure 4). This is evidenced by 94 pupils (84.68%) having this optimistic view towards efforts and achievements in mathematics. The number of respondents who viewed their mathematical abilities as improvable through continuous engagement is striking. However, 17 students (15.32%) still held a fixed mindset, believing that mathematical talent is genetic and cannot be changed. These findings align with previous research that indicates variations in mathematical abilities are more likely connected to behavioral and cognitive factors related to mindset, rather than innate or genetic influences (Purbaningrum et al., 2023; Saefudin, 2023).

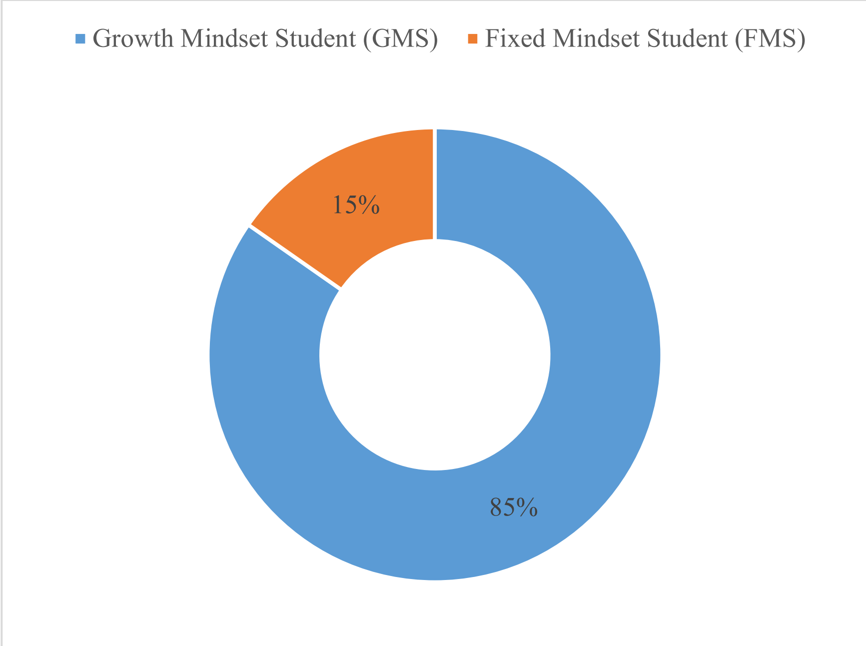


Figure 4. Student's Mindset

RQ1: What kind of pseudo-thinking do students use when solving the problem of the obtuse triangle area from each type of mindset?

To answer RQ1, subjects were identified by their mindset and categorized based on their work with the obtuse triangle. Their results were verified based on the categories of their thinking, as shown in Table 1. The focus was on differences in results and work processes, including correct answers with incorrect processes, and incorrect answers with potential for improvement due to an understanding that could be refined. The results are presented in Table 2.

Table 2

The Condition of Students' Thinking

Type of Mindset	Non-Pseudo-Thinking		Totals Non-selected Participant	Pseudo-thinking		Totals Selected Participant
	Fully True	Fully False		True Pseudo	False Pseudo	
GMS	12	18	30	25	39	64
FMS	5	6	11	6	0	6
Totals			41			70

Based on Table 2, the research involves 70 students, comprising 64 GMS and 6 FMS, who exhibit pseudo-thinking. For RQ1, we found that GMS engaged in both true pseudo-thinking and false pseudo-thinking, whereas FMS engaged only in true pseudo-thinking. This happens because a growth mindset person is likely to explore and test various hypotheses, sometimes leading to incorrect conclusions (Fukui et al., 2024). Meanwhile, a fixed mindset person clings to incorrect beliefs without exploring alternative solutions, so FMS makes true pseudo (Adhitya & Prabawanto, 2019).

RQ 2: What are the characteristics of pseudo-thinking that students use to solve the problem of the obtuse triangle area from each type of mindset?

There are three coding themes: true pseudo-thinking in GMS, false pseudo-thinking in GMS, and true pseudo-thinking in FMS. To answer RQ2, all themes were analyzed using the grounded theory phase to create codes that represent the characteristics of each theme. The pseudo-thinking analysis process, from open to selective coding, was carried out by assigning codes to the data. The following table presents the obtained codes.

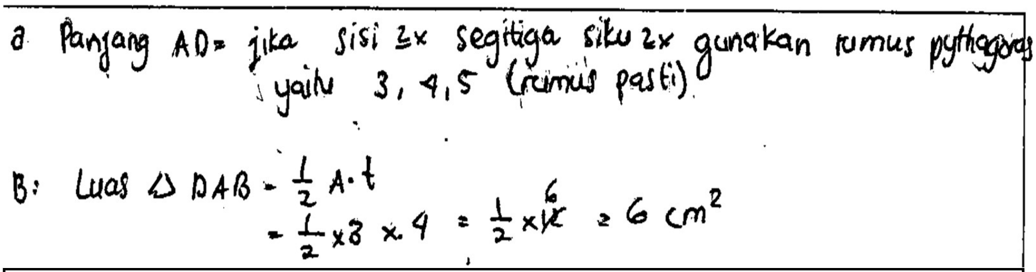
Table 3
Code of Pseudo-Thinking

Type of Error	*Code*	*Type of Mindset*		*Pseudo*
		GMS	*FMS*	
Performing calculations less logically on your own	Calculation	0	6	*True Pseudo*
Using the Pythagorean triple	Triples	28	0	
Performing calculations using Pythagoras' theorem	Pythagorean	36	0	*False Pseudo*

Table 3 lists three codes: calculation, triples, and Pythagorean. Below is a detailed analysis of each code.

True Pseudo-Thinking in GMS

After analyzing the results of GMS's work, the researcher identified a code named 'triples' that represents GMS using Pythagorean triples. The following are the results of GMS's work, which are indicated as True Pseudo-Thinking Errors.



Translation

A. Length AD
   In the right triangles, we can use the Pythagorean theorem so the sides are 3, 4, and 5 (exact formula)
B. Area of $\Delta DAB = 6\ cm^2$

Figure 5. True Pseudo in GMS

Figure 5 shows that GMS has solved the problem correctly; however, there is an error in determining the AD length. Regarding HST, GSM makes an error in the third step (see Figure 6). Based on HST, GSM already understands that AD is the height of a triangle. However, GSM does not use information from the area ∆DBC to determine the height. GMS writes that AD is obtained from the Pythagorean triple.

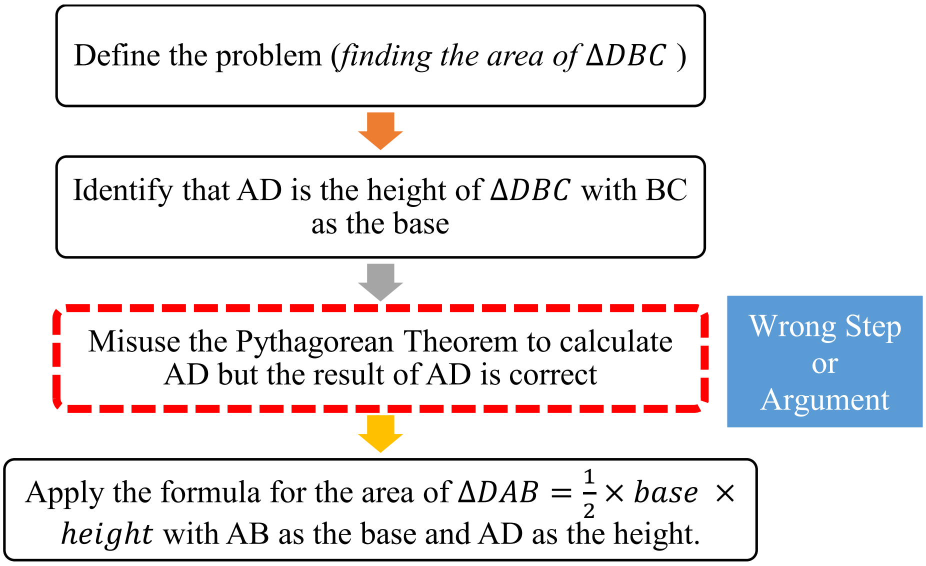


Figure 6. Mapping of GMS's True Pseudo-Thinking

The researcher interviewed GSM to confirm this code, and here is the transcript.

Researcher : Why do you use the Pythagorean theorem?
GMS : Because it is a right triangle
Researcher : What is the meaning of the exact formula that you wrote? Is it the Pythagorean triple?
GMS : Yes, sir, if one side is three, then the other side is 4 and 5

Based on the interview transcript, the main reason is that GSM is unfamiliar with the Pythagorean theorem. Although the student's answer is correct, GSM's argument in solving the length of AD is incorrect because GSM applies the theorem in the wrong situation. True Pseudo arose from GMS's misuse of a Pythagorean triple (3, 4, 5), who thought that if one side of a right triangle was 3 cm, the other sides had to be 4 cm and 5 cm, respectively. This thinking appears to be proper but incorrect, as it is not universally valid for all right triangles. To claim that it is a Pythagorean triple, one must verify the lengths of all sides of the triangle, including the hypotenuse. Even though these students can understand concepts more effectively, they can still provide incorrect answers because they are often driven by intuition. Fortunately, research shows that a growth mindset student is more likely to engage in reflective thinking by reviewing their answer to mitigate their mistake in thinking in the future (Kwan et al., 2022; Wang et al., 2021). Then, reflective thinking can transform students' pseudo-thinking into real thinking in mathematical problem-solving (Nizaruddin & Kusmaryono, 2023).

False Pseudo-Thinking in GMS

In the other subject of GMS, the researcher selected a code, namely Pythagorean, representing the thinking condition of GMS that utilizes the Pythagorean theorem in solving the area of an obtuse triangle. The following are the results of GMS work, which are indicated as False Pseudo. Based on Figure 7, it can be seen that GMS made an error in determining the AD length. Similarly, HST also makes an error in the third step (see Figure 8). Even though GMS's work is incorrect, GMS knows how to calculate the area of ΔDAB. The researcher does not know why GMS uses $AD^2 = AB^2 + BD^2$.

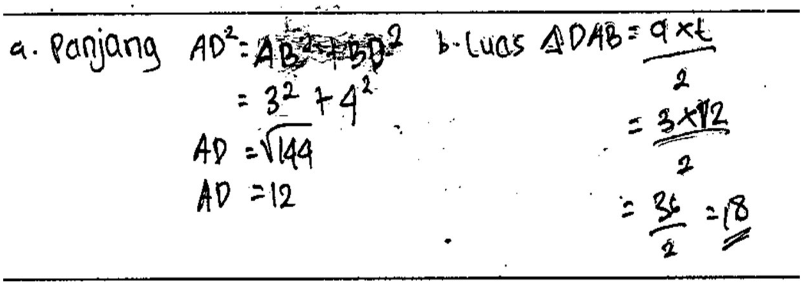


Figure 7. False Pseudo in GMS

The formula is correct, but the information on BD is not provided in the test. Students may recognize a problem as similar to a previously encountered one and apply a known procedure without considering whether that procedure is appropriate for the current context (Adhitya & Prabawanto, 2019). Therefore, the researchers claim that GMS is unfamiliar with the Pythagorean theorem. The researcher interviewed GSM to confirm this, and here is the transcript.

Researcher: Can you explain how you get AD to be 12?
GMS : AB is 3, and BD is 4, so I use the Pythagorean theorem to get 12 for the length of AD
Researcher : How do you get 4 for the length BD?
GMS : It is usually when a side is 3, then another side is 4

Based on the interview transcript, it is evident that GMS provided a false pseudo-answer. We observed that GMS's answer was incorrect; however, GMS is aware of the steps to solve the area of DAB, starting with finding AD. GMS's mistake lies in using the Pythagorean theorem to find AD instead of applying the triangle area formula, which is incorrect. This is because GMS believes that the right triangle can be used with the Pythagorean triple, but it cannot be applied in this case. Even though they understand the theorem, sometimes they do not use that knowledge correctly because it is inaccurate (Idris, 2024; Rudi et al., 2020).

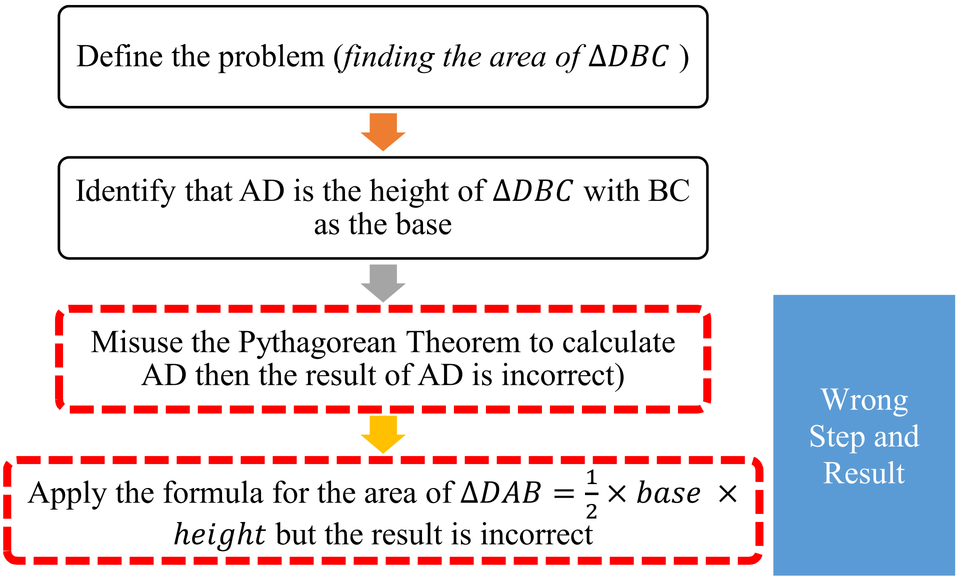


Figure 8. Mapping of GMS's False Pseudo-Thinking

True Pseudo-Thinking in FMS

On the other hand, from FMS's work, the researcher chose a code, namely calculation, representing the thinking condition of FMS, which made true pseudo-thinking errors. The following are the results of FMS work, which are indicated as True Pseudo.

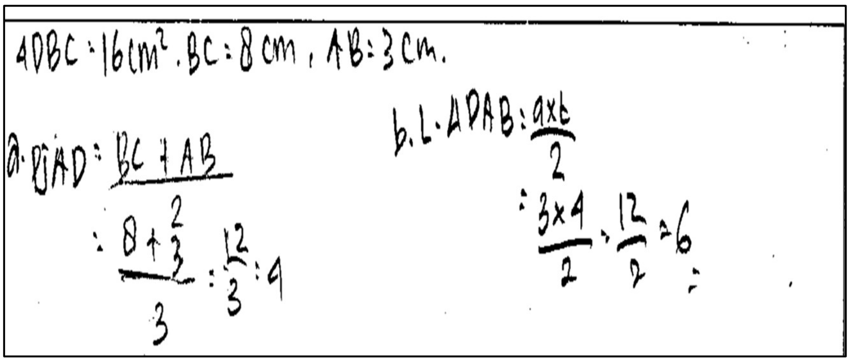


Figure 9. True Pseudo in FMS

Based on Figure 9, FMS's work is correct. FMS knows the formula for calculating the area of a triangle and can determine the correct answer for the area of ΔDAB. However, FMS made a mistake in determining AD. From FMS's work, they use an unusual formula by finding AD as $\frac{BC+AB}{2}$. The formula is incorrect, and FMS also makes an error in its calculation. This suggests that a student with a fixed mindset lacks mathematical ability. For details, see Figure 9 below.

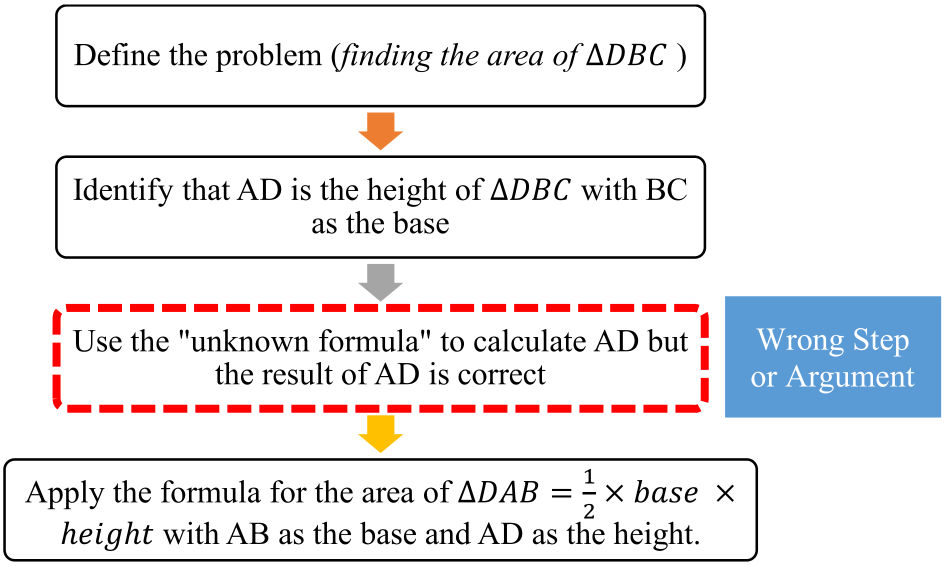


Figure 10. Mapping of FMS's True Pseudo-Thinking

The researcher interviewed with FMS to confirm this condition, and here is the transcript.

Researcher: Can you explain how you get AD to be 4?
GMS : Just like that
Researcher : Do you think that your answer is accurate?
GMS : I do not know, Sir

Based on the interview transcript, it is confirmed that FMS does true pseudo-thinking. It was observed that FMS's answer is correct, but their step in solving the length of AD is incorrect. It is because FMS uses an unknown formula that may be an invalid personal formula. It correlated with previous studies that stated that students with a fixed mindset are more likely to interpret mistakes as personal failures rather than growth opportunities, which can hinder their learning process (Rege et al., 2021). From the interview, FMS rationalized their struggles by saying, "Just like this, and I do not know," indicating a lack of inherent ability, leading to disengagement and lower performance (Hwang et al., 2019; Sun, 2018)

For RQ1, the results indicate that both GMS and FMS students engage in pseudo-thinking when solving obtuse triangles, with GMS exhibiting both true and false pseudo-thinking, whereas FMS exhibits only true pseudo-thinking. This aligns with Adhitya & Prabawanto (2019) research for GMS differs from that for FMS, possibly due to differences in subjects and materials, as the study utilized number operation materials in mathematical reasoning. Findings indicate that students with a growth mindset display both types of pseudo-thinking due to conceptual and procedural errors (Adhitya & Prabawanto, 2019). A growth mindset correlates with higher creativity, critical thinking, and problem-solving skills, which may lead to pseudo-thinking, as students explore hypotheses that sometimes result in errors (Fukui et al., 2024). Meanwhile, a fixed mindset is usually stuck in its opinion, so if it has incorrect knowledge, it will remain and retain its old knowledge, even if it is wrong (Adhitya & Prabawanto, 2019).

For RQ2, the characteristics of pseudo-thinking differed by the errors made by each being. Below is a comparison table of the two types of pseudos.

Table 4
Comparison of Pseudo-Thinking Characteristics Between Growth and Fixed Mindset Students

Aspect	Growth Mindset Students (GMS)	Fixed Mindset Students (FMS)
Types of Pseudo-Thinking	True pseudo-thinking and false pseudo-thinking	True pseudo-thinking
Typical Reasoning Pattern	Correct answer, but incorrect reasoning	Incorrect calculations and only memorized formulas
Nature of Error	Conceptual errors in decision-making	Procedural errors
Underlying Cause	Overconfidence in prior knowledge and flexibility in reasoning, even when wrong	Inability to internalize reasoning and adapt to new problems.
Illustrative Example	The student calculates the correct area of an obtuse triangle using invalid reasoning.	The student uses the wrong formula (for right triangles) and gets an incorrect result.

GMS engages in both true and false pseudo-thinking, where, for example, it is possible to arrive at the correct answer using incorrect reasoning, particularly when the incorrect application of the Pythagorean theorem and Pythagorean triples is involved. The mistake stems from making wrong decisions. This aligns with previous research, which suggests that a growth mindset can lead to overconfidence in outdated knowledge that is perceived as either correct or incomplete, ultimately resulting in incorrect decisions (Dong et al., 2023a; Stohlmann & Yang, 2024). In contrast, FMS only performs true pseudo-thinking, which relies on incorrect calculations based on formulas. Their mistakes are even more rooted in their inability to internalize the way of thinking toward the task. This aligns with previous research findings, which indicate that FMS often memorizes formulas without reflecting on whether their thinking has been correct (Adhitya & Prabawanto, 2019; Anggraini et al., 2018b; Muslim et al., 2021).

The discovery that pseudo-thinking occurs in both mindset categories highlights the need for targeted instructional strategies to lessen its impact. This suggests that teachers should not only address students' conceptual misunderstandings but also promote adaptive mindsets that foster genuine reasoning. Previous studies have emphasized that learning environments that encourage reasoning and exploration, such as problem-based learning, can effectively reduce students' reliance on pseudo-thinking patterns (Pyne et al., 2024). This aligns with the current findings, where pseudo-thinking in GMS often comes from exploratory but misguided reasoning, while FMS tend to apply procedures rigidly. Similarly, Boaler et al. (2018, 2021) and Dong et al. (2023b) reported that classroom practices emphasizing effort and understanding rather than performance outcomes fostered resilience and conceptual flexibility, traits that may counteract pseudo-thinking tendencies. Therefore, these results support the view that promoting a growth-oriented classroom culture can strengthen students' reasoning structures while reducing manifestations of pseudo-thinking.

Conclusion

The findings suggest that students of both mindsets experience pseudo-thinking errors in solving areas of obtuse triangles that are not similar. GMS made both true and false pseudo-thinking because they did not understand how to apply the Pythagorean theorem. Meanwhile, FMS only committed true pseudo-thinking based on the wrong formula used. The overconfidence condition in GMS and merely memorising formulas in FMS become factors influencing the mindset towards pseudo-thinking. The results underscore the necessity of teaching methods that develop reasoning and flexibility, rather than relying solely on memorization as a learning strategy. The students' exploration, reflection, and even making mistakes would be seen as strengthening their real mathematical understanding and minimizing pseudo-thinking. Furthermore, teachers must find ways to teach that promote a growth mindset for children, who need to learn the importance of making mistakes rather than developing rigid thinking patterns.

Nevertheless, this study has its drawbacks. First, the number of participants is limited, especially for students with fixed mindsets. Additionally, this study was conducted for only one topic in one school, which may not necessarily capture and generate a theory of pseudo-thinking in other geometry problems based on mindset. Lastly, it focused solely on a mindset that categorized subjects based on results from a single questionnaire. This methodology does not account for the fact that students may have different mindsets at different times when solving problems. In the future, research can be expanded by incorporating additional subjects and exploring other geometry topics.

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