
Analysis of the Pseudo-Thinking Process of Field-Dependent 8th-Grade Students at SMP Negeri 2 Palu in Solving Pythagorean Theorem Problems

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Abstract. *The occurrence of pseudo-thinking processes in mathematics learning remains prevalent, as many students solve problems by relying on memorized procedures rather than understanding the underlying concepts. While previous research has largely focused on error analysis or general problem-solving abilities, studies specifically examining pseudo-thinking processes among field-dependent students when solving Pythagorean theorem problems remain limited. This study aims to analyze the pseudo-thinking processes of eighth-grade students at SMP Negeri 2 Palu specifically those with a field-dependent cognitive style while solving Pythagorean theorem problems, by examining the relationship between cognitive style characteristics and pseudo-thinking processes. A descriptive qualitative approach was employed. Data were collected from a single student, purposively selected to represent the field-dependent cognitive style, using the Group Embedded Figures Test (GEFT), a Pythagorean theorem problem-solving test, and semi-structured interviews. Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña, comprising data condensation, data display, and conclusion drawing/verification. The results indicate that the field-dependent student exhibited "correct pseudo-thinking" during the planning and execution stages of the solution. This was characterized by the use of procedures based on prior learning experiences and provided examples, lacking support from deep conceptual understanding. However, during the review stage, the subject was able to verify the solution, meaning the characteristics of pseudo-thinking were no longer present. These findings demonstrate that cognitive style plays a role in shaping students' thinking processes during mathematical problem-solving and provide a basis for teachers to design instruction that accounts for students' cognitive style characteristics to enhance conceptual understanding..*

Keywords: *Pseudothinking, Cognitive Style, Field-Dependent, Pythagorean Theorem.*

INTRODUCTION

Mathematics is a subject that plays a crucial role in developing students' logical, analytical, critical, and systematic thinking skills. In mathematics education, students are expected not only to arrive at correct answers but also to

understand the processes and underlying reasoning behind each step of problem-solving. With the evolving demands of 21st-century learning, conceptual understanding has become a vital aspect, as it enables students to connect learned concepts to various problem-solving situations. Research indicates that students' thinking skills need to be cultivated through instruction that fosters reasoning rather than mere procedural mastery (Alamsyah & Hidayanto, 2019; Anjelina et al., 2023; Ghufon & Suminta, 2020; OECD, 2023; Mullis et al., 2024). However, in practice, many students still solve problems by memorizing formulas without grasping the underlying concepts. Consequently, while students may obtain correct answers, they are often unable to explain the mathematical rationale behind the steps they have taken.

This phenomenon is known as "pseudo-thinking" a state in which students automatically apply procedures or algorithms without grasping their underlying conceptual meaning (Kusmaryono, 2023). According to Wulandari et al. (2023), pseudo-thinking occurs when students arrive at the correct answer by applying memorized formulas rather than through conceptual understanding. This condition can hinder the development of higher-order thinking skills, as students struggle when faced with non-routine tasks or contextual problems that require the flexible application of concepts (Anjelina et al., 2023; Ghufon & Suminta, 2020; OECD, 2023; Schoenfeld, 2023). The Pythagorean Theorem is one topic where pseudo-thinking frequently manifests. This topic represents a fundamental concept that students must master, as it serves as a foundation for various other geometric concepts. However, Yuliana et al. (2022) revealed that many students merely memorize the Pythagorean Theorem formula without understanding the conditions for its application, leading them to make frequent errors when encountering problems set in different contexts.

In addition to conceptual understanding, individual characteristics such as cognitive style influence students' thinking processes when solving mathematical problems. Cognitive style refers to the way an individual receives, processes, and utilizes information to complete a task. One cognitive style frequently studied in mathematics education is the Field-Dependent (FD) style. Students with an FD

cognitive style tend to grasp material more easily when provided with examples, guidance, or assistance from the learning environment. Consequently, these students are more inclined to follow demonstrated procedures or steps rather than independently constructing a conceptual understanding (Nurafni et al., 2018). This tendency is believed to contribute to the occurrence of "pseudo-thinking" during mathematical problem-solving (Prayoga et al., 2024). Although various studies have examined pseudo-thinking and cognitive styles in mathematics education, most have focused primarily on error analysis or general problem-solving abilities. Research that deeply investigates the pseudo-thinking processes of students with an FD cognitive style particularly regarding the Pythagorean Theorem at the junior high school level remains relatively limited. Thus, there is a research gap that warrants further study to gain a more comprehensive understanding of the relationship between cognitive style and students' pseudo-thinking processes.

Several previous studies have examined pseudo-thinking and cognitive styles in mathematics learning. Kusmaryono (2023) found that students often arrive at correct answers by applying memorized procedures without understanding the underlying concepts, thereby exhibiting characteristics of pseudo-thinking. Wulandari et al. (2023) reported that pseudo-thinking emerges when students solve problems based on previously provided examples, leading to difficulties with modified problems. Meanwhile, Prayoga et al. (2024) demonstrated that cognitive style influences students' thinking processes during mathematical problem-solving; specifically, students with a field-dependent cognitive style tend to rely on examples and teacher guidance to solve problems. Another study by Rifqy et al. (2026) showed that students with a field-independent cognitive style are capable of independently developing solution strategies, resulting in fewer instances of pseudo-thinking compared to students who rely on learned procedures. In general, findings from previous research indicate that pseudo-thinking is associated with low conceptual understanding and is influenced by students' cognitive style characteristics. However, there is limited research specifically examining the pseudo-thinking processes of field-dependent students within the context of the Pythagorean theorem.

Based on this gap, the novelty of this study lies in its in-depth analysis of the pseudo-thinking processes of field-dependent students when solving problems involving the Pythagorean Theorem across the stages of problem-solving. This study not only identifies the presence of pseudo-thinking but also characterizes it at each stage of the problem-solving process, thereby providing a more comprehensive overview than previous research.

Interviews with mathematics teachers at SMP Negeri 2 Palu indicate that students still struggle to grasp the concept of the Pythagorean Theorem, particularly in identifying the positions of triangle sides and selecting the appropriate formula for a given problem context. Most students rely on rote memorization rather than conceptual understanding, leading to confusion when faced with varied problem types. Although teachers have attempted to relate the material to real-life situations to facilitate understanding, students with a "*field-dependent*" cognitive style tend to rely on examples and teacher guidance to solve problems, thereby risking "pseudo-thinking." These findings highlight the importance of identifying pseudo-thinking processes among *field-dependent* students when they solve problems involving the Pythagorean Theorem.

Based on the foregoing, this study aims to analyze the pseudo-thinking processes of eighth-grade students at SMP Negeri 2 Palu specifically those with a field-dependent cognitive style when solving problems involving the Pythagorean Theorem. A descriptive qualitative approach is employed to gain in-depth insight into the characteristics of students' thinking processes while solving mathematical problems. The findings are expected to provide empirical evidence regarding the relationship between cognitive style and pseudo-thinking processes, as well as contribute to the development of more effective mathematics teaching strategies for enhancing students' conceptual understanding.

RESEARCH METHOD

This study employs a qualitative approach with a descriptive design, aiming to provide an in-depth description of the pseudo-thinking processes of a field-dependent eighth-grade student at SMP Negeri 2 Palu when solving problems related to the Pythagorean Theorem. The research was conducted at SMP Negeri 2

Palu, Central Sulawesi, during the even semester of the 2025/2026 academic year. The research subject was selected using purposive sampling. Subject selection began with administering the Group Embedded Figures Test (GEFT) to all eighth-grade students to categorize them into field-independent and field-dependent cognitive styles. Based on the GEFT results, mathematics teacher recommendations, and the student's communication skills, one student with a field-dependent (FD) cognitive style was selected as the research subject.

The primary instrument in this study was the researcher, while supporting instruments included the Group Embedded Figures Test (GEFT) for cognitive style, a written test on the Pythagorean Theorem, and a semi-structured interview guide. The test items were developed based on indicators of pseudo-thinking (Table 1) and were validated by experts prior to use.

Table 1. Indicators of Pseudo-thinking

Pseudo-Correct Thinking	Flawed Pseudothinking
1. The student is able to answer the question correctly, but the steps taken are not entirely accurate.	1. The student answered the question incorrectly but was able to correct the mistake after reflection.
2. The concept written by the student is correct, but their understanding of the concept is incorrect.	2. The concept written by the student is incorrect, yet their conceptual understanding is correct.

Source: Adapted from Subanji & Nusantara (2016).

Data collection was conducted sequentially through the administration of the GEFT, a written test, and interviews. One of the problems used in this study is presented in Figure 1. This problem was formulated based on indicators of pseudo-thinking and designed to identify students' thinking processes when solving problems involving the Pythagorean Theorem. Through this problem, the researcher analyzed the accuracy of the answers, the steps taken to reach the solution, the reasoning behind the concepts applied, and the students' conceptual understanding of the Pythagorean Theorem.

1. Saskia berjalan 6 m ke timur, lalu 8 m ke utara. Saskia mengatakan bahwa Jarak langsung dari titik awal ke titik akhir adalah:

$$6 + 8 = 14 \text{ meter}$$

Pertanyaan:

- Apakah pernyataan Saskia tersebut benar? Jelaskan alasanmu
- Gambarkan rute perjalanan Saskia
- Tentukan jarak langsung dari titik awal ke titik akhir menggunakan konsep yang tepat

Figure 1: Problem-solving test question

Data validity in this study was ensured through credibility checks specifically prolonged engagement, persistent observation, peer debriefing, and member checking as well as dependability checks via audits conducted by the supervising lecturer. Data analysis was performed using a descriptive qualitative approach based on the Miles, Huberman, and Saldaña model, comprising data condensation, data display, and conclusion drawing/verification. This process aimed to obtain a comprehensive overview of the pseudo-thinking processes of students with a field-dependent cognitive style when solving problems related to the Pythagorean Theorem. During the data condensation stage, the researcher selected, focused, simplified, and organized data obtained from written tests and interviews, guided by indicators of pseudo-thinking. Subsequently, the condensed data was systematically presented through descriptive narratives, tables, and interview excerpts, facilitating the identification of the subjects' thinking process characteristics at each stage of problem-solving. The final stage involved drawing and verifying conclusions by reviewing all data and cross-referencing written test results with interview data to ensure the consistency of the findings. Through this process, an in-depth and reliable account of the pseudo-thinking processes of field-dependent students in solving Pythagorean Theorem problems was obtained.

RESULT AND DISCUSSION

Research subjects were selected using the Group Embedded Figures Test (GEFT) administered to 24 students from class VIII-F at SMP Negeri 2 Palu. The classification results revealed 18 students with a Field-Dependent (FD) cognitive

style and 6 students with a Field-Independent (FI) cognitive style. From the 18 students with the Field-Dependent (FD) cognitive style, one student designated by the code DAP and holding a GEFT score of 15 was selected as the research subject. This selection was made purposively based on GEFT scores, a mathematics teacher's recommendation, and the subject's ability to articulate their thought processes while solving problems.

Table 2. Research Subjects

No	Name	GEFT score	Cognitive style type
1.	DAP	15	<i>Field-dependent</i>

Following the selection of the subjects listed in Table 2, students were administered a Pythagorean Theorem problem-solving test designed based on Polya's problem-solving stages (as shown in Table 3). This was followed by interviews to gain deeper insight into the students' thought processes while solving the problems. Analysis was conducted using triangulation between the written test results and interview findings, enabling a comprehensive identification of the research subjects' "pseudo-thinking" characteristics. The Polya problem-solving stages employed are outlined below.

Table 3. Problem-Solving Stages According to Polya

No	Problem-Solving Stage	Indicator
1.	Understanding the problem	Students are able to identify the problem and state what is known and what is being asked in the question.
2.	Developing a problem-solving plan	Students can state and write down the model used to solve the problem.
3.	Implement problem resolution plans	Students can solve problems according to the plan by performing calculations correctly.
4.	Double-checking	The student reviews the problem-solving steps used.

Field-Dependent (FD) Subjects

Based on the Group Embedded Figures Test (GEFT) results, the subject, DAP, falls into the Field Dependent (FD) category. Interview findings further indicate that DAP exhibits characteristics consistent with this cognitive style. DAP stated that understanding problems is easier when a solution example is provided first, as this allows for following the steps outlined in the example. Additionally, the subject mentioned frequently asking peers or teachers for help when encountering difficulties or feeling uncertain about an answer. DAP also prefers group learning, believing that discussion facilitates the exchange of understanding with peers. These characteristics suggest that DAP tends to rely on external assistance or guidance from the environment when comprehending and solving problems. These findings align with research by Apriyani and Ibrahim (2021), which indicates that students with a Field Dependent cognitive style grasp material more easily when provided with examples or teacher guidance and tend to rely on external support when facing challenges. Research by Nurafni et al. (2018) also shows that Field Dependent students find it easier to follow demonstrated procedures than to independently devise solution strategies. Furthermore, a study by Prayoga et al. (2024) reveals that students with a Field Dependent cognitive style often require guidance during problem-solving, leading them to frequently follow prescribed steps. Research by Setiawan et al. (2025) similarly indicates that Field Dependent students tend to learn collaboratively and solve problems more effectively through peer discussion than by working independently. These characteristics serve as the basis for analyzing the subject's thinking process across each stage of Polya's problem-solving framework.

Problem Understanding Stage

When viewed through the lens of Polya's problem-solving stages, the subject was able during the problem-comprehension phase to identify both the given information and the information sought in the problem. The subject also determined that the Pythagorean Theorem was the appropriate strategy for a solution. However, the visual representation created was imprecise, indicating that

the subject's understanding of the problem context was not entirely accurate. The subject's work during the problem-comprehension stage is illustrated in Figure 2.

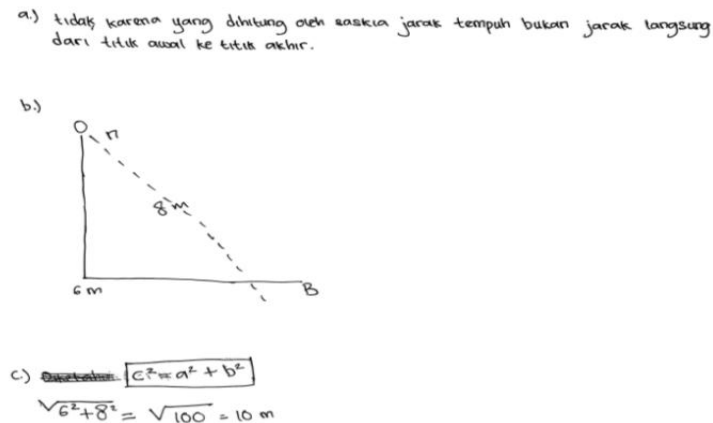


Figure 2 Problem Understanding Stage

To gain deeper insight into the subject's thought processes during the problem-understanding stage, semi-structured interviews were conducted. The results of the DAP interviews are presented in Table 4.

Table 4. DAP Subject Interviews at the Understanding the Problem Stage

Interview Transcript	
PN	Try explaining this problem again in your own words.
DAP	For part (a), my answer is "no," because the distance Saskia covered was the path from the starting point to the final point. For part (b), the movement went from point O to 8 meters, and then to 6 meters. Finally, for part (c), the Pythagorean theorem is used: $c^2 = a^2 + b^2$, which gives $c^2 = 6^2 + 8^2 = \sqrt{100} = 10$.
PN	What information do you gather from the problem?
DAP	The information I gathered allows me to map out Saskia's travel route and also apply the Pythagorean theorem.

Based on the written test and interview results, the subject was able to restate the problem in their own words and identify both the given information and the information requested in the problem. However, the subject's explanation focused primarily on the solution procedure and formulas used, while the representation of the travel route on the answer sheet did not fully align with the problem's context.

This indicates that the subject's understanding of the problem situation was not entirely accurate. These findings align with research by Berek et al. (2025), which revealed that students with a field-dependent cognitive style are capable of recognizing information in a problem but struggle to accurately represent the problem situation, as they tend to view information holistically without isolating key components.

Completion Planning Stage

At the solution planning stage according to Polya, subject DAP was able to determine a solution strategy by choosing to use the Pythagorean theorem formula. This strategy aligned with the characteristics of the given problem. The subject's work at the solution planning stage is shown in Figure 3.

Handwritten mathematical work showing the Pythagorean theorem formula $c^2 = a^2 + b^2$ and the calculation $\sqrt{6^2 + 8^2} = \sqrt{100} = 10 \text{ m}$.

Figure 3. Planning Settlement Stage

To gain deeper insight into the subject's thought processes during the solution planning stage, semi-structured interviews were conducted. The results of the DAP interviews are presented in Table 5.

Table 5. Interviews with DAP subjects at the planning completion stage

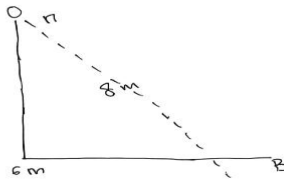
Interview Transcript	
PN	How do you solve this problem?
DAP	First, I understood the problem, and then I solved it using the applicable formula.
PN	What formula do you use?
DAP	I am using the Pythagorean theorem, namely $c^2 = a^2 + b^2$
PN	Why did you choose that method? Is there another method that could be used?
DAP	Because I think this method is easy to understand. There is
Based on the written test and interview results, the subject chose to use the Pythagorean theorem formula, considering it an easily understood method.	

When asked about the possibility of using other strategies, the subject acknowledged that alternatives existed but could not explain the conceptual reasoning behind the chosen strategy. This indicates that the choice of strategy was based more on procedural application than on an understanding of the underlying concepts. Consequently, during the solution-planning stage, the subject exhibited characteristics of "pseudo-true thinking"; while capable of identifying the correct strategy, the subject could not provide the conceptual rationale for that choice. These findings align with research by Pradiarti and Subanji (2022), which indicates that students with a field-dependent cognitive style tend to select solution strategies based on prior examples or experiences rather than conducting a conceptual analysis of the problem at hand. The findings also concur with Kusmaryono (2023), who states that relying on experience-based procedures without conceptual understanding is a characteristic of pseudo-thinking in mathematics learning. Furthermore, this is supported by Wulandari et al. (2023), who found that students exhibiting pseudo-thinking tend to choose strategies based on previously learned examples, leading to difficulties in adapting their solution strategies when faced with problems in different contexts.

Implementing Settlement Stage

During the solution implementation stage according to Polya, subject DAP was able to apply the planned strategy using the Pythagorean theorem formula, thereby obtaining the correct answer. The solution steps recorded on the answer sheet demonstrate that the subject systematically applied the strategy selected during the planning stage. The subject's work at the solution implementation stage is shown in Figure 4.

b.)



c.)

$$c^2 = a^2 + b^2$$

$$\sqrt{6^2 + 8^2} = \sqrt{100} = 10 \text{ m}$$

Figure 4. Stage of Implementing Settlement

To gain deeper insight into the subject's thought processes during the solution implementation stage, semi-structured interviews were conducted. The results of the DAP interviews are presented in Table 6.

Table 6. DAP Subject Interviews at the Implementing Settlement Stage

Interview Transcript	
PN	Please explain the steps you took to solve the problem.
DAP	The steps I took to solve the problem were as follows: first, I understood the given problem and observed that the travel route formed a right-angled triangle; therefore, I used the Pythagorean theorem, which is $c^2 = a^2 + b^2$
PN	Why did you take that step?
DAP	I often use that method to solve problems like this one, so I've become accustomed to using it.
PN	Where did you get that move from?
DAP	I adopted that approach a long time ago and have continued to apply it to this day.

Based on the written test and interview results, the subject was able to solve the problem using the Pythagorean theorem formula and arrive at the correct answer. The subject's statement that this step is "frequently used" and "long-established" indicates that the problem-solving process relied on experience applying the same procedure to previous problems. This suggests that the subject's success in obtaining the correct answer was driven more by the habit of applying a procedure than by an understanding of the Pythagorean theorem concept—specifically, the relationship between the sides of a right-angled triangle. Consequently, during the solution phase, the subject exhibited characteristics of "pseudo-true thinking": the ability to produce a correct answer without a deep conceptual understanding of the rationale behind the procedure used. These results align with research by Rifqy et al. (2025), which explains that pseudo-true thinking is characterized by the ability to obtain correct answers through procedural

application, while the student remains unable to provide the underlying conceptual justification, rendering their understanding superficial. Similar findings were reported by Kusmaryono (2023), who stated that pseudo-thinking occurs when students correctly solve problems by applying memorized formulas or algorithms without grasping the underlying concepts. Furthermore, Wulandari et al. (2023) found that students exhibiting pseudo-thinking tend to rely on previously learned examples to reach correct answers but struggle to explain the mathematical reasoning behind the steps taken. These findings are also supported by Subanji and Nusantara (2016), who explain that pseudo-true thinking is marked by accurate final results unaccompanied by adequate conceptual understanding, meaning the student's thought process remains superficial.

Review Stage

During the review stage, subject DAP re-examined their answers by recalculating the results and checking the solution steps. DAP was also able to identify areas of uncertainty, specifically regarding the representation of the travel route and the determination of the distance from the starting point to the endpoint. This indicates that DAP engaged in a verification process regarding their work; consequently, no characteristics of "pseudo-thinking" were observed at this stage. The subject's work during the review stage is shown in Figure 5.

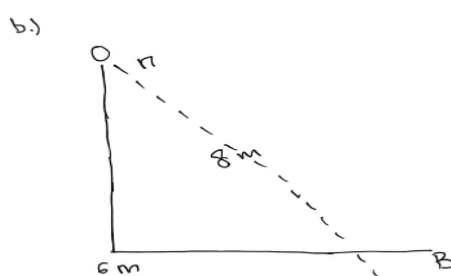


Figure 5. Rechecking Stage

To gain deeper insight into the subject's thought processes during the "checking back" stage, semi-structured interviews were conducted. The results of the DAP interviews are presented in Table 7.

Table 7. Interview with Subject DAP at the Re-checking Stage

Interview Transcript	
PN	Are you confident in the steps you are taking?
DAP	I am confident in my answer.
PN	Did you double-check your answers?
DAP	Yes, I am double-checking my answer to see if there is anything incorrect or not quite right.
PN	How do you ensure your answer is correct?
DAP	The way I confirm my answer is by calculating my answer again.
PN	If your answer is incorrect, where do you think the mistake lies?
DAP	I am not entirely confident about part (b) specifically regarding Saskia's travel route and part (c), which involves calculating the distance from the starting point to the ending point.

Based on the written test and interview results, the subject engaged in a "looking back" process by recalculating the results and reviewing the solution steps taken. The interview revealed that, despite feeling confident in the obtained answer, the subject performed a re-check to ensure there were no errors in the solution process. Furthermore, the subject was able to identify areas of uncertainty, specifically regarding the representation of the travel route and the determination of the distance from the starting point to the endpoint. The ability to verify the solution and recognize potential errors indicates that the subject reflected on their own thought process. Consequently, no characteristics of "pseudo-thinking" were observed during the "looking back" stage, as the subject did not merely accept the final result but also re-evaluated the accuracy of the process and the answer obtained. This situation demonstrates that the subject did not rely solely on previously used procedures but also re-evaluated the correctness of the steps and the solution itself; thus, no pseudo-thinking characteristics were found during the review stage. These findings align with research by Jannah et al. (2025), which states that the "looking back" stage is an evaluative phase allowing students to discover errors or uncertainties in the solution process, thereby improving the accuracy of their answers. The findings also concur with research by Rifqy et al.

(2025), showing that students who verify their solution processes are more likely to detect errors and provide more logical justifications for their answers. These results reinforce the findings of Ulya and Setyaningsih (2024) and Berek et al. (2025), which concluded that students with a field-dependent cognitive style are generally capable of following problem-solving stages but tend to rely on procedures and prior learning experiences rather than independently constructing conceptual understanding.

CONCLUSION

Students with a field-dependent cognitive style are able to navigate all stages of Polya's problem-solving process: understanding the problem, planning the solution, executing the solution, and reviewing the results. At the stage of understanding the problem, the subject is able to identify the given information and what is being asked, as well as determine that the Pythagorean Theorem should be used as the solution strategy, although the problem representation created is not entirely accurate. At the stage of planning the solution, the subject selects a strategy based on prior experience and examples previously studied, meaning the choice is not yet fully grounded in a conceptual understanding.

During the solution execution stage, the subject successfully obtained the correct answer; however, the reasoning provided indicated that the solution was reached by applying memorized procedures. This characteristic reflects "pseudo-true thinking," as the answer obtained was not supported by a deep conceptual understanding. In contrast, during the review stage, the subject was able to verify the solution steps and the resulting answer, meaning the characteristics of pseudo-thinking were no longer present.

The results of this study indicate that the Field-Dependent cognitive style influences students' thinking processes when solving mathematical problems. Therefore, teachers need to design instruction that not only emphasizes the use of procedures but also encourages students to build a deeper conceptual understanding, thereby minimizing the tendency for "pseudo-thinking" to occur during lessons on the Pythagorean Theorem.

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