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Pseudo-Thinking in Solving Mathematical Problems Based on Field Independent Cognitive Style

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ABSTRACT

Pseudo-truth thinking often serves as an implicit obstacle in mathematics education, since pupils can provide correct answers without fully comprehending its basic principles. This issue necessitates deeper comprehension, especially for pupils' psychological traits, including cognitive style. This study seeks to elucidate the pseudo-truth cognitive process exhibited by individuals with a Field Independent (FI) cognitive style when addressing arithmetic issues among eighth-grade students at Muhammadiyah Middle School in Parepare. This study used a descriptive qualitative approach. The subject of the study was one student with a FI cognitive style selected through the Group Embedded Figures Test (GEFT). Supporting instruments included a mathematics problem-solving test and clinical interview guidelines. Data validity was guaranteed through method and time triangulation, while data analysis was carried out through the stages of data condensation, data presentation, and conclusion drawing. The research shows that FI participants thought pseudo-analytically. Subjects can isolate problem variables yet intentionally use logic to get perfect responses. The Pythagoras formula and calculation method were disconnected, resulting in severe exponent mistakes. The individuals thought they answered the problem correctly because they followed the mathematical "format," even if the steps were illogical. Metacognitive control and algorithm memorization were also areas of weakness, demonstrating conceptual comprehension problems. This study suggests that educators should be more aware that students' correct answers may not reflect their conceptual knowledge. These findings can help teachers create learning interventions that detect and correct pseudo-thinking based on students' cognitive styles.

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1. INTRODUCTION

Mathematics is called the "queen of sciences" for its usefulness in other fields and its role in developing reasoning and logic (Prasanna, 2022). However, the reality on the ground shows that students' problem-solving abilities are far from ideal. Educators often encounter a unique phenomenon where students are able to provide correct answers, but when their thought processes are examined, they fail to understand why they took these steps (Heyd-Metzuyanim, 2015; Jackson et al., 2017). This phenomenon is known as pseudo-thinking.

Pseudo-thinking is a condition where there is a disconnect between a student's cognitive structure and the resulting response (Kusmaryono et al., 2020; Ono, 2022). Students appear to be thinking, but in reality, they are simply imitating algorithms or recalling memories without any deeper meaning (Anggraini et al., 2018; Cahdriyana et al., 2019). In the context of solving complex mathematical problems, this behavior becomes a serious obstacle because students will fail when faced with problem modifications that require logical adaptation (Adhitya et al., 2025; Setyaningrum et al., 2025).

The main cause of pseudo-thinking is an overemphasis on the end result (product-oriented) rather than the process (process-oriented) (Badar & Anwar, 2025; Muslim et al., 2021). Many classrooms measure mathematics success by the speed and accuracy of answers (Marshall & Battey, 2025; Nanda & Rani, 2025). This situation triggers students to seek mental "shortcuts." Vinner, a pioneer in this concept, differentiates between pseudo-conceptual and pseudo-analytical (Vinner, 2014; Vinner, 2019). Pseudo-conceptual occurs when students use terms or concepts without understanding their meaning, while pseudo-analytical occurs when students apply mechanical procedures without logical control (Muslim, 2021). Students' inability to reflect on their answers (looking back) in Polya's steps often becomes the gateway to pseudo-thinking (Nurmaela et al., 2024). Students believe they have solved the problem when, in reality, they were merely "lucky" because the memorized pattern coincidentally matched the given problem (Syahraini et al., 2023).

To understand why a student falls into pseudo-thinking, we cannot ignore the aspect of individual differences, one of which is cognitive style. Cognitive style is a consistent way an individual perceives, remembers, thinks, and solves problems (Aggarwal et al., 2023; Hidajat et al., 2024; Muzaini et al., 2021). One of the most relevant dimensions in mathematics is the Field Independent (FI) and Field Dependent (FD) dimensions (Giancola et al., 2023). Students with a Field Independent (FI) cognitive style tend to have strong analytical abilities (Agoestanto et al., 2017). They are able to separate elements from their environmental context (cognitive reorganization). Theoretically, FI students should be more resistant to pseudo-thinking due to their tendency to analyze problems independently. However, preliminary research indicates that FI students are not immune to pseudo-errors, especially when they feel overconfident in their self-constructed analytical patterns that turn out to be mathematically invalid.

The relationship between FI and mathematical thinking processes is crucial. FI students, who are independent in organizing information, should be able to self-correct (Marjud et al., 2025; Suryanti & Masduki, 2024). If they persist in pseudo-thinking, there is an anomaly in their cognitive control mechanisms that requires further examination.

This article offers several novel points that distinguish it from previous research on pseudo-thinking and cognitive styles. Previously, the literature tended to position field-independent students as superior and systematic problem solvers (Lestari & Waluyo, 2025). The novelty of this research lies in revealing FI students' vulnerability to pseudo-thinking. This research proves that analytical ability does not guarantee the correctness of their thinking processes if it is not accompanied by a complete conceptual scheme. This research does not simply label students as "wrong" or "pseudo-" but rather maps the specific areas where FI students experience pseudo-thinking. Is pseudo-thinking occurring at the problem deconstruction stage or at the modeling stage? We found that in FI typing, pseudo-thinking often occurs due to "premature analytical assumptions." This study uses Piaget's equilibration lens to explain accommodation failure in FI students. Its uniqueness is in showing how the rigid way FI students think makes it hard for them to accept new information, leading to fake responses as a way to protect their minds. Furthermore, in contrast to quantitative descriptive research, this article uses in-depth qualitative analysis with task-based interview techniques designed to trigger "cognitive conflict." This allows researchers to capture the precise moment when students shift from analytical thinking to pseudo-thinking.

Why is this research important? If we don't understand the pseudo-thinking profile of students with specific cognitive styles, teachers' pedagogical interventions will always be general and ineffective. Mathematics teachers often provide the same scaffolding to all students, even though FI students require different types of stimulation to escape the pseudo-thinking trap than FD students.

Overall, the main challenge in today's mathematics education is no longer simply enabling students to answer questions but rather ensuring that those answers are the result of authentic thought constructions. Through an in-depth exploration of field-independent cognitive styles, this research seeks to uncover the veil behind the phenomenon of "correct but wrong process" (pseudo-thinking) to create more meaningful and reflective mathematics learning. By mapping pseudo-thinking based on FI cognitive styles, this article contributes to (1) Learning Theory: Enriching the treasury of cognitive psychology in mathematics education. (2) Instructional Practice: Providing guidance for teachers to design "anti-pseudo" questions for analytical students. (3) Curriculum Development: Emphasizing the importance of metacognition as an antidote to pseudo-thinking.

2. METHOD

This qualitative study aims to describe how pseudo-thinking is used in solving mathematical problems in subjects with a field-independent cognitive style. The study was conducted at Muhammadiyah Middle School in Parepare during the 2024/2025 academic year. The methods used in this study included tests and interviews. The research instruments consisted of a cognitive style test, the Group Embedded Figure Test (GEFT), a mathematics problem-solving test, and interview guidelines and research documentation.

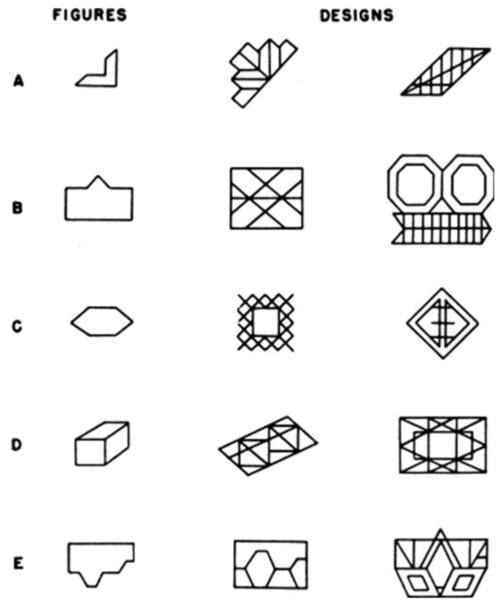

Figure 1. One Example of a Test on the GEFT Instrument

The participants in this study were eighth-grade students from Muhammadiyah Middle School in Parepare, chosen according to the outcomes of a cognitive style assessment modified from the Witkin cognitive style instrument. The cognitive style test was administered to determine students with a field-independent cognitive style. Of the 19 students who took the cognitive style test, one student with a field-independent cognitive style was selected as the research subject, considering input from subject teachers and the students' readiness. The results of the cognitive style test are shown in the following Table 1.

Table 1. Student Cognitive Style Test Results

Student Initials	Test Score	Category
JA	3	Field Dependent
NA	4	Field Dependent
FA	5	Field Dependent
A	5	Field Dependent
MH	6	Field Dependent
A	6	Field Dependent
PR	7	Field Dependent
Z	8	Field Dependent
SW	8	Field Dependent
A	9	Field Dependent
F	9	Field Dependent
J	9	Field Dependent
A	10	Field Dependent
A	10	Field Dependent
A	10	Field Dependent
SAI	10	Field Dependent
MI	11	Field Independent
MRZ	11	Field Independent
SM	15	Field Independent

The mathematical problem-solving test consisted of a single math problem based on the Pythagorean theorem. The problem-solving test was administered to assess the subject's problem-solving process and to identify pseudo-thinking. Interviews were conducted using a semi-structured interview guide that adhered to Polya's step-by-step procedure indicators, including questions that outlined the problem. Interviews were conducted to clarify the subject's answers to the mathematics problem-solving test and to further investigate the subject's thinking process and identify pseudo-thinking.

Data analysis in this study was conducted using the Miles and Huberman data analysis model, which includes the following stages: data condensation, data presentation, and conclusion drawing. Validity testing used triangulation, comparing data obtained from the subject's mathematics problem-solving test results with the interview results.

3. RESULTS AND DISCUSSION

Results

This study was conducted by administering a cognitive style ability test, and from the results, one student with a Field Independent cognitive style was selected. The subjects were then given a math problem-solving test and interviewed to identify pseudo-thinking. The following is a presentation of the problem-solving test results and interviews conducted with the Field Independent subjects.

Stages of Understanding the Problem

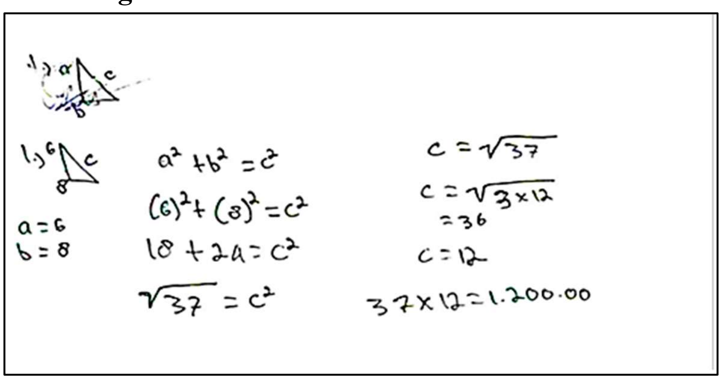

Figure 2. Results of the problem solving test for the Field Independent subject

The following are the results of interviews with Field Independent subjects at the stage of understanding the problem.

P	:	*What do you understand from the problem?*
SFI	:	*What I understand is that the sides are 6 meters and 8 meters long, and the fence costs 100,000 per meter.*
P	:	*So, what other information do I need to know before working on this?*
SFI	:	*What I'm trying to find is the total cost of the fence.*
P	:	*Did you encounter any difficulties while working on this problem?*
SFI	:	*No.*

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At first glance, the SFI appears to understand the problem well because it is able to isolate the relevant variables. This skill is a typical characteristic of the field-independent cognitive style, which has the ability to analytically separate elements from their context. Although in the interview, the SFI stated "No difficulty," the data in the figure indicates a fatal failure of logical structure. The SFI merely "memorized" the formula form without understanding the operation of exponents. This is a form of pseudo-thinking, where the subject forces the numbers to appear "reasonable" or approximate the desired pattern (perhaps trying to achieve a whole number).

An interesting finding from this interview is when the SFI answered "No" when asked about difficulties. This indicates that the SFI felt she had followed the correct procedure because she had followed the mathematical "format" she remembered (there is a triangle, there is the Pythagorean theorem, and there is a final result). Furthermore, the subject felt she understood at a surface level but was unaware that her internal logical processes were seriously disrupted. Overall, the Field Independent (SFI) student demonstrated a unique tendency toward pseudo-thinking; they remain confident and analytical in stating the facts of the problem but carry out illogical procedural manipulations on the answer sheet without realizing the error (weak metacognitive aspects)."

Stages of Developing a Settlement Plan

The following are the results of interviews with Field Independent subjects at the stage of preparing a completion plan.

P : *After understanding the information obtained from the problem, what plan do you use to solve the problem?*
SFI : *I use the formula: a squared plus b squared equals c squared.*
P : *Pythagorean theorem?*
SFI : *Yes.*
P : *Is there another reason or formula that can be used besides that?*
SFI : *I don't know either.*

The gap between FI's analytical skills and mastery of mathematical concepts is starkly apparent at this stage. SFI immediately cited the formula $a^2 + b^2 = c^2$ as the only plan. When asked if there was another way, he replied, "I don't know either." This demonstrates cognitive rigidity; SFI is fixated on an algorithm stored in short-term memory without the flexibility to explore alternatives. SFI consciously "created" false logic to obtain a whole number (12), which he then multiplied by the price of the fence. This scenario is clear evidence of analytical pseudo-thinking, where students use mathematical procedures that appear "intellectual" but actually lack a basis in logical truth.

SFI's subjects exhibit a unique pseudo-thinking profile. Although the field-independent cognitive style is typically associated with analytical rigor, in this case, this independence actually leaves the subjects "isolated" within their logic. SFI tends to employ a forced procedural justification to reach a final answer deemed ideal, without exercising cognitive control (metacognition) over the correctness of each calculation step.

Stages of Implementing the Settlement Plan

The following are the results of interviews with Field Independent subjects at the stage of implementing the completion plan

P : So, can you explain how the process works once you know the formula you want to use?
SFI : So, I raise 6 to the power of 2, then add 8 to the power of 2.
P : And then?
SFI : I get 18 and 24, then add them together to get 37. Then I find the root, then I find the product of 12 that's closest to 37. But what I get is 3 times 12 equals 36. So, simply multiplying 37 by 12 gives me 1,200,000.
P : Is there any difficulty in answering the question?
SFI : The calculation

This stage is the culmination of the analytical pseudo-thinking phenomenon experienced by SFI. There is a complete disconnect between the chosen formula and the calculation process carried out. SFI states that 6^2 is 18 and 8^2 is 24. This indicates that the subject performed an incorrect cognitive "cleaning," where he multiplied the base number by the exponent (6 x 3) or another incorrect pattern instead of performing the exponent. The SFI subject shows an analytical pseudo-thinking profile. The field-independent characteristic, which should be strong in dissecting problems, in this case actually triggers the subject to perform forced logical justification. SFI prioritizes completion of the calculation procedure (procedural fluency) over conceptual truth (conceptual understanding). The subject's unawareness of his operational errors indicates a weak metacognitive function in monitoring his thought processes.

Re-Checking Stages

The following are the results of the Field Independent subject interviews at the re-examination stage.

P : Are you sure about the answer you got?
SFI : God willing.
P : So how do you verify the answer? Is it correct or not?
SFI : Yes, but I don't know.
P : What is the conclusion of this answer?
SFI : Hopefully, it's correct.

The final stage confirmed the weakness of metacognitive control in this FI subject. When asked to verify, the FI subject responded, "Yes, but I don't know." He felt his answer was administratively correct (because he had already reached the final result), but cognitively, he lacked the mechanism to verify the validity of his logic. Answers like "Hopefully, it's correct" indicate that, for the FI subject, mathematics is a game of following procedures, not about believing in logical truth.

The FI subject exhibited analytical pseudo-thinking behavior. Despite possessing a field-independent cognitive style that should be analytical, the subject was trapped in forced procedural justification. The subject prioritized reaching the final answer by consciously manipulating logic (such as root extraction) to conform to a pattern of answers he considered reasonable, indicating a weak metacognitive control function in validating conceptual truth.

Discussion

Building upon the analysis, SFI subjects exhibited a unique pseudo-analytical thinking profile. Although the field-independent cognitive style is typically associated with sharp analytical skills and independence in processing information, the subjects in this study were trapped in forced procedural justifications.

Isolated Analytical Characteristics

SFI subjects were able to understand the problem by separating the relevant variables (side lengths of 6 m and 8 m and the cost of the fence), which is a characteristic of the FI cognitive style. However, this independence actually left the subjects "isolated" in their own logic. This aligns with cognitive style theory, which states that FI individuals tend to be analytical (Giancola et al., 2023; Nicolaou & Xistouri, 2011). However, this study shows that without strong conceptual mastery, these analytical abilities are used only to construct formal formats without the substance of logical truth.

Procedural Logic Failure and "Making Sense" Manipulation

A fatal breakdown in logical structure was found during the plan implementation stage. The subject calculated that $6^2 = 18$ and $8^2 = 24$, indicating a flawed "cognitive cleansing" where the subject multiplied base numbers using an incorrect pattern. The subject also consciously manipulated the results to obtain round numbers (such as forcing the square root to 12) to make the results appear "appropriate" or ideal. This phenomenon confirms the presence of pseudo-thinking, where students prioritize procedural fluency over conceptual understanding (Nurmaela et al., 2024). The subject felt they had followed the correct mathematical procedure simply because the format appeared complete (there was a formula, there were calculations, and there was a result).

Weaknesses in Metacognitive Control

One crucial finding was the weakness of metacognitive control. The subject felt she had no difficulty and was confident in her answer ("God willing"), but when asked to verify it, she answered, "Yes, but I don't know." This indicates that the FI subjects in this study lacked mechanisms to validate the logical correctness of their own steps. For the subject, mathematics was viewed as a game of following administrative procedures to reach a final result, rather than a matter of belief in logical truth (Detlefsen, 2023; Ormerod, 2023).

This study provides a new perspective on the Field Independent (FI) cognitive style in the context of mathematical problem-solving. It corrects the common view that the

FI style is always correlated with logical rigor. This study demonstrates that the independence of the FI style can actually trigger "logical isolation," where subjects believe in conceptually flawed procedures. It enriches the literature on pseudo-thinking by introducing a specific profile of FI subjects, namely the use of procedures that appear "intellectual" and administrative but are consciously manipulated to achieve perceived ideal results. It demonstrates a significant gap between the ability to separate variables (an FI characteristic) and metacognitive control in validating the correctness of thought processes.

Furthermore, these results can be used by educators to design more appropriate interventions. Teachers should not assume that students who appear independent and analytical (an FI characteristic) already understand basic concepts such as exponents or square roots correctly. It demonstrates the need to shift assessment from simply "reasonable end results" to "validity of each logical step" to detect procedural manipulation. It provides a basis for developing learning modules that train students to conduct substantive self-verification (rechecking), not just administrative ones.

4. CONCLUSION

Research findings indicate that SFI subjects exhibit a pseudo-analytical thinking profile, where they are able to independently separate problem variables but consciously manipulate logic to achieve the ideal answer. There is a disconnect between the chosen formula ($a^2 + b^2 = c^2$) and the calculation process, such as fatal errors in exponentiation operations ($6^2 = 18$ and $8^2 = 24$). Subjects feel they have solved the problem correctly because they have followed the mathematical "format" (formula, calculation, and final result), even though the steps involved lack a basis in logical truth. Furthermore, there is a significant weakness in metacognitive control functions, where subjects are unable to verify the validity of their logic and tend to resign themselves to the final result with statements such as "Hopefully, it's right." Furthermore, subjects fixate on a memorized algorithm and lack the flexibility to explore other methods, indicating limitations in deep conceptual understanding.

As a recommendation, teachers need to conduct in-depth checks on FI students who appear calm and independent, as they may be trapped in false logic hidden behind neat answer formats. Students need to be accustomed to verifying not only the final results but also each step of the process to ensure logical consistency. It is recommended to examine the comparison of pseudo-thinking profiles between field-independent and field-dependent subjects to see differences in the patterns of logical manipulation. Conduct experimental research on the effectiveness of providing "cognitive conflict" to make SFI subjects aware of procedural errors they perceive as administratively correct.

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