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# Pseudo Students' Thinking Process in Solving Function Composition Inverse Problems Based on Piaget's Theory

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**ABSTRACT:** The purpose of this study was to describe the pseudo-thinking process of students in solving inverse function composition problems based on Piaget's theory. This study was descriptive qualitative research. Subjects were selected using purposive sampling, with two 11th-grade students from MAN 3 Banyuwangi participating in the study. The instruments used were mathematics tests and interview guidelines. Data collection techniques included test sheets with think-aloud, followed by interviews, which were then analyzed and described. Data analysis techniques employed the Miles and Huberman procedure, which consisted of data condensation, data presentation, and conclusion drawing. The data validity technique used triangulation methods. The test used in this study consisted of two questions. The results showed that students who think pseudo-correctly or pseudo-incorrectly tend to experience many assimilation processes in Piaget's stages. Students who think pseudo-correctly continue to experience assimilation, so they will only be in a state of disequilibrium. Students who think pseudo-incorrectly initially experience many assimilation processes, followed by disequilibrium, but can reach a state of equilibrium. Individuals with pseudo-wrong thinking have a more effective accommodation process than those with pseudo-right thinking. Thus, students with pseudo-right thinking tend to go through two Piaget stages in solving inverse function composition problems, while students with pseudo-wrong thinking go through all four Piaget stages.

**KEYWORDS:** Inverse Composition Functions, Pseudo, Piaget, Thinking Process.

## INTRODUCTION

Mathematical reasoning is a fundamental ability that plays a crucial role in students' thinking processes when solving mathematical problems (Hasanah et al., 2023). In mathematics education, reasoning functions as a cognitive activity that enables students to construct logical conclusions based on previously learned concepts (Khoirunnisa, 2025). Through mathematical reasoning, students engage in a sequence of thinking processes, including understanding the problem, planning appropriate solution strategies, and producing solutions. These processes may occur either correctly or pseudo (illusory), depending on the depth of students' conceptual understanding (Alifah & Aripin, 2018).

One type of thinking error frequently observed in mathematics learning is pseudo-thinking. Pseudo thinking occurs when students apply solution procedures that appear correct but are founded on incomplete or superficial conceptual understanding. In this condition, students tend to treat new problems as identical to previously encountered examples, despite differences in context or problem requirements, which ultimately leads to inaccurate conclusions (Efendi & Pratama, 2020; Ismiasih, 2024). Pseudo thinking can be classified into two forms: pseudo-correct, where students arrive at the correct answer using incorrect reasoning, and pseudo-incorrect, where students produce incorrect answers even though their reasoning appears logical. From the perspective of Piaget's theory, pseudo-thinking is associated with an imbalance between assimilation and accommodation processes within students' cognitive structures.

Students' thinking errors, including pseudo thinking, require serious attention because they may hinder the development of meaningful conceptual understanding in mathematics learning (Devi Angraerni, 2021). Meaningful teaching and learning require the integration of real-life contexts in mathematics instruction to support students in accessing and constructing mathematical knowledge (Lestari & Juniati, 2018). Piaget's theory offers a relevant theoretical framework for examining students' thinking processes through the stages of disequilibrium, assimilation, accommodation, and equilibrium, which reflect how students construct and reorganize mathematical knowledge (Agustina, 2021; Rahmaniar et al., 2021).

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Mathematical understanding is a key component in ensuring the younger generation's readiness to participate in modern societal life (Kurniati, 2016). One mathematical topic that demands strong reasoning and deep conceptual understanding, and thus has the potential to elicit pseudo-thinking, is the inverse of function composition. This topic is often perceived as difficult by students because it involves the integration of several related concepts, including functions, inverse functions, and function composition (Kamin et al., 2021; Susanti & Lestari, 2019). Insufficient conceptual exploration and limited practice in this topic may lead students to rely on procedural imitation rather than genuine understanding, increasing the likelihood of pseudo-thinking (Parwati et al., 2024).

Previous studies have investigated pseudo thinking from various perspectives, such as self-confidence and Polya's problem-solving stages (Salsabila dan Azhar, 2022; Syahraini, 2023). However, research that explicitly examines students' pseudo-thinking processes based on Piaget's cognitive development theory, particularly in the context of inverse function composition, remains limited. Therefore, this study aims to analyze students' pseudo-thinking processes in solving inverse function composition problems based on Piaget's theory, to provide deeper insights into students' cognitive difficulties and contribute to the improvement of mathematics learning practices.

## MATERIALS AND METHODS

### Design and Participants

This type of research is descriptive research with a qualitative approach, as it aims to describe the pseudo-students' thought processes in solving inverse function composition problems based on Piaget's theory. Qualitative descriptive research aims to obtain a more in-depth picture and a holistic or comprehensive understanding, based on the natural setting of the phenomenon to be studied (Yusanto, 2019). The subjects of this study were students of class XI-3 at MAN 3 Banyuwangi. The research subjects were selected using purposive sampling, which is the determination of samples based on specific considerations. The selection of subjects was based on several indicators, namely: (1) at least one student experienced pseudo-errors and pseudo-correct answers, (2) students had good communication skills and were cooperative in conducting in-depth research. This study is a descriptive study with a qualitative approach, as it aims to describe the thinking process of students in solving inverse function composition problems based on Piaget's theory. Qualitative descriptive research aims to obtain a more in-depth description and holistic or comprehensive understanding based on the natural context of the phenomenon to be studied (Yusanto, 2019). The subjects of this study were students of class XI-3 at MAN 3 Banyuwangi. The research subjects were selected using purposive sampling, which is the determination of samples based on certain considerations. The selection of subjects was based on several indicators, namely: (1) at least one student experienced false errors and false correct answers, (2) students had good communication skills and were cooperative in conducting in-depth research. Four subjects were selected who met the research criteria, namely S1 and S2 experienced pseudo-correct thinking, then S3 and S4 experienced pseudo-incorrect thinking.

### Instrument

The data collection methods used in this study were tests and interviews. The test questions consisted of two questions containing material on inverse function composition. Inverse composition is still often considered difficult by students because of its abstract nature (Pramesti & Ferdianto, 2019). This test was used to measure students' pseudo-thinking. Think-aloud was used to observe students' thinking processes while working on the questions. Interviews were used to supplement data not obtained from written tests and interviews, and to determine how students' pseudo-thinking processes worked in answering test questions based on Piaget.

Pseudo-thinking indicators used in this study are those (Swaraswati et al., 2019) and can be seen in Table 1.

**Table 1. Pseudo-thinking indicators**

| Aspect | Pseudo-thinking indicators |
|---|---|
| Correct pseudo-thinking | Students can answer correctly, but cannot provide logical reasons, or their understanding of the concept is incorrect |
| Incorrect pseudo-thinking | Students answer incorrectly, but when reflecting on their answers, they can correct them and explain them logically, or their understanding of the concept is correct |

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The characteristics of Piaget's stages in students (Susanto, 2010) can be seen in Table 2.

**Table 2. Characteristics of students in the thinking-process based on Piaget's stages**

| Terms in thinking | Description | Characteristics |
|---|---|---|
| Disequilibrium | The state of imbalance experienced by a person as a result of the problems they face | Students have difficulty understanding questions, as evidenced by repeated reading and muttering |
| | | Students take a long time to respond to questions, indicating uncertainty in understanding the problem and planning the steps to solve it |
| | | Students are not yet able to systematically develop a solution strategy, so they tend to simply repeat the question or information without stating a clear plan |
| | | Students show hesitation in determining concepts and formulas, especially on questions that have not been given before, indicating low self-confidence and limited mathematical reasoning |
| | | Students tend to only repeat the information in the question without being able to solve it, which shows limited problem-solving and critical thinking skills in the context of mathematics |
| Assimilation | The process of directly integrating new information into an existing scheme | Students are able to state the information known in the question, even though in some cases the initial answer is not correct |
| | | Students can quickly and accurately identify what is being asked in the problem |
| | | Students show quick and accurate responses to questions that are straightforward or familiar |
| | | Students have mastered the formula and can write it down fluently |
| | | Students are able to solve problems similar to the examples they have studied, demonstrating their ability to apply concepts |
| | | Students tend to use spontaneous strategies, such as trial and error, when faced with problems |
| Accommodation | Modifying old schemes or creating new ones to accommodate the information received | Students use trial and error strategies to solve problems, trying certain numbers as solutions even though they are still wrong |
| | | Students continue to try other numbers until they find an answer they consider to be correct, without ensuring that it is mathematically correct. |
| | | Students use unstructured methods of solving problems, such as relying on intuition or guesswork (trial and error) |
| | | Students do not yet fully understand the concept of inverse function composition, as evidenced by their |

| Terms in thinking | Description | Characteristics |
|---|---|---|
| | | initial inaccuracy in stating the formula and their change of answer after reconsidering |
| Equilibrium | The state of equilibrium experienced by a person due to the problems faced has been resolved after a process of assimilation and accommodation. | Students initially used trial-and-error strategies and did not get the correct answers |
| | | After going through the assimilation and accommodation processes, students successfully found the correct answers |
| | | Students made cognitive adjustments and improved their understanding of the concepts |

**Data analysis technique**

The test results, think-aloud, and interviews consisted of data reduction, data presentation, and conclusion drawing. The details of the data analysis performed are as follows: (1) data from test results, think-aloud, and interviews are summarized by selecting important data and eliminating unimportant data; (2) data from test results, think-aloud, and interviews are analyzed and described descriptively for each pseudo-thinking criterion based on Piaget's stages; (3) conclusions were drawn from the findings.

**Procedures**

All students in class XI-3 have received material on inverse function composition. All students in class XI-3 were given a test on inverse function composition to identify students who think pseudo. The test had to be completed in 40 minutes, accompanied by a recording (think-aloud), after which the students were interviewed. Two students who experienced true pseudo and two students who experienced false pseudo were selected. All four subjects communicated well and were very cooperative in participating in the study.

## RESULTS

Based on the test results, think-aloud and interviews, the pseudo thinking process based on Piaget's model of students in class XI-3 can be seen in Table 3.

**Table 3. Pseudo-Thinking Process Based on Piaget's Model**

| Pseudo Type | Test Questions | Subject | Thinking Process *Disequilibrium* | Thinking Process Asimilasi | Thinking Process Akomodasi | Thinking Process *Equilibrium* |
|---|---|---|---|---|---|---|
| Pseudo-correct | Number 1 | S1 | √ | √ | | |
| | Number 2 | S2 | √ | √ | | |
| Pseudo-incorrect | Number 1 | S3 | √ | √ | √ | √ |
| | Numberr 2 | S4 | √ | √ | √ | √ |

Based on Table 3, the following presents the results of research describing the pseudo-correct thinking process, namely S1 and S2, and the pseudo-incorrect thinking process, namely S3 and S4, based on Piaget's stages.

**The pseudo-correct thinking process of students based on Piaget's theory**

Students with pseudo-correct thinking are classified as S1 and S2. The pseudo-thinking process based on the Piaget S1 stage for the first category can be seen in Figure 1.

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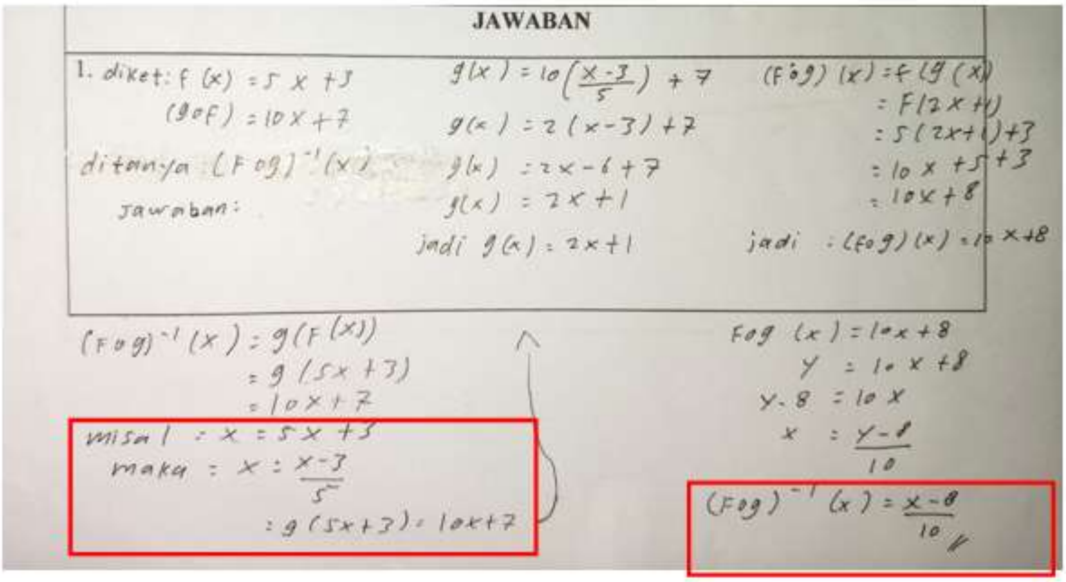


**Figure 1. First Test Answer of S1**

Based on Figure 1, the analysis of test results, think-aloud data, and interviews, subject S1 produced a correct final answer for the inverse composition function problem namely $\frac{x-8}{5}$ . However, deeper analysis revealed inconsistencies in S1's conceptual understanding. Although the written solution included the expression $\frac{x-3}{5}$ . S1 was unable to explain logically how this expression was obtained. During the think-aloud process and interviews, S1 relied on procedural imitation, trial-and-error strategies, and examples from notes rather than conceptual reasoning.

The interview data indicated that S1 applied incorrect transformation rules when manipulating algebraic expressions, such as arbitrarily "moving" terms without understanding the underlying operations. S1 also demonstrated misconceptions regarding inverse functions, referring to inverses as "minus one" or "power −1," and assumed that determining the left and ight functions in a composition involved identical procedures. Furthermore, when asked about the relationship between $(f^{-1} \circ g^{-1})(x)$ and $(f \circ g)^{-1}(x)$. S1 responded based on intuition rather than verification, indicating a lack of reflective reasoning.

From the perspective of Piaget's theory, S1 consistently exhibited assimilation throughout the problem-solving process. The student attempted to incorporate new problems into existing cognitive structures without restructuring those structures through accommodation. As a result, no equilibrium was achieved, and S1 remained in a state of cognitive disequilibrium. Although the final answer was correct, the reasoning process was flawed and unsupported by conceptual understanding.

Therefore, S1 can be classified as experiencing pseudo-correct thinking, characterized by correct answers generated through incomplete or incorrect reasoning. The dominance of assimilation without accommodation suggests that S1's understanding of inverse composition functions is superficial, highlighting the need for instructional strategies that emphasize conceptual reconstruction rather than procedural imitation.

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**The pseudo-thinking process based on the Piaget S2 stage for the second category can be seen in Figure 2.**

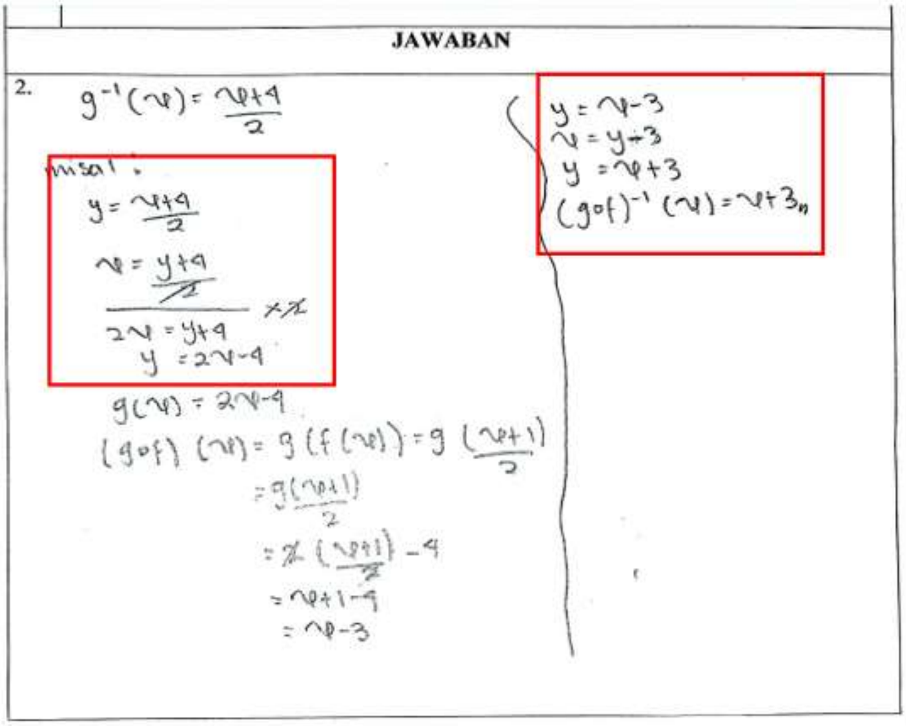


**Figure 2. Second Test Answer of S2**

Based on Figure 2, the test results, Subject S2 produced a correct final answer to the inverse function composition problem, namely $x + 3$. However, the think-aloud data and interview findings revealed that S2 was unable to explain the reason for changing the variable from y to x and vice versa in the written solution steps. The subject tended to follow procedural steps taken directly from the textbook without understanding the mathematical meaning underlying those steps.

Further analysis indicated errors in algebraic manipulation, particularly in writing inverse function equations. S2 incorrectly wrote expressions such as $y = 2x - 4$ and $y = x + 3$, which should have been written as $x = 2y - 4$ and $x = y + 3$, respectively. These errors suggest that S2 had not fully understood the concept of variable interchange in determining inverse functions. Additionally, when asked to compare the inverse of $(g \circ f)(x)$ with $(f^{-1} \circ g^{-1})(x)$, S2 responded based on personal belief rather than mathematical justification or verification.

From the perspective of Piaget's theory, S2's thinking process was dominated by assimilation. The subject attempted to solve the problem by incorporating new information into existing cognitive structures through imitation of textbook examples, without restructuring those structures through accommodation. Consequently, cognitive equilibrium was not achieved, and the subject remained in a state of disequilibrium.

Although the final answer was correct, the reasoning process was not supported by adequate conceptual understanding. Therefore, Subject S2 is classified as experiencing pseudo-correct thinking, characterized by correct answers obtained through incomplete or flawed reasoning. The dominance of assimilation without accommodation indicates that S2's understanding of inverse function composition remains procedural and superficial.

**The pseudo-incorrect thinking process of students based on Piaget's theory**

Students with pseudo-incorrect thinking are classified as S3 and S4. The pseudo-thinking process based on the Piaget S1 stage for the first category can be seen in Figure 3.

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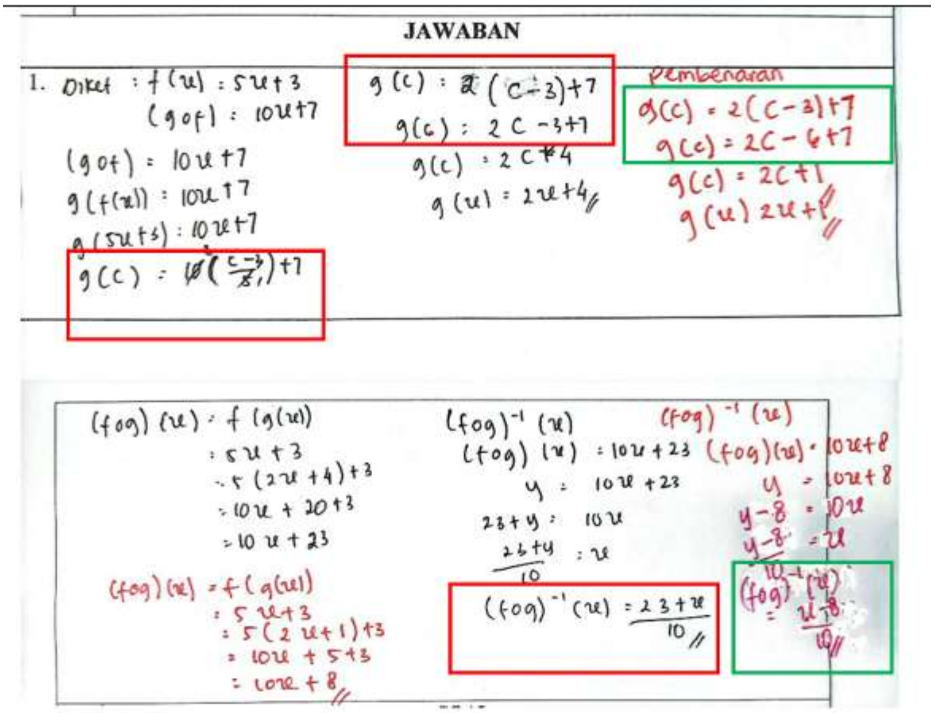


**Figure 3. S3 First Test Answer of S3**

Based on Figure 3, the test results, Subject S3 produced an incorrect final answer to the inverse function composition problem. However, the think-aloud data indicated that S3 was able to explain the solution steps in a relatively systematic manner. Although the written solution contained an error, S3 demonstrated an understanding of the reasoning behind using variable substitution and inverse operations. During the think-aloud process, S3 was able to explain how the expression $\frac{c-3}{5}$ was obtained, even though the explanation was not fully complete.

Interview findings revealed that S3 clearly understood the purpose of using substitution, namely, to determine the left function in a known composition before finding the inverse of the composed function. When prompted to reflect on the incorrect final result, S3 was able to identify the specific error made in the algebraic manipulation, particularly in multiplying expressions, where $2(c-3)+7$ was incorrectly written instead of the correct form $2c-6+7$. S3 acknowledged that the error was caused by a lack of carefulness rather than a misunderstanding of the concept. After reflection, S3 was able to correct the steps and obtain the correct final answer.

According to Piaget's theory, S3's thinking process was initially dominated by assimilation, which is the use of existing cognitive structures to solve problems. This included when asked to compare the formula $(f^{-1} \circ g^{-1})(x)$ and $(f \circ g)^{-1}(x)$. The doubts and confusion that arose during the interview process indicate a state of cognitive disequilibrium. Through the researcher's guidance and attempts to re-try the inverse composition function formula, S3 made adjustments to their understanding that reflected the process of accommodation. This process led S3 to a state of cognitive equilibrium, which was characterized by a more accurate understanding of the relationship between inverse functions and function composition.

Although the initial answer provided by S3 was incorrect, the subject showed the ability to recognize and correct errors through reflection and conceptual reasoning. Therefore, S3 is classified as experiencing pseudo-incorrect thinking, characterized by an incorrect final answer despite the presence of generally correct reasoning processes. Unlike other subjects who remained dominated by assimilation, S3 was able to progress through disequilibrium and accommodation to reach equilibrium, indicating a relatively strong conceptual understanding of inverse function composition.

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**The pseudo-thinking process based on the Piaget S4 stage for the second category can be seen in Figure 4.**

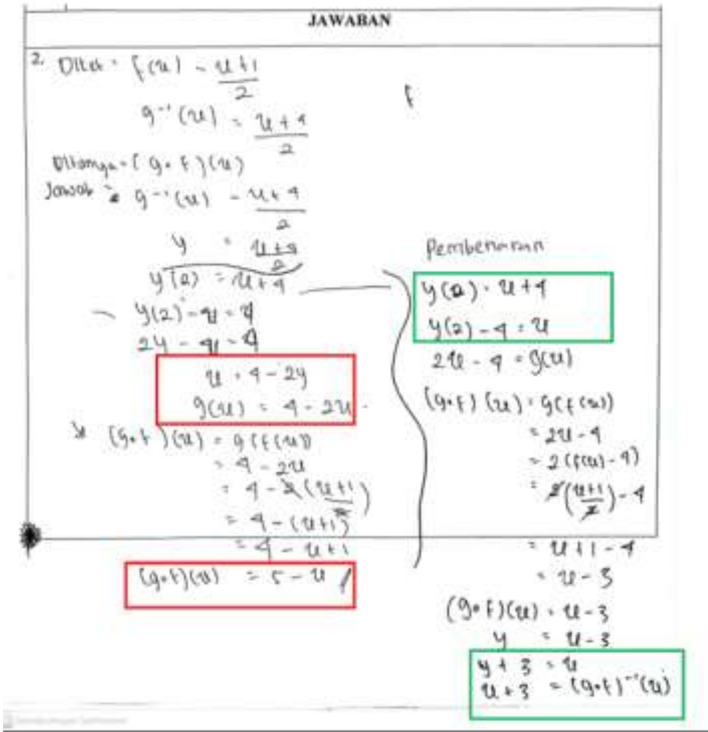

**Figure 4. Second Test Answer of S4**

Based on Figure 4, the test results, Subject S4 produced an incorrect final answer to the inverse composition function problem. Nevertheless, the think-aloud data revealed that S4 was able to explain the solution steps in a structured and logical manner. The incorrect answer was not caused by a lack of conceptual understanding, but rather by inaccuracies in interpreting the problem and performing algebraic transformations.

Interview results indicated that S4 understood the initial steps required to solve the problem, particularly the need to determine the original function from its inverse before forming the composition. However, S4 admitted that the solution was incomplete because the focus was mistakenly placed on finding the function composition rather than its inverse. In addition, S4 showed uncertainty when manipulating equations, specifically in determining the correct form of the variable transformation, such as confusing $2y - x = 4$ with $2y - 4 = x$. Despite this confusion, S4 demonstrated a clear understanding of why solving for $x$ was necessary in determining the function.

After reflection during the interview, S4 was able to identify the errors and correct the solution steps appropriately. This indicates that the incorrect final answer resulted primarily from carelessness in reading the problem and inaccuracies in applying algebraic rules, rather than from misconceptions about inverse and composition functions.

From the perspective of Piaget's cognitive development theory, S4 predominantly exhibited assimilation, as prior knowledge was continuously applied throughout the problem-solving process. When confronted with contradictions between assumed formulas of the inverse $(g \circ f)(x)$ with $(f^{-1} \circ g^{-1})(x)$, S4 experienced cognitive disequilibrium. With guidance, S4 re-evaluated and reconstructed the understanding of inverse composition rules, demonstrating accommodation and ultimately reaching cognitive equilibrium.

Although S4 initially produced an incorrect and incomplete solution, the subject was capable of correcting the reasoning process after reflection. Therefore, S4 is categorized as experiencing pseudo-incorrect thinking, characterized by correct conceptual understanding accompanied by procedural errors. Overall, despite frequent reliance on assimilation, S4 was able to undergo disequilibrium, accommodation, and equilibrium, indicating a relatively strong conceptual grasp of inverse composition functions.

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## DISCUSSIONS

The results of this study indicate that students' pseudo-thinking processes in solving inverse composition function problems can be categorized into two types, namely pseudo-correct thinking and pseudo-incorrect thinking. Each type exhibits distinct characteristics in terms of both the final answers produced and the underlying cognitive processes.

Students who experienced pseudo-correct thinking (S1 and S2) were able to produce correct final answers; however, their solutions were not supported by adequate conceptual understanding. These students were unable to provide logical explanations for key procedural steps, such as variable substitution and algebraic manipulation in inverse functions. Their reasoning tended to rely on memorized procedures or examples from textbooks rather than on conceptual comprehension. This finding supports previous studies (Subanji, 2011; Syahraini et al., 2023), which states that pseudo-correct thinking occurs when students obtain correct results through flawed or superficial reasoning. From Piaget's perspective, these students predominantly remained in the assimilation stage and failed to adjust their cognitive structures when confronted with new or conflicting information, resulting in prolonged disequilibrium.

In contrast, students who experienced pseudo-incorrect thinking (S3 and S4) produced incorrect final answers, yet demonstrated relatively strong conceptual understanding. Their errors were mainly procedural or technical, such as inaccuracies in algebraic operations or misinterpretation of given information. Through reflective interviews, these students were able to identify and correct their mistakes, indicating that the errors did not stem from misconceptions but rather from a lack of carefulness. This finding is consistent with previous research (Layn & Kahar, 2017; Ulfa & Kartini, 2021), which highlights that students may commit calculation or procedural errors despite having a sound understanding of mathematical concepts.

Based on Piaget's theory, students with pseudo-incorrect thinking experienced not only assimilation but also disequilibrium, followed by accommodation, and ultimately reached equilibrium. Cognitive conflict emerged when students were questioned about alternative formulas for inverse composition functions, prompting them to reorganize their existing knowledge structures. Their ability to accommodate new information reflects cognitive flexibility and supports the development of deeper conceptual understanding.

Overall, this study reveals that students exhibiting pseudo-correct thinking tend to be trapped in excessive assimilation and encounter difficulty achieving cognitive equilibrium. In contrast, students with pseudo-incorrect thinking are more likely to reach equilibrium because they are capable of adjusting their understanding when faced with new information. These findings emphasize the importance of instructional practices that prioritize conceptual understanding, reflective thinking, and cognitive conflict, rather than focusing solely on correct final answers in mathematics learning.

## CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that students who experience pseudo thinking, when viewed from Piaget's theory, tend to rely predominantly on the process of assimilation and remain in a state of cognitive disequilibrium. This occurs because students primarily memorize procedures, formulas, or examples provided by the teacher without sufficient conceptual understanding. Consequently, new information is continuously incorporated into existing cognitive schemas without adequate accommodation, resulting in a superficial or pseudo understanding of inverse function composition. This condition is reflected in students who are able to produce correct final answers but are unable to explain the underlying concepts or reasoning processes, a phenomenon referred to as pseudo-correct thinking.

Meanwhile, students who experience pseudo-incorrect thinking also predominantly engage in assimilation; however, this process is supported by sufficient accommodation. Errors made by these students are generally procedural or technical in nature, leading to incorrect final answers despite a relatively good conceptual understanding. Through reflection and cognitive conflict (disequilibrium), these students are able to adjust their thinking and achieve cognitive equilibrium. Therefore, this study highlights the importance of aligning procedural success with conceptual understanding in mathematics learning. Strengthening both aspects is essential to minimize pseudo thinking and to support students in developing more meaningful and coherent mathematical understanding.

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