

ANALYSIS OF STUDENT'S MATHEMATICAL REASONING BASED ON FIELD DEPENDENT AND FIELD INDEPENDENT COGNITIVE STYLES

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Abstract

This study focuses on describing students' mathematical reasoning profiles based on Field Dependent (FD) and Field Independent (FI) cognitive styles, particularly in solving problems involving linear absolute value equations and inequalities of one variable. This research is a descriptive qualitative study. The research subjects comprised 4 eleventh-grade students (Class XI IPA 6) from SMA Negeri 1 Sumberpucung, categorized into 2 FD students and 2 FI students. Data collection techniques included the GEFT, mathematical reasoning tests, interviews, and documentation. The results indicate that FD students, in the indicator of formulating conjectures, tended to write down information using verbal sentences. In mathematical manipulation, they relied on illustrative images and intuitive understanding but committed errors in constructing mathematical models for absolute value inequalities. Consequently, this hindered their ability to draw valid conclusions and they tended to neglect re-checking their answers. Conversely, FI students formulated conjectures using mathematical notation and utilized formal absolute value concepts for manipulation. Furthermore, FI students were able to draw correct conclusions and consistently verified the validity of their arguments.

Keywords: mathematical reasoning, cognitive style, field dependent, field independent

Abstrak

Penelitian ini difokuskan untuk memaparkan profil penalaran matematis siswa ditinjau dari gaya kognitif *Field Dependent* (FD) dan *Field Independent* (FI), khususnya dalam menyelesaikan masalah persamaan dan pertidaksamaan nilai mutlak linear satu variabel. Penelitian ini menggunakan jenis penelitian deskriptif kualitatif. Subjek penelitian terdiri dari 4 siswa kelas XI IPA 6 SMA Negeri 1 Sumberpucung, yang dikategorikan menjadi 2 siswa FD dan 2 siswa FI. Teknik pengumpulan data meliputi tes GEFT, tes penalaran matematis, wawancara, dan dokumentasi. Hasil penelitian menunjukkan bahwa siswa FD, pada indikator mengajukan dugaan, cenderung menuliskan informasi menggunakan kalimat verbal. Dalam manipulasi matematis, mereka mengandalkan gambar ilustrasi dan pemahaman intuitif namun melakukan kesalahan dalam menyusun model matematika untuk pertidaksamaan nilai mutlak. Akibatnya, hal ini menghambat kemampuan mereka untuk menarik kesimpulan yang valid dan mereka cenderung mengabaikan pemeriksaan ulang jawaban mereka. Sebaliknya, siswa FI merumuskan dugaan menggunakan notasi matematika dan memanfaatkan konsep nilai mutlak formal untuk melakukan manipulasi. Lebih lanjut, siswa FI mampu menarik kesimpulan yang benar dan secara konsisten memverifikasi kesahihan argumen mereka.

Kata kunci: penalaran matematis, gaya kognitif, field dependent, field independent

INTRODUCTION

Mathematical reasoning is a fundamental ability that students must master, as emphasized by the National Council of Teachers of Mathematics (NCTM) and the Indonesian curriculum standards (Permendikbud No. 21 of 2016). Reasoning serves as the foundation for students to make conjectures, manipulate mathematical models, and draw valid conclusions. However, empirical conditions in schools often indicate that students' reasoning abilities remain suboptimal. Students frequently struggle to connect formal mathematical concepts

with problem-solving contexts, particularly in abstract materials such as Linear Absolute Value Equations and Inequalities. This topic demands not only calculation skills but also strong logical consistency in defining positive and negative domains.

The ability to reason mathematically is not uniform among students; it is significantly influenced by internal factors, one of which is cognitive style. Witkin (1977) distinguishes cognitive styles into Field Dependent (FD) and Field Independent (FI). Students with the FI style tend to be analytical and capable of separating items from their context (disembedding), whereas FD students tend to view problems globally and are easily influenced by the context. Understanding these differences is crucial for teachers to map out students' thinking processes and errors in solving algebra problems.

Several studies have explored the relationship between cognitive styles and mathematical abilities. For instance, Wulan and Anggraini (2019) examined Polya's problem-solving profiles in FD and FI students, while other studies have focused on geometry or general arithmetic. However, research specifically analyzing mathematical reasoning indicators on the topic of Absolute Value remains limited. Most previous studies (Zaini, 2021; Khasanah, 2019; Ratnawati, 2018) focused on final learning outcomes or general algebraic manipulation errors without deeply investigating the *process* of how FD and FI students construct arguments and conjectures in the complex context of absolute value inequalities.

Therefore, this study offers a novelty by focusing on the specific reasoning mechanisms of FD and FI students in transitioning from verbal understanding to symbolic manipulation in absolute value problems. This research aims to fill the gap in the literature by providing a detailed description of how cognitive styles influence the validity of arguments and the tendency for misconceptions in absolute value inequalities. By understanding these specific profiles, this study provides a new perspective on the epistemological obstacles faced by FD students in abstract algebra.

Based on the background above, this study aims to describe students' mathematical reasoning abilities based on Field Dependent and Field Independent cognitive styles on the material of linear absolute value equations and inequalities of one variable. The results of this study are expected to be useful, especially to the school regarding student's abilities in mathematical reasoning, so that they can help develop student's mathematical reasoning abilities at the school.

METHODS

This study employed a descriptive qualitative research design to describe students' mathematical reasoning based on field-dependent (FD) and field-independent (FI) cognitive styles in solving linear absolute value equations and inequalities of one variable. The participants were 27 students of Class XI IPA 6 at SMA Negeri 1 Sumberpucung who had previously received instruction on absolute value concepts.

Data were collected using the Group Embedded Figures Test (GEFT), a mathematical reasoning test related to linear absolute value equations and inequalities, semi-structured interviews, and documentation. Initially, students completed the GEFT to determine their cognitive style categories. Subsequently, two students from each cognitive style group (FD and FI) were purposively selected as research subjects to complete the mathematical reasoning test. In-depth interviews were then conducted based on the students' written responses to further explore their reasoning processes and to obtain information that could not be captured through written tests alone.

Data analysis was carried out through data reduction, data display, and conclusion drawing by comparing students' written work with interview transcripts to obtain comprehensive insights into students' mathematical reasoning in terms of FD and FI cognitive styles. Analysis of student work is carried out based on indicators reasoning mathematical in the following table.

Table 1. Indicator Mathematical Reasoning

Indicator Mathematical Reasoning	Description
Formulating a conjecture	Student can write or explain what is known and asked in the problem as well as suspect answers and solution processes from problem with explain strategy used for solve problem .
Do manipulation mathematical	Student can write steps to solve problem, work on in accordance algorithm settlement problem, and do operation mathematics with correct so that find the requested answer with right .
Drawing conclusion	Student can make and get appropriate conclusion with context problem on the question.
Checking the validity of an argument	Student inspect return truth from something solution that has done

RESULTS AND DISCUSSION

The research began by administering the Group Embedded Figures Test (GEFT) to 27 students of Class XI IPA 6 at SMA Negeri 1 Sumberpucung. The test results were scored to classify students into Field Dependent (FD) and Field Independent (FI) cognitive styles. The distribution of the students' cognitive styles is presented in Table 2.

Table 2. Distribution of Students Based on Cognitive Styles

No.	Cognitive Styles	Number of Students
1.	FD	11
2.	FI	16

Based on the classification above, four subjects were selected for further analysis using the mathematical reasoning test and interviews. The subjects consisted of two FD students and two FI students, as shown in table 3.

Table 3. List of Research Subjects

No.	subject	Information
1.	MIP	FD
2.	AF	FD
3.	GDT	FI
4.	RKN	FI

Mathematical Reasoning of Field Dependent (FD) Students.

The analysis of FD students' reasoning profiles was based on the work of subjects MIP and AF. In understanding the problem, both FD subjects relied heavily on concrete visual representations rather than abstract mathematical models. They tended to rewrite information verbally. When identifying the "house number" problem, Subject MIP translated the verbal clues into a drawing of a number line rather than an absolute value equation.

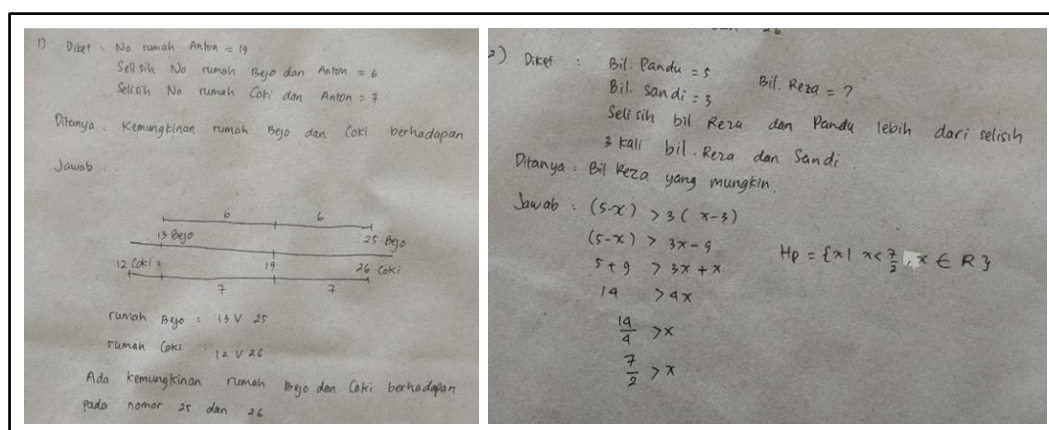


Figure 1. Subject MIP's visualization of the problem.

This reliance on visual aids was confirmed during the interview. Subject MIP stated that he needed to "see" the position physically to understand the context. Similarly, Subject AF used a circling method to identify the numbers manually. This indicates that FD students struggle to disembed the mathematical problem from its visual context.

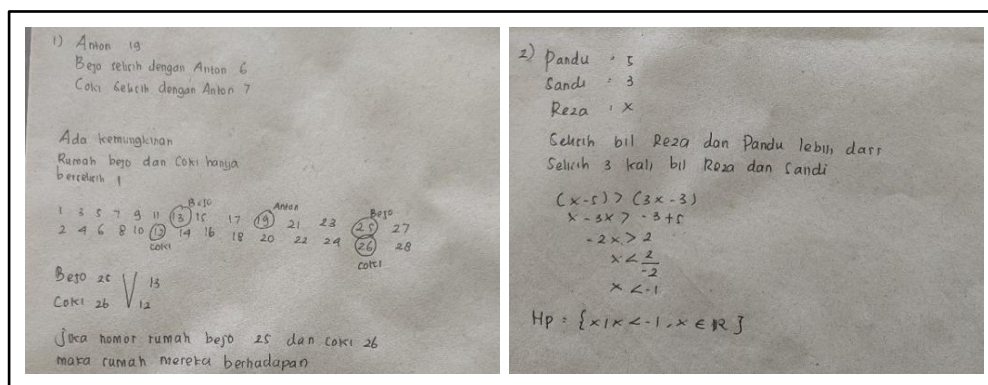


Figure 2. Subject AF's visualization of the problem.

While the visual strategy worked for simple problems, it became a hindrance in complex absolute value inequalities. In the second problem (Reza's number), both subjects failed to apply the formal definition of absolute value. They treated the inequality intuitively without considering the multiple cases (positive and negative domains) required by the absolute value concept. They struggled to abstract the concept of "maximum distance" into the absolute value symbol, leading to errors in the calculation process.

Consequently, this affected the indicator of drawing conclusions. Due to the initial error in the mathematical model, the final conclusion regarding the range of values was incorrect. Furthermore, regarding the indicator of checking validity, the interview results revealed that FD subjects did not perform a re-check or substitution to verify their answers. They felt sufficient with the steps they had written down without proving the truth of their arguments.

Mathematical Reasoning of Field Independent (FI) Students

A different profile was demonstrated by the Field Independent subjects, GDT and RKN. For the indicator of formulating conjectures, both subjects immediately identified the variables and wrote down the known information using mathematical symbols/notation. They did not rely on verbal descriptions but directly converted the text into algebraic form. For the house number problem, Subject RKN directly formulated the absolute value equation $|x - 19| = 6$ without drawing the houses or lines. The subject RKN using formal concepts is

presented in Figure 3. This confirms that FI students can effectively separate the mathematical structure from the narrative context.

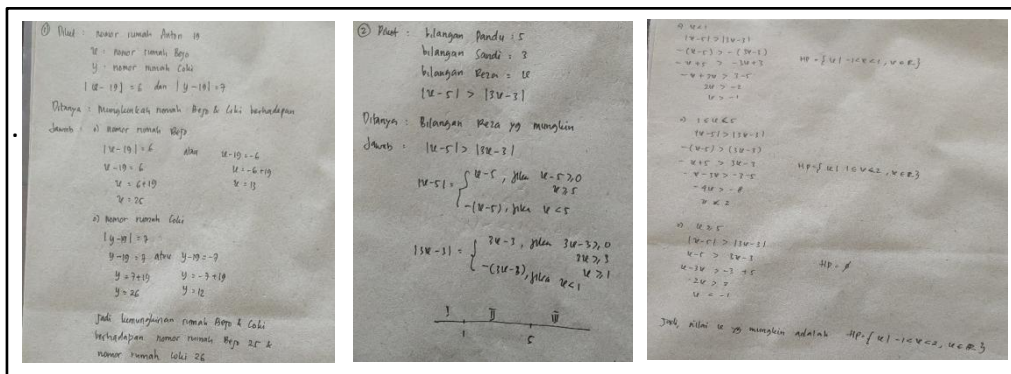


Figure 3. Subject RKN (FI) using formal concepts.

In solving inequalities, FI subjects utilized the formal properties of absolute value. Subject GDT, for instance, explicitly mentioned using the "concept" of absolute value to split the problem into positive and negative cases. As displayed in Figure 4, subject GDT solved the inequality problem by applying the definition of absolute value correctly

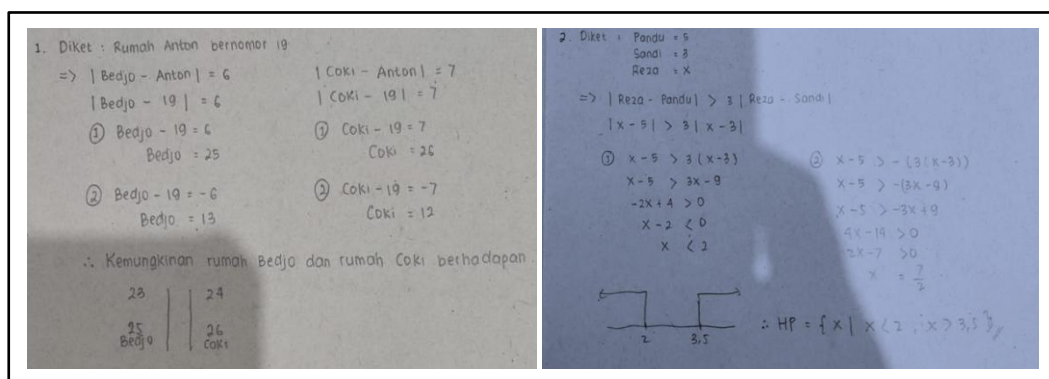


Figure 4. Mathematical manipulation by Subject GDT (FI) using formal concepts.

Figure 4 shows that the subject systematically wrote the inequality and solved it using algebraic procedures. They did not require visual illustrations to understand the context. This accurate manipulation allowed them to draw valid conclusions regarding the interval of height requirements.

Finally, for the indicator of checking validity, both FI subjects demonstrated a habit of verification. Based on the interview transcripts and their worksheets, they substituted the final values back into the initial equation to ensure that the results were logical and mathematically correct.

Divergence in Representation and Conceptual Understanding

The findings of this study highlight a distinct contrast in mathematical reasoning profiles between Field Dependent (FD) and Field Independent (FI) students, particularly in solving linear absolute value problems. While both groups could initiate the problem-solving process, their methods of representation and manipulation differed significantly.

A key difference was observed in the conjecturing stage. FD students (MIP and AF) relied heavily on verbal sentences and illustrative images to represent the problem information. This aligns with Wulan & Anggraini (2019), who noted that FD learners tend to process information globally and verbally. In contrast, FI students (GDT and RKN) immediately translated the problem into mathematical sentences (symbols). This validates Witkin's (1977) theory that FI learners possess a higher analytical ability to disembed information from its context and restructure it into abstract forms.

The divergence became critical during mathematical manipulation, specifically in absolute value inequalities. FD students successfully used visual illustrations for the first problem but failed to construct the correct mathematical model for the inequality in the second problem. They struggled to abstract the context into the rigorous definition of absolute value (e.g., changing "distance" into $|x - a| < b$). This confirms Istiqomah (2014), who found that FD students face difficulties when the context requires shifting from concrete situations to abstract rules. Conversely, FI students utilized the formal concept of absolute value systematically. As noted by Akramunnisa (2017), FI students demonstrate sequential and analytical reasoning, allowing them to apply abstract rules (inequalities) without relying solely on visual intuition.

A significant gap was also found in the validity checking indicator. FI students consistently verified their answers by substituting values or recalculating, whereas FD students tended to be satisfied with their initial written steps without re-checking. This passivity in verification among FD students supports Basir (2015), suggesting that FD learners are more likely to accept the "given structure" of their initial thought process rather than analytically questioning it.

Based on these findings, there are important implications for mathematics instruction. Teachers should recognize that FD students may struggle with the immediate transition to symbolic algebra, especially in abstract topics like absolute value inequalities. Therefore,

scaffolding is required. Teachers should not only provide formulas but also help FD students bridge the gap between their visual/verbal intuition and formal mathematical symbols. Using visual aids that gradually transition to abstract notation could help FD students avoid the conceptual errors observed in this study

CONCLUSION

Based on the analysis and discussion, this study concludes that there are distinct differences in the mathematical reasoning profiles of students with Field Dependent (FD) and Field Independent (FI) cognitive styles, particularly in the topic of linear absolute value equations and inequalities.

Students with the Field Dependent (FD) style tend to initiate the reasoning process by representing problem information verbally and relying on concrete visual illustrations. While this approach is helpful for basic understanding, it poses a significant obstacle when constructing mathematical models for absolute value inequalities. FD students struggle to abstract the context into formal algebraic definitions, leading to errors in the conjecturing and manipulation stages. Furthermore, they demonstrate a passive attitude in validating arguments, often neglecting to re-check their answers.

Conversely, students with the Field Independent (FI) style demonstrate a strong analytical ability to translate verbal problems directly into symbolic mathematical notation. They effectively utilize the formal properties of absolute value to solve inequalities and are capable of drawing valid conclusions. A key characteristic of FI students is their consistency in verifying the validity of their arguments through substitution or recalculation.

These findings suggest that mathematics instruction on abstract topics, such as absolute value, requires differentiated approaches. For FD students, teachers should provide scaffolding to bridge the gap between their visual intuition and formal symbolic algebra. Learning strategies should not immediately force abstract formulas but should gradually transition from concrete visual aids to mathematical modeling to minimize conceptual errors.

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