



Numerical Ability in Problem Solving Among MTs NU Miftahul Huda: A Review of Cognitive Styles that Dependent and Independent of the Field of Study

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Abstract

Numerical skills and problem-solving are crucial competencies influenced by students' cognitive styles. This qualitative descriptive study aims to describe the numerical abilities of eighth-grade students of MTs NU Miftahul Huda Prigen in solving problems of the System of Linear Equations in Two Variables reviewed from the cognitive styles of Field Dependent (FD) and Field Independent (FI). Numerical abilities are measured through indicators of counting, logical thinking, organizing information, and identifying patterns, while the problem-solving process is guided by Polya's steps (understanding, planning, implementing, and re-checking). The research subjects were determined using the Group Embedded Figures Test (GEFT). Data were collected through numerical ability test instruments and interviews, then analyzed descriptively. The results of the study show significant differences between the two types of cognitive styles. Students with the FI cognitive style tend to be more independent, analytical, and organized in processing numerical data and are able to separate relevant information from the problem context. In contrast, FD students tend to need additional guidance, have difficulty in separating important information from complex contexts, and rely heavily on previously given example problems. This conclusion highlights the importance of an adaptive teaching approach to students' thinking characteristics in mathematics learning.

Keyword: Numerical Ability, Problem Solving, Cognitive Style, Field Dependent, Field

Introduction

Mathematics education plays a central role in shaping students' logistical and analytical mindsets. Mathematics is not simply a discipline filled with formulas and numbers (Alam, 2023), but rather an essential tool for practicing reasoning and systematic thinking. Therefore, the primary goal of mathematics instruction in schools is to ensure students not only master concepts but also apply them in broader contexts, both in academic matters and in everyday life. One of the core competencies that must be achieved in mathematics learning is problem-solving ability (Gunawan,

2020; Hanin & van Nieuwenhoven, 2020). Problem-solving is a process that challenges students to identify, analyze, and find appropriate solutions to previously unseen situations (Afifah & Putri, 2021). This ability is often considered the heart of the mathematics curriculum, as it encourages students to think creatively and use the various knowledge they have acquired in an integrated manner.

In the context of problem-solving, numerical skills are an integral foundation. Numerical skills encompass an understanding of basic numbers, arithmetic operations, and the efficient manipulation of quantitative data (Michael, 2024; Stagnaro, 2023). Specifically, in ensuring algebraic material such as Systems of Linear Equations in Two Variables (SLSV), strong numerical skills are essential for accurately completing procedural steps such as substitution, elimination, and final calculations. Without adequate numerical mastery, the mathematical problem-solving process will be hampered, even at the conceptual analysis stage.

The System of Linear Equations in Two Variables (SLSV) is essential material at the intermediate level, requiring a synthesis of algebraic concepts and numerical skills (de Chambrier, 2021). SLSV presents contextual problems that must be modeled mathematically before being solved using methods such as substitution, elimination, or mixed methods (Grace & Sekhon, 2024). The complexity of the modeling and the need for precision in calculations in SLSV often leads to conceptual and procedural difficulties for students, requiring a strong mastery of SLSV concepts and high numerical accuracy (Helm, 2020; Tian, 2023; Topsakal, 2022). Although the learning objectives are the same, the effectiveness of the learning and problem-solving processes is greatly influenced by the unique characteristics of each student. These individual differences are known as learning styles and cognitive styles. Cognitive style refers to the consistent way in which an individual receives, processes, stores, and uses information. Understanding cognitive styles is key to explaining why some students excel at certain types of tasks over others (Qomaria, Afifah, & Manivannan, 2025).

One dimension of cognitive style relevant to mathematics learning is Field Dependent (FD) and Field Independent (FI). Students with a Field Dependent cognitive style tend to view a problem holistically, influenced by the surrounding context or "field." They require a clear external structure and tend to rely on the available direction and context (Gutsche, 2023). In contrast, Field Independent students tend to analyze problems partially, are able to separate important elements from distracting contexts (fields), and are more independent in developing problem-solving strategies. Theoretically, the differences between FD and FI cognitive styles are closely correlated with how students solve problems, fundamentally affecting the use and efficiency of their numerical abilities (Khajanchi, 2021; Vanbecelaere, 2021). FI students may be quicker at identifying calculation steps and sorting relevant data for numerical operations. Meanwhile, FD students may take longer to process numerical information when presented in complex or less structured contexts. Therefore, in-depth research is needed to empirically test this hypothesis in the context of SPLDV materials.

Although numerous studies have examined cognitive abilities, focusing on general problem-solving skills, few have specifically examined the numerical ability profiles of students with FD and FI, particularly when faced with SPLDV material that demands precision and abstraction (Zhang, 2020). This study aims to address this gap by examining in detail how these two cognitive style groups utilize and demonstrate their numerical abilities when solving SPLDV problems (Barbieri, 2020; Botting, 2020). Based on this background, this study aims to describe and analyze in depth the numerical ability profiles of junior high school students in solving SPLDV problems, as viewed from the perspective of Field Dependent and Field Independent cognitive styles (Baiduri, 2020; Hu, 2024). The results of this study are expected to provide practical contributions to mathematics teachers in developing more adaptive learning strategies, more structured materials, and assessments that accommodate the diversity of students' cognitive styles, ultimately improving overall mathematics learning outcomes.

Method

This study employs a qualitative approach with a descriptive research design to provide an in-depth and holistic description of students' numerical ability profiles in solving System of Linear Equations in Two Variables (SPLDV) problems, analyzed through Field Dependent (FD) and Field Independent (FI) cognitive styles (Gea, Hernández-Solís, Batanero, & Álvarez-Arroyo, 2023). The

descriptive design is specifically intended to present the subjects' cognitive processes in their entirety without involving statistical hypothesis testing. The research was conducted at MTs NU Miftahul Huda Prigen during the even semester of the 2024/2025 academic year. The initial subject pool consisted of all eighth-grade students, who were subsequently screened using the Group Embedded Figures Test (GEFT) to determine their respective cognitive styles. Based on the test results, two primary subjects representing extreme characteristics were selected: one subject with a Field Dependent (FD) style from the lowest score group and one subject with a Field Independent (FI) style from the highest score group. Both subjects were also required to demonstrate adequate conceptual understanding of SPLDV to ensure a comprehensive problem-solving process.

Data collection was carried out through three primary techniques (Nguyen, 2022). First, the Group Embedded Figures Test (GEFT) served as a classification instrument to categorize students into FD and FI groups. Second, a Numerical Ability Test consisting of SPLDV-themed essay problems was administered to measure four key indicators: information grouping, pattern or formula construction, mathematical resolution, and comprehensive explanation of the solution. Third, semi-structured interviews were conducted following the written test to clarify the subjects' thought processes, strategies, and numerical awareness. The data were then analyzed using descriptive qualitative techniques through three systematic stages (Roh, 2021): data reduction, which involved summarizing and focusing on data relevant to the subjects' numerical profiles; data display, presented through descriptive narratives supported by tables and excerpts of student work to highlight the differences between FD and FI profiles; and conclusion drawing, achieved by comparing findings from the written tests and interviews (methodological triangulation) to obtain credible data regarding the numerical ability profiles of each cognitive style.

Result and Discussion

Result

This study analyzes the numerical abilities of Islamic Junior High School (MTs) students in solving problems related to the System of Linear Equations in Two Variables (SPLDV), with a focus on comparing the performance between subjects characterized by Field Dependent (FD) and Field Independent (FI) cognitive styles.

Table 1. Analyses thje numerical abilities

Name	Scor e 1	Scor e 2	Tota l Skor	cognitive style
PKR	2	3	5	Field-Dependent
BSZA	4	5	9	Field-Dependent
KNF	6	2	7	Field-Dependent
A	4	4	8	Field-Dependent
NNS	5	3	8	Field-Dependent
AWDL	4	3	7	Field-Dependent
FZ	3	3	6	Field-Dependent
AAZZR	3	5	8	Field-Dependent
NLZ	5	3	8	Field-Dependent
NLZ	6	7	13	Field-Independent
LM	6	6	12	Field-Independent
ABS	5	5	10	Field-Independent
MMR	7	7	14	Field-Independent
MFA	6	4	10	Field-Independent
RY	8	8	16	Field-Independent
AZF	8	9	17	Field-Independent
DR	8	8	16	Field-Independent
MFA	8	8	16	Field-Independent
DNAT	6	4	10	Field-Independent
KSA	9	7	16	Field-Independent
NWAK	6	7	13	Field-Independent

Based on the Group Embedded Figures Test (GEFT) conducted with 21 students, the distribution of cognitive styles revealed that 9 students (40%) were classified as Field Dependent (FD), while 12 students (60%) exhibited a Field Independent (FI) cognitive style. The findings indicate that students with an FI cognitive style demonstrate integrated and effective numerical abilities across all stages of the SPLDV problem-solving process based on Polya's framework. These students tend to work more systematically and structurally. Analysis of subjects FI-1 and FI-2 showed that they were highly capable of identifying essential information and accurately transforming verbal problems into precise mathematical models. Furthermore, they formulated logical and efficient strategies, performed algebraic operations with high consistency and precision, and successfully verified their final results to ensure relevance to the initial problem.

In contrast, students with an FD cognitive style exhibited numerical abilities that require further guidance, particularly in organizing information and structuring solution steps. Subjects FD-1 and FD-2 demonstrated significant challenges in abstracting or decomposing primary information from complex contexts. These subjects often struggled to construct complete mathematical models and frequently proceeded to calculations without clear planning. They tend to focus on visible numerical values rather than the underlying structure of the SPLDV, leading to errors in variable manipulation and significant inaccuracies in algebraic operations, such as substitution or elimination. Additionally, FD students rarely performed evaluations or re-checks of their results, often leading to

conclusions that were inconsistent with the problem context.

The assessment of numerical abilities in this study was specifically measured through four key indicators. First, the ability to categorize and organize information necessary for problem-solving. Second, the capacity to identify numerical patterns and formulate mathematical summaries. Third, the proficiency in solving problems provided through accurate mathematical procedures. Finally, the ability to provide a comprehensive explanation of the entire solution process. The disparity between FI and FD subjects across these indicators suggests that cognitive styles significantly influence how students process quantitative data and execute mathematical reasoning in the context of linear equations.

The analysis of the first subject (SFI) commenced with an assessment of the first numerical indicator: the ability to categorize information required for problem-solving. The subject was presented with a contextual word problem involving a fruit transaction made by two individuals, Rahman and Malik. The problem posited that Rahman purchased 1 kg of mangoes and 2 kg of oranges for a total of IDR 50,000, while Malik bought 1 kg of mangoes and 1 kg of oranges for IDR 35,000. To evaluate numerical proficiency, the subject was required to perform two key tasks based on this scenario. First, the subject has to identify and categorize the specific information from the narrative that is relevant for the solution. Second, the subject was tasked with constructing mathematical patterns or formulas derived from the categorized data to calculate the specific unit prices for 1 kg of oranges and 1 kg of mangoes

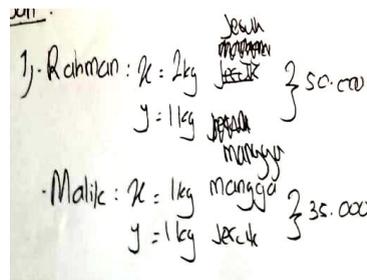


Figure 1. SFI Answer

Based on Figure 1, SFI explicitly organized the problem components by noting, Rahman $x=2$ kg oranges and $y=1$ kg mangoes = 50,000 and Malik $x=1$ kg mangoes and $y=1$ kg oranges = 35,000. This written evidence demonstrates the subject's capacity to effectively categorize the information required to solve the problem. This finding is further corroborated by the interview data, where in the subject explained the strategy of separating the information into two distinct segments: Rahman's transaction (buying 1kg of oranges and 2kg of mangoes for 50,000) and Malik's transaction (buying 1kg of mangoes and 1kg of oranges for 35,000). When queried regarding the difficulty of this task, SFI confirmed that the process was not difficult. The consistency between the written work and the verbal explanation validates that SFI fulfills the first indicator. Consequently, the analysis proceeds to the second indicator, which assesses the student's ability to construct numerical patterns and their underlying relationships.

Subsequently, SFI formulated the mathematical model by writing $x+2y=50,000$ and $x+y=35,000$, demonstrating the student's proficiency in constructing numerical patterns and identifying their corresponding conditions. This observation is substantiated by the interview data, where in the subject confirmed the ability to identify numerical patterns or formulas within the provided problem. When probed regarding the specific method employed, SFI explicitly explained that the solution was derived using the System of Linear Equations in Two Variables (SPLDV) formula. This verbal confirmation, combined with the written evidence, indicates that the subject is capable of formulating numerical patterns along with their technical relationships, thereby fulfilling the criteria for the second indicator.

Regarding the third indicator, which assesses the student's proficiency in mathematically solving the assigned problem, the analysis of SFI's answer sheet reveals a systematic algebraic approach. SFI correctly documented the solution process by writing the equations $x+2y=50,000$ and substituting variables to derive the solution, noted as $x(35,000-y)+2y=50,000$, which simplified to $35,000+y=50,000$, resulting in $y=15,000$. Subsequently, the student solved for the second variable using $x+y=35,000$, rearranging it to $x=35,000-y$, yielding $x=20,000$. This written evidence demonstrates SFI's capability to execute the mathematical procedures required. This finding is further corroborated by the semi-structured interview, where the researcher sought to validate the solution process. When asked to articulate the strategy employed, SFI confirmed the ability to solve the problem and explicitly detailed the steps taken: "To find the value of y , I used the formula $x+2y=50,000$ (and the substitution process). so the value of y is 15,000. To find the value of x , I used $x+y=35,000$... so the value of x is 20,000." The consistency between the written calculations and the verbal explanation confirms that SFI is capable of solving the problem regularly, thus fully satisfying the third indicator.

Regarding the fourth indicator, which evaluates the student's aptitude for explaining the overall solution process, the analysis confirms that SFI is capable of articulating the entire problem-solving sequence comprehensively. Based on the interview data, the subject demonstrated a clear understanding of the problem's structure by explicitly noting that the task consisted of multiple components, recognizing that the initial requirement was to categorize the relevant information presented in the prompt.

The analysis of the Field Dependent (SFD) subject begins with the first indicator: the ability to categorize information. The

subject explicitly detailed Rahman's transaction as $x=2$ kg oranges and $y=1$ kg mangoes totaling IDR 50,000, and Malik's transaction as $x=1$ kg mangoes and $y=1$ kg oranges totaling IDR 35,000. These data points demonstrate that SFD is capable of identifying and grouping information relevant to problem resolution. Regarding the second indicator, which maintains the ability to construct numerical patterns and their relationships, SFD demonstrated adequate competence. Based on interview data, the subject confirmed the ability to formulate mathematical models using the principles of the System of Linear Equations in Two Variables (SPLDV), thus fulfilling the second indicator.

For the third indicator, SFD demonstrated the capacity to solve the problem mathematically and systematically. The subject articulated the solution procedure through substitution, where the step $35,000 - y + 2y = 50,000$ is simplified to $35,000 + y = 50,000$, resulting in a value of $y=15,000$. Subsequently, the value of x was determined using the equation $x + 15,000 = 35,000$, yielding $x=20,000$. Based on this procedure, SFD satisfied the third indicator. However, regarding the fourth indicator, the subject was unable to articulate the solution process in its entirety. During the interview, the subject acknowledged this limitation, stating that while they could explain the categorization of information and the formation of mathematical models ($x+2y=50,000$ and $x+y=35,000$), they struggled to provide a comprehensive interpretation of the final results. Consequently, SFD is categorized as not having fully met the fourth indicator.

These findings fundamentally reinforce the theory that differences in cognitive styles (Field Dependent/Field Independent) significantly influence how students organize, analyze, and abstract data within the context of mathematical problem-solving. Field Independent (FI) students, possessing the analytical ability to separate elements from a broader context, are inherently superior in stages requiring systematic formulation, planning, and algebraic calculations. Their numerical abilities are well-integrated within Polya's problem-solving framework. Conversely, Field Dependent (FD) students, who tend to view contexts holistically, face substantial challenges in the abstraction stage such as transforming word problems into mathematical models and in problem decomposition. Their numerical calculations are often impeded by difficulties in distinguishing relevant data from distracting contextual information. These implications underscore the necessity for educators to provide more detailed and structured scaffolding, particularly for FD students, to assist them in visualizing variables, constructing mathematical models, and executing algebraic procedures sequentially in SPLDV subject matter.

Discussion

This study fundamentally corroborates Witkin's theory that differences in cognitive styles (Field Dependent/Field Independent) directly influence the mechanisms by which students organize, analyze, and abstract data during mathematical problem-solving. Based on the findings, students with a Field Independent (FI) cognitive style demonstrate numerical abilities that are effectively integrated and systematic across all stages of Polya's problem-solving framework. In terms of data analysis (Fauza, Inganah, Darmayanti, Prasetyo, 2022; Yapatang & Polyiem, 2022), FI subjects are capable of distinguishing essential elements from narrative contexts and transforming them into precise mathematical models (variables x and y).

Procedurally, they exhibit high accuracy in algebraic operations both substitution and elimination with minimal calculation errors (Olsson & Granberg, 2024). Furthermore, FI subjects fulfill all ability indicators, including the capacity to logically and autonomously articulate the solution process without external assistance. This aligns with the characteristics of the FI style, which tends to be analytical and efficient in separating relevant elements from distracting contexts.

In contrast, students with a Field Dependent (FD) cognitive style encounter more significant challenges, particularly in the stages of abstraction and procedural precision. FD subjects frequently

struggle to decompose primary information when problems are presented in complex word formats; they tend to perceive the problem holistically but fail to attend to technical details. Numerical weaknesses in this group often manifest as inaccuracies in basic arithmetic operations such as calculations involving negative numbers and sign errors during coefficient elimination. Although they may solve problems in written form, they often face verbal barriers when asked to rationalize their steps, indicating that their understanding remains heavily reliant on scaffolding or external cues.

These findings underscore that numerical ability is not merely a matter of computational proficiency but is profoundly influenced by the student's information processing mechanisms. As a result, FI students require more complex challenges to hone their independent analytical skills, whereas FD students need structured scaffolding support such as step by step guides or variable visualization to navigate the complexities of SPLDV word problems. Overall, this research emphasizes the urgency for educators to adopt teaching strategies that are adaptive to students' cognitive characteristics to optimize learning outcomes.

Conclusion and Recommendation

Based on in-depth qualitative analysis, this study identifies significant disparities in numerical ability profiles between students with Field Independent (FI) and Field Dependent (FD) cognitive styles in solving problems related to the System of Linear Equations in Two Variables (SPLDV). Students with an FI cognitive style demonstrate superior and precise numerical proficiency, exhibiting the capacity to regularly implement procedural steps ranging from modeling and algebraic manipulation to complex arithmetic operations. This advantage is driven by their analytical characteristics, which enable the independent verification of critical numerical elements within the problem context, thereby minimizing procedural errors. Conversely, students with an FD cognitive style, while capable of constructing global models, exhibit significant weaknesses in computational precision. Frequently identified errors include inaccuracies in operational signs, basic arithmetic errors, and coefficient inconsistencies. This phenomenon is closely attributed to their tendency towards holistic information processing, where microscopic numerical details are often overlooked in favor of the overall problem structure. Theoretically, cognitive style is proven to influence numerical accuracy; the analytical approach of FI students supports the deconstruction of problems into distinct sub-steps, whereas the holistic approach of FD students acts as a structural impediment to maintain rigor in subject matter requiring high algebraic precision.

Based on these findings, several strategic recommendations are proposed. For mathematics educators, it is recommended to adopt teaching strategies that are adaptive to cognitive styles, particularly for FD students. Interventions may include the presentation of material with explicit step-by-step guidance, the utilization of visualization techniques (such as color markers or focus boxes) to highlight operational variables, and the habituation of re-checking procedures at each calculation stage to reduce negligence. For future researchers, it is suggested to conduct experimental studies to test the effectiveness of adaptive learning models such as the use of structured visual media in enhancing numerical abilities and reducing procedural errors among Field Dependent students in SPLDV material or other procedural mathematics topics.

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