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Research Article

ENHANCING STUDENTS' CRITICAL THINKING IN NUMERACY PROBLEM-SOLVING THROUGH A FIELD-INDEPENDENT LEARNING STYLE AND HIGH SELF EFFICACY

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Abstract
The urgency of addressing the lack of critical thinking skills among class V-B students at elementary school Ketintang 1 Surabaya is paramount. This study aims to elucidate the critical thinking abilities of students who exhibit a field-dependent cognitive style and high self-efficacy. The study employed a qualitative approach and phenomenological method. Data collection involved the use of the Group Embedded Figures Test (GEFT), self-efficacy questionnaires, and critical thinking assessments in mathematics, specifically on topics related to cubes and rectangular prisms. Data analysis comprised data condensation, data presentation, and conclusion drawing. Based on GEFT and self-efficacy questionnaire results, one class V-B student with a field-dependent cognitive style and high self-efficacy was selected for further critical thinking skills assessment. Based on the results of the critical thinking skills test, the student with a field-dependent cognitive style and high self-efficacy demonstrated notable strengths. In the process of basic clarification, the student met the indicators for analyzing arguments and formulating statements, effectively presenting their arguments. When providing reasons for decisions, the student showed the ability to consider the credibility of sources by selecting appropriate problem-solving strategies. However, she occasionally made calculation errors due to inaccuracy. In the process of concluding, the student met the indicators for making and evaluating decisions, successfully composing conclusion sentences that aligned with the problems and final answers.

Keywords: Critical Thinking Ability, Field-Dependent Cognitive Style, Self-Efficacy.

INTRODUCTION

The progress of the 21st century is marked by placing knowledge at the forefront as the main catalyst for development. The National Education Association highlights the "4Cs"—critical thinking, creativity, communication, and collaboration—as essential 21st-century skills. In this globalized era, people must undergo significant transformations in personal qualities. Society is expected to use critical thinking and knowledge to tackle and resolve issues (Yustitia & Juniarso, 2020; Kurniawan et al., 2023;

Rahmayani et al., 2023). Additionally, modern education focuses on student-centered learning, aiming to provide students with key cognitive abilities such as (1) critical thinking, (2) problem-solving, (3) metacognition, (4) communication, (5) collaboration, (6) creativity and innovation, and (7) information literacy, with critical thinking being particularly important.

In the epoch of globalization and accelerated technological progress, the cultivation of critical thinking skills has emerged as a fundamental requisite for students to adeptly navigate future exigencies. This proficiency encompasses the capacity to dissect, appraise, and address problems with a methodical and rational approach. Within the realm of mathematics education, especially in the resolution of numerical challenges, the development of this skill is imperative from an early stage. This is supported by Wardani et al. (2021), who noted that mathematics education often presents problems similar to those in daily life. Students with strong critical thinking skills can solve these problems, thus practicing and enhancing their abilities. Consequently, students with a critical mindset can effectively process and manage the information or issues they face. Critical thinking guides individuals toward more precise and effective thought processes, making it indispensable for activities such as teaching and learning.

In learning, each student approaches problem-solving uniquely, influenced by their method of receiving information and their environment, collectively known as cognitive style. Cognitive style encompasses the learning methods and attitudes that significantly affect academic performance (Fadilah & Winarso, 2021; Astalini et al., 2023; Chumburidze et al., 2023). Individuals' cognitive styles vary based on their comprehension type, categorized as either field-dependent or field-independent. Field-dependent individuals typically exhibit higher confidence and independence, while field-independent types tend to rely more on external factors (Son et al., 2020; Mawardani et al., 2023; Saputro et al., 2023). This study specifically focuses on the field-dependent cognitive style.

The development of critical thinking skills also hinges on fostering self-confidence and a belief in one's respective abilities, commonly referred to as self-efficacy. Self-efficacy plays a crucial role in alleviating anxiety and uncertainty when tackling educational challenges. According to Nuraeni et al., (2019), self-efficacy correlates with critical thinking by indicating high confidence in students' capacity to succeed in tasks and excel as critical thinkers. Individuals who cultivate self-efficacy demonstrate confidence in their abilities and a keen interest in learning materials, problem-solving in mathematics, and completing assignments. Higher levels of self-efficacy correspond to increased confidence and enthusiasm in addressing mathematical challenges (Afifah & Kusuma, 2021; Fauziyah et al., 2023; Khoiruddin et al., 2023). Hence, students with elevated self-efficacy are more likely to exhibit enthusiasm, diligence, perseverance, and a proactive approach to completing assigned tasks.

Mathematics education inherently involves critical thinking, as it encompasses problems requiring numerical calculations and the application of analytical skills. Most mathematics content for elementary school students is connected to real-life scenarios. For instance, the concept of calculating the volume of geometric solids, such as cubes and rectangular prisms, is a key component. In the fifth-grade curriculum, this topic is addressed in Chapter 6 of the odd semester under the new curriculum. This study specifically examines the volume of cubes and rectangular prisms, as these geometric solids present mathematical challenges that require critical thinking for effective problem-solving. Volume is defined as the measurement of the space an object occupies, encompassing three dimensions: length, width, and height. In mathematics, volume calculations are used to determine the capacity of three-dimensional objects such as cubes and rectangular prisms. The volume of these shapes is typically calculated using the formula: base area × height, where the base area is derived from length × width. Consequently, the formula for the volume of a cube is $s \times s \times s$, and the formula for a rectangular prism is $l \times w \times h$. Solving problems related to volume requires critical thinking skills, with evaluations based on specific criteria.

Research related to students' critical thinking abilities, particularly those with field-dependent cognitive styles and high self-efficacy, reveals several relevant findings. Edianto et al., (2022) demonstrated that students with field-independent cognitive styles perform differently compared to those with field-dependent styles. Specifically, students with a field-independent cognitive style can effectively document their understanding and questions (interpretation), analyze the relationships between concepts (analysis), follow appropriate steps to arrive at correct answers (evaluation), and draw logical conclusions from their findings (inference). In contrast, students with a field-dependent cognitive style typically meet only three out of these four indicators: interpretation, analysis, and evaluation. Supporting this, Risdianah (2022) found a link between self-efficacy and critical thinking, noting that self-efficacy affects critical thinking levels and is associated with variations in accuracy. Students with high self-efficacy generally meet all four critical thinking indicators but may struggle with precision in interpreting questions. Those with moderate self-efficacy typically meet three indicators but are prone to errors due to hastiness, lack of attention, and insufficient experience in concluding. Conversely, students with low self-efficacy often meet only two indicators, frequently demonstrate imprecision in calculations, and address problems with hesitation. Hidayat & Noer (2021) found that students with high self-efficacy exhibit superior mathematical critical thinking skills compared to their low self-efficacy counterparts.

To further deepen the understanding of the relationship between cognitive styles, self-efficacy, and critical thinking in mathematics education, it is essential to incorporate the concept of numeracy. Numeracy, often referred to as mathematical literacy, is the ability to use, interpret, and apply mathematical concepts and skills in various contexts, both in academic settings and in everyday life. In the 21st century, numeracy has evolved from being a basic skill to a more complex competency that integrates not only mathematical knowledge but also the ability to reason logically, solve problems, and communicate mathematical ideas effectively. Numeracy suggests that a numerate individual is someone who is not only able to carry out basic arithmetic but is also capable of using mathematical reasoning to make decisions, analyze information, and solve problems in real-world contexts (Isnawati et al., 2024; Rochman et al., 2024; Pramulia et al., 2025). This perspective emphasizes that numeracy extends beyond memorization and computation. It involves understanding mathematical concepts deeply enough to apply them in various situations, which requires critical thinking.

The importance of numeracy in the development of critical thinking skills cannot be overstated. In mathematics education, numeracy involves the ability to understand and use numbers, measurements, patterns, and geometric concepts to analyze and solve problems (Goos et al., 2024). For example, when solving problems related to the volume of cubes and rectangular prisms, students must not only understand the formulas but also be able to apply those formulas accurately in different contexts. The act of solving such problems is inherently a numeracy activity because it requires the application of mathematical knowledge in a meaningful way, which directly involves critical thinking. Incorporating numeracy into the discussion of cognitive styles and self-efficacy adds a layer of complexity to the understanding of students' mathematical problem-solving abilities (Mizian, 2023; Oktaviani & Elmojahed, 2023; Yustitia & Kusmaharti, 2024). Numeracy skills are closely tied to cognitive style because individuals with a field-dependent cognitive style may approach problems differently compared to field-independent students. Those with a field-dependent style might rely more on external guidance or context to make sense of a problem, whereas field-independent students may be more self-sufficient in their mathematical reasoning.

Furthermore, self-efficacy plays a significant role in numeracy development. Students who have high self-efficacy are more likely to persist in solving complex mathematical problems, apply multiple strategies, and evaluate their results critically (Indraswara et al., 2023). Their belief in their own abilities can encourage them to approach numeracy tasks with confidence, making them more likely to engage in deep thinking and problem-solving (King & Purpura, 2021). On the other hand, students with low self-efficacy may lack the confidence to approach numeracy tasks, leading to hesitation, errors, and a lack of perseverance. In the context of mathematics education, the integration of numeracy theory into the development of critical thinking, cognitive styles, and self-efficacy provides a more holistic approach to teaching and learning. Educators can enhance students' numeracy skills by encouraging them to apply mathematical reasoning in diverse contexts, thereby fostering critical thinking and self-efficacy. For students with a field-dependent cognitive style, this might involve providing additional support or scaffolding to help them process mathematical problems more independently. Meanwhile, for students with high self-efficacy, challenging them with complex numeracy tasks could further develop their problem-solving abilities and boost their confidence. In conclusion, numeracy theory enriches the discussion on critical thinking, cognitive styles, and self-efficacy by emphasizing the practical application of mathematical knowledge. It aligns with the view that numeracy is a dynamic skill set that requires not only the mastery of mathematical concepts but also the ability to apply those concepts in real-world scenarios. By fostering numeracy, critical thinking, and self-efficacy, educators can better prepare students to navigate the complexities of the 21st century, where mathematical reasoning and problem-solving are indispensable tools for success.

Based on the preceding discussion and findings, it is evident that there is a gap in research concerning the critical thinking abilities of students with a field-dependent cognitive style and high self-efficacy. The researchers posit that a field-dependent cognitive style and high self-efficacy substantially influence students' critical thinking skills in mathematics education, warranting a more comprehensive investigation. Consequently, the researchers aim to explore this topic further in the study titled "Critical Thinking Ability of Students with Field-Dependent Cognitive Style and High Self-Efficacy." It is anticipated that this research may provide deeper insights into students' understanding and self-confidence, thereby enhancing their critical thinking skills in elementary education.

RESEARCH METHOD

This study employed a descriptive qualitative research design with a phenomenological approach. Qualitative research aims to provide a comprehensive understanding of phenomena (Siswono, 2019). The primary objective of this study was to explore and describe the critical thinking abilities of students with a field-dependent cognitive style and high self-efficacy. Conducted at elementary school Ketintang 1 Surabaya, the research focused on fifth-grade students from class V-B for the 2023–2024 academic year. The study involved a single participant who demonstrated a field-dependent cognitive style and high self-efficacy. Data collection was facilitated through three instruments: the Group Embedded Figure Test (GEFT), a self-efficacy questionnaire, and a critical thinking assessment.

The Group Embedded Figure Test (GEFT) is planned to classify students' cognitive styles as either field-dependent (FD) or field-independent (FI). Created by Witkin et al. (1971), the GEFT requires understudies to distinguish basic geometric shapes implanted inside more complex figures. The test comprises 25 things to be completed inside a indicated time constrain and is partitioned into three areas: the primary segment incorporates 7 hone things, whereas the moment and third areas each comprise of 9 appraisal things.

Scoring for the GEFT starts from the second session, where each correct response is assigned 1 point and each incorrect response receives 0 points. The highest possible score is 18 points. Students scoring ≤ 11 are classified as having a field-dependent (FD) cognitive style, while individuals scoring ≥ 11 are classified as having a field-independent (FI) cognitive style (Ridwanah & Masriyah, 2021). The scoring categories for cognitive styles are summarized in the table below.

Table 1. Cognitive Style Scoring Categories

Cognitive Style	Criteria
Field Dependent (FD)	0 ≥ 11
Field Independent (FI)	11 ≤ 18

Based on the results of the GEFT (Group Embedded Figure Test) administered to 24 fifth-grade students in Class V-B at elementary school 1 Surabaya, 19 students exhibited a field-dependent cognitive style, while 5 students demonstrated a field-independent cognitive style. The students with a field-dependent cognitive style subsequently completed a self-efficacy questionnaire, revealing that 5 of them possessed high self-efficacy. Following this, the researchers conducted interviews with the teacher or homeroom teacher of Class V-B to assess the critical thinking abilities of these 5 students. S1 was selected as the subject based on the teacher's assessment of superior critical thinking skills.

The self-efficacy questionnaire comprises 35 items, categorized into two sections: 18 positive statements and 17 negative statements. These items are organized into three dimensions: (1) Level: This dimension assesses task completion, task difficulty, and optimism in handling tasks; (2) Strength: This dimension evaluates persistence in learning, perseverance in task execution, and consistency in achieving goals; (3) Generality: This dimension examines mastery of assigned tasks, understanding of learning material, and time management skills (Bandura, 1994). The breakdown of items in the self-efficacy questionnaire is outlined in the Table 2.

Table 2. Self-Efficacy Questionnaire Items

Dimensions	Item Number
Level	1 to 12
Strength	13 to 24
Generality	25 to 35

The assessment of students' self-efficacy scores employs a questionnaire with Likert scale calculations, as detailed in the following Table 3.

Table 3. Likert Scale Scoring for Self-Efficacy Questionnaire

Dimensions	Statement Scoring	
	Positive	Negative
Strongly Agree (SA)	4	1
Agree (A)	3	2
Disagree (D)	2	3
Strongly Disagree (SD)	1	4

The Likert scale scores are assigned based on student's responses to each item. Total scores are then calculated, followed by averaging the scores for each student. The students' self-efficacy levels are subsequently determined from the questionnaire data by calculating the mean score, computing standard deviation, and categorizing the scores into high, medium, and low. The criteria for self-efficacy categorization are presented in the Table 4.

Table 4. Self-Efficacy Criteria

Self-Efficacy Levels	Criteria
High	Students with a self-efficacy score $\geq \bar{x} + SD$
Medium	Students with a self-efficacy score between $\bar{x} + SD$ and $\bar{x} - SD$
Low	Students with a self-efficacy score $\leq \bar{x} - SD$

This study utilizes a critical thinking test consisting of three essay questions focusing on the volume of cubes and rectangular prisms. These questions are designed as word problems relevant to everyday life and are accompanied by contextual illustrations. The critical thinking test questions has been validated by two expert. Here is question number 3 in this study.

Figure 1. Question Number 2 of the Critical Thinking Test

Aby's bathtub is cube-shaped like the picture on the side. If the bathtub has been filled with 100 liters of water, is it true that Aby has to fill it with 25 more liters of water to make it full?. The test results are further analyzed using modified indicators of critical thinking based on Ennis' theory as cited in Arif et al. (2020). The specific critical thinking indicators applied in this research are outlined below.

Table 5. Critical Thinking Indicators

No.	Aspects	Indicator
1.	Basic Clarification	Analyzing arguments Formulating questions
2.	The Bases for a Decision	Considering the credibility of sources
3.	Inference	Making and evaluating value judgments

The collected data are then subjected to descriptive-qualitative analysis, following the model by Miles and Huberman as cited in Ahmad & Muslimah (2021). This model encompasses data condensation, data display, and conclusion drawing. The sequence of this data analysis process is depicted in the following figure 2.

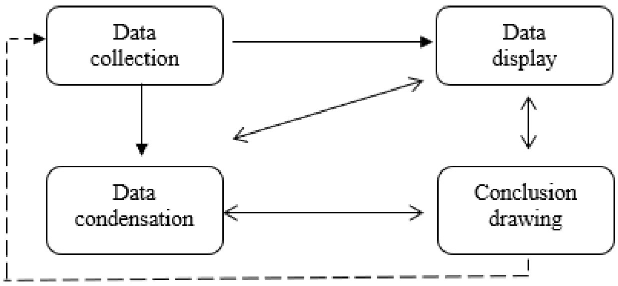

Figure 2. The Flow of Data Analysis

The test results were examined to categorize students into field-dependent and field-independent cognitive styles. Those identified as field-dependent then completed a self-efficacy questionnaire. Based on the analysis of the questionnaire, students were classified into high, medium, and low self-efficacy levels, with those exhibiting high self-efficacy being selected. From this group, one student who possessed both a field-dependent cognitive style and high self-efficacy was chosen as the subject. The selected student then undertook a critical thinking test on the volume of cubes and rectangular prisms and participated in an in-depth interview to further explore her critical thinking skills.

RESULTS AND DISCUSSION

The student was tasked with identifying the spatial structure based on the provided dimensions of a bathtub and calculating the remaining volume of water required. Below is S-1's response to question number 2.

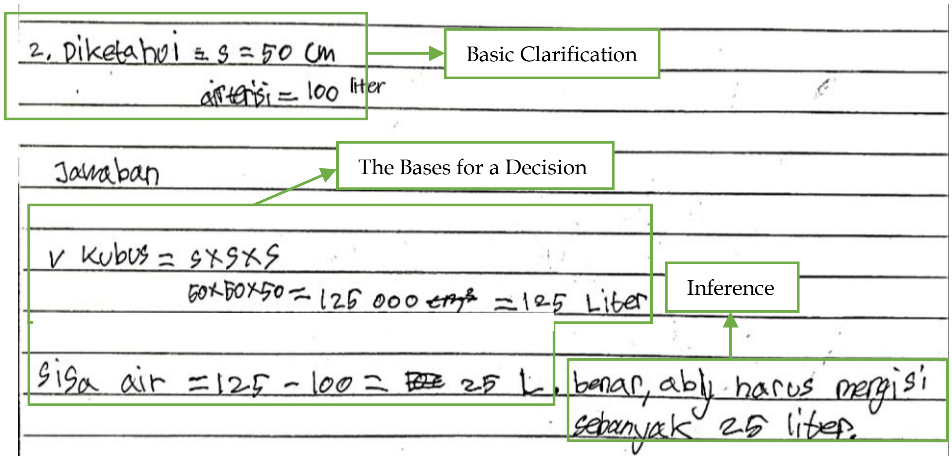

Figure 3. Answer to Question Number 2

This process involves indicators such as analyzing arguments and formulating a question. Below is an excerpt from the researchers' interview with S-1.

Table 6. Interview Excerpt on Basic Clarification Process for Question Number 2

Label	Interview Excerpts	Indicator
P	Considering question number 2, what do you understand after reading the question?	
S-1	*The bathtub is 50 cm wide and currently holds 100 liters of water. To add another 25 liters to fill it, we need to determine the volume of a cube.*	
P	All right, so we need to find the volume of a cube. What resembles a cube? How do you know it's a cube?	Analyzing arguments
S-1	*It's the bathtub because only one side of the bathtub is shown in the picture. The other sides are not mentioned in the question, so its dimensions must be equal, similar to those of a cube.*	
P	Okay, as you mentioned earlier, the bathtub has a "width" of 50 cm. If you're talking about "finding the volume of a cube", does a cube have a width like a rectangular prism?	

Label	Interview Excerpts	Indicator
S-1	*No, I meant its side was 50 cm, not its width.*	Formulating questions
P	What is the issue in the question?	
S-1	*Should Aby add another 25 liters of water to fill it?*	
P	Why wasn't this question addressed in your answer sheet?	
S-1	*Yes, earlier, I forgot to write it down.*	

S-1 demonstrates an effective analysis of the question image. She identifies the bathtub's shape as a cube based on the image, where only one side displays 50 cm, leading her to conclude that the other sides are of equal length, characteristic of a cube. S-1 also frames a question statement that accurately reflects the problem and explains its relevance. However, on her answer sheet, S-1 failed to record the specific question or its formulation due to oversight in verification.

This process involves indicators of considering the credibility of a source. Below is an interview excerpt with S-1 conducted by the researchers.

Table 7. Excerpt from Interview on the Process of Justifying a Decision for Question Number 2

Label	Interview Excerpts	Indicator
P	Based on your understanding of the question, what method will you employ to solve it?	Considering the credibility of a source
S-1	*I will use the method of calculating the volume of a cube.*	
P	So, to determine the remaining water needed to fill it, do you need to calculate the volume of a cube? Why? Please explain your reasoning!	
S-1	*Because I am calculating the remaining water required to fill the bathtub, considering it is shaped like a cube.*	
P	Can the liter unit effectively measure volume? Please elaborate!	
S-1	*Yes, because the liter is a standard unit of volume.*	
P	All right, what comes next?	
S-1	*Volume = s × s × s = 50 × 50 × 50 = 125,000 cm^3 = 125 liters. The remaining water amounts to 125 liters minus the 100 liters already filled, resulting in 25 liters.*	
P	Why subtract the volume of the cube from the water already in the bathtub?	
S-1	*To determine the additional amount needed to fill it.*	

S-1 demonstrates proficiency in devising problem-solving strategies based on acquired information, exemplified by employing the volume formula for a cube due to the measurement of water in liters. S-1 confidently asserts that liters serve as a unit of volume, thereby substantiating the rationale behind selecting this approach. Subsequently, the outcome is derived by subtracting the calculated volume from the amount of water already present. S-1 executes the computations accurately, yielding the precise volume of additional water required.

This phase entails assessing and formulating value-based judgments. Below is an excerpt from the researchers' interview with S-1.

Table 8. Interview Excerpt on the Process of Drawing Conclusions for Question Number 2

Label	Interview Excerpts	Indicator
P	Based on the method you employed in your answer, how do you conclude?	Making and evaluating value judgments
S-1	*Aby needs to add 25 liters of water.*	
P	Will adding 25 liters fill the bathtub?	
S-1	*Yes, it will.*	
P	Does your conclusion align with the question and the resultant answer?	
S-NRHS	*Yes, it does. Adding 25 liters to fill the bathtub is accurate based on the subtraction of the bathtub's volume and the pre-filled water.*	

It can be seen that S-1 explains the conclusions drawn with appropriate considerations, specifically the final answer obtained from subtracting the volume of the bathtub and the filled water. Additionally, the conclusion is written comprehensively and accurately on the answer sheet. In analyzing arguments for each question, a student with a field-dependent cognitive style and high self-efficacy shows an ability to understand the questions and the contextual images. She is able to convey all the information gathered from the problem. As noted by Astuti et al. (2023), students with a field-dependent cognitive style can effectively present the relevant information from questions and accurately identify important facts throughout the problem-solving process. Students with high self-efficacy are also capable of discovering new insights from existing clues to aid in problem-solving, as corroborated by Ningsih et al. (2023). These students often exhibit simple yet effective explanations when determining strategies.

However, when formulating problem statements, the student often neglects to write down the questions clearly in her answer sheets, largely due to a lack of double-checking. Despite this, she demonstrates a clear understanding during interviews, confidently articulating her problem formulation verbally. The combination of high self-efficacy and a field-dependent cognitive style allows her to present her arguments fluently and with confidence, underscoring strong verbal reasoning skills. When evaluating the credibility of sources and choosing problem-solving strategies for questions, the student exhibits strong decision-making abilities. By leveraging the information available, she adeptly selects appropriate methods to solve the problems. Misbahudin (2019) supports the notion that students with high self-efficacy tend to make more accurate decisions during mathematical tasks, thanks to their enhanced critical thinking abilities. However, the student occasionally makes calculation errors, particularly in questions 1 and 3, which result in inaccurate answers. These mistakes highlight a common issue among students with a field-dependent cognitive style, as noted by Astuti et al. (2023), where a lack of meticulous attention to detail during problem-solving can compromise the accuracy of their conclusions.

In terms of making and evaluating conclusions across all questions, the student demonstrates strong proficiency in linking her results to the problem's requirements. She carefully evaluates the outcomes and articulates her reasoning logically and coherently. By doing so, she ensures that her conclusions are aligned with the analysis and reflect a comprehensive understanding of the problem. This ability to connect her thought processes to the final answer underscores her critical thinking skills, particularly in the context of field-dependent cognitive style and high self-efficacy.

This study highlights that students with a field-dependent cognitive style and high self-efficacy possess strong verbal reasoning and can effectively articulate their problem-solving processes (Ondog & Kilag, 2023). Their ability to extract and interpret information is well-developed, leading to solid argument formulation and decision-making. However, they may face challenges with calculation accuracy and attention to detail. These students often rely on their confidence in understanding the problem but must enhance their meticulousness to avoid errors. Numeracy aligns with the notion that mathematical education is not merely about learning specific formulas or procedures but about developing the ability to think critically and logically about problems. When students engage in tasks that involve numeracy, such as calculating volume, they must analyze the information presented, select the appropriate method, and interpret the results in a manner that is relevant to the context. This level of thinking transcends rote learning and taps into deeper cognitive processes, making numeracy a key component of critical thinking.

However, a critical limitation lies in the students' occasional lack of precision in calculations, which can lead to inaccuracies in their final answers. This suggests the need for instructional strategies that emphasize carefulness and meticulous attention to detail. Furthermore, while self-efficacy enhances persistence and confidence in problem-solving, it must be balanced with strategies that mitigate overconfidence, ensuring that students approach problems with both confidence and precision. Overall, the study underscores the importance of integrating cognitive style awareness and self-efficacy enhancement in educational approaches. Educators should design interventions that cultivate students' confidence while fostering careful problem-solving habits. Encouraging students to develop a habit of verifying their answers and refining their calculation accuracy will further strengthen their critical thinking skills in numeracy problem-solving.

Furthermore, self-efficacy plays a pivotal role in boosting their critical thinking abilities, as students with higher confidence are more persistent in problem-solving tasks. While they may sometimes overlook critical details, their capacity to comprehend and address complex problems reflects the importance of fostering both cognitive skills and self-belief in the learning process. This underscores the need for educators to help students balance confidence with carefulness to maximize their potential in critical thinking development.

CONCLUSION

The research highlights the importance of fostering both cognitive style understanding and self-efficacy to enhance critical thinking abilities in students. Students with high self-efficacy and a field-dependent cognitive style show notable potential in critical thinking but must work on accuracy and thoroughness in mathematical problem-solving. This study can provide valuable insights for educators to tailor learning approaches that support the development of critical thinking in students with varying cognitive styles and self-efficacy levels.

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AUTHOR CONTRIBUTIONS

Author 1 creates articles and creates instruments, helps input research data, and is responsible for research, author 2 Analyzes research data that has been collected, author 3 and 4 assists in research data analysis and instrument validation.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

REFERENCES

Afifah, S. N., & Kusuma, A. B. (2021). Pentingnya Kemampuan Self-Efficacy Matematis Serta Berpikir Kritis Pada Pembelajaran Daring Matematika. *JURNAL MathEdu (Mathematic Education Journal)*, *4*(2), 313–320. https://doi.org/10.37081/mathedu.v4i2.2642

Ahmad, & Muslimah. (2021). Memahami Teknik Pengolahan dan Analisis Data Kualitatif. *Proceedings*, *1*(1), 173–186.

Arif, D. S. F., Zaenuri, & Cahyono, A. N. (2020). Analisis Kemampuan Berpikir Kritis Matematis Pada Model Problem Based Learning (PBL) Berbantu Media Pembelajaran Interaktif dan Google Classroom. *Prosiding Seminar Nasional Pascasarjana UNNES*, *3*(1), 323–328.

Astalini, A., Pino-Fan, L. R., Boonsiri, S., Zainudeen, U., Aye, T. N., & Duong, V. (2023). Development of combinatorial optimization models with discrete mathematics methods in mathematical physics courses. *Interval: Indonesian Journal of Mathematical Education*, *1*(2), 110-117. https://doi.org/10.37251/ijome.v1i2.1354.

Astuti, Y., Muhtarom, & Prayito, M. (2023). Analisis Kemampuan Berpikir Kritis Siswa dalam Menyelesaikan Soal Cerita Aljabar ditinjau dari Gaya Kognitif. *Jurnal Pendidikan Guru Matematika*, *4*(2), 121–129. https://doi.org/10.33387/jpgm.v3i2.6131

Bandura, Albert. (1994) Self Effiacy. In V. S. Ramachaudran (Ed.), Encyclopedia Of Human Behavior (Vol 4, pp. 71-81). New York: Academic Press.

Chumburidze, M., Setiabudi, E., Vassiliadou, M., Hasanov, R., & Duangpaserth, K. (2023). Unveiling the complex interplay between active learning and teacher development: Insights from TIMSS 2022 in Georgia. *Interval: Indonesian Journal of Mathematical Education*, *1*(2), 118-125. https://doi.org/10.37251/ijome.v1i2.1363.

Edianto, Darwis, M., & Ilhamuddin. (2022). Analisis Kemampuan Berpikir Kritis Matematis Siswa pada Materi Sistem Persamaan Linear Dua Variabel (SPLDV) Ditinjau dari Perbedaan Gaya Kognitif. *Infinity: Jurnal Matematika Dan Aplikasinya (IJMA)*, *3*(1), 12–18.

Ennis, R. H. (2011). The Nature of Critical Thinking. Informal Logic, 6(2), 1–8. https://doi.org/10.22329/il.v6i2.2729

Fadilah, F., & Winarso, W. (2021). Profil Critical Thinking Skill Siswa pada Pembelajaran Matematika Ditinjau dari Perbedaan Gaya Kognitif dan Gender. *Susca Journal of Mathematics Education*, *7*(2), 129–140.

Fauziyah, A. N., Ramadan, M., Gumede, P. R., & Udosen, I. N. (2023). Development of digital book bilingual physics learning media using kvisoft flipbook for high school class x semester 1 subject of newton's law. *Journal of Educational Technology and Learning Creativity*, *1*(1), 7-15. https://doi.org/10.37251/jetlc.v1i1.618.

Goos, M., Bennison, A., Forgasz, H., & Yasukawa, K. (2024). Research in numeracy education. In *Research in Mathematics Education in Australasia 2020–2023* (pp. 59-84). Singapore: Springer Nature Singapore.

Hidayat, R. A., & Noer, S. H. (2021). Analisis kemampuan berpikir kritis matematis ditinjau dari self efficacy siswa dalam pembelajaran daring. *Media Pendidikan Matematika*, *9*(2), 1. https://doi.org/10.33394/mpm.v9i2.4224

Indraswara, W. T., Kusmaharti, D., & Yustitia, V. (2023). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Numerasi Ditinjau dari Self Efficacy. *Indo-MathEdu Intellectuals Journal*, *4*(3), 1685-1708.

Isnawati, I., Sandi, M., Werdhian, I. K., & Giorgadze, I. (2024). Scientific reasoning ability of class xi students of sma negeri 1 sindue tombusabora on dynamic fluid matter. *EduFisika: Jurnal Pendidikan Fisika*, *9*(2), 247-225. https://doi.org/10.59052/edufisika.v9i2.36833.

Khoiruddin, M. H., Bahari, Z. H. Z., Kaka, M. S., & Saenpich, S. (2023). Development of visual novel games as learning media for the history of Indonesia's Independence. *Journal of Educational Technology and Learning Creativity*, *1*(1), 33-41. https://doi.org/10.37251/jetlc.v1i1.622.

King, Y. A., & Purpura, D. J. (2021). Direct numeracy activities and early math skills: Math language as a mediator. *Early Childhood Research Quarterly*, *54*, 252-259.

Kurniawan, D. A., Elfaituri, K., Samuel, A., Dalhadi, N. J., & Sindu, S. (2023). The influence of traditional navigation knowledge and the utilization of ethnomathematics on the success of traditional fishermen's operations. *Interval: Indonesian Journal of Mathematical Education*, *1*(2), 99-109. https://doi.org/10.37251/ijome.v1i2.1353.

Mawardani, A., Mirunalini, M., Meechi, C., & Shah, S. (2023). Development of interactive multimedia based on adobe flash as a learning media steps of geographical research. *Journal of Educational Technology and Learning Creativity*, *1*(1), 16-24. https://doi.org/10.37251/jetlc.v1i1.620.

Miles, Matthew B. dan A. Michael Huberman. 1992. Qualitative Data Analysis: A Sourcebook of New Method. Terjemahan Tjetjep Rohendi Rohidi. Analisis Data Kualitatif: Buku Sumber tentang Metode-metode Baru. Jakarta: Penerbit Universitas Indonesia (UI-PRESS). (t.t.).

Misbahudin, A. R. (2019). Hubungan Self Efficacy terhadap Kemampuan Berpikir Kritis Siswa SMK pada Materi Barisan dan Deret Aritmatika. *Journal On Education*, *1*(2), 445–450.

Mizian, Z. (2023). Development of an electronic brick bonding module using the autocad program for students. *Tekno - Pedagogi : Jurnal Teknologi Pendidikan*, *13*(2), 35-43. https://doi.org/10.22437/teknopedagogi.v13i2.32531.

National Education Association. (n.d.). *Preparing 21st Century Studentd for a Global Society: An Educator's Guide to the "Four Cs."* Diakses pada tanggal 05 September 2023. https://www.nea.org/professional-excellence/student-engagement/tools-tips/being-21st-century-educator

Ningsih, N. I., Wulandari, T. C., & Ilmi, Y. I. N. (2023). Analisis Kemampuan Berpikir Kritis ditinjau dari Self Efficaci Peserta Didik pada Materi Segiempat Kelas VII MTs Nurul Huda Malang. *Jp3*, *18*(31), 1–13.

Nuraeni, S., Feronika, T., & Yunita, L. (2019). Implementasi Self-Efficacy dan Keterampilan Berpikir Kritis Siswa Pada Pembelajaran Kimia di Abad 21. *Jambura Journal of Educational Chemistry*, *1*(2), 49–56. https://doi.org/10.34312/jjec.v1i2.2553

Oktaviani, A. ., & Elmojahed, A. . (2023). The use of puzzle learning media to improve student learning outcomes in science subjects for class iv. *Tekno - Pedagogi : Jurnal Teknologi Pendidikan*, *13*(2), 44-52. https://doi.org/10.22437/teknopedagogi.v13i2.38459.

Ondog, J., & Kilag, O. K. (2023). A Constructivist Framework for Early Grade Numeracy: Drawing on Jean Piaget's Cognitive Development Theory. *Excellencia: International Multi-disciplinary Journal of Education (2994-9521)*, *1*(4), 308-320.

Pramulia, P., Yustitia, V., Kusmaharti, D., Fanny, A. M., & Oktavia, I. A. (2025). Ethnomathematics of Al Akbar Mosque Surabaya: Augmented reality comics to improve elementary school students' literacy and numeracy. *Multidisciplinary Science Journal*, *7*(6), 2025277-2025277.

Rahmayani, F., Hambali, S. M., Moghadam, A. A., Ripeanu, D., & Nkambule, T. (2023). Unveiling college student preferences: integrating numerical and factor analysis in understanding choices for mathematics majors. *Interval: Indonesian Journal of Mathematical Education*, *1*(2), 83-98. https://doi.org/10.37251/ijome.v1i2.1346.

Ramadhani, R. (2020). Pengukuran Self-Efficacy Siswa dalam Pembelajaran Matematika di SMK Negeri 6 Medan. *Jurnal Pionir LPPM Universitas Asahan*, *7*(3), 32–38.

Ridwanah, R. M., & Masriyah, M. (2021). Profil Komunikasi Matematika Tulis Siswa Dalam Pemecahan Masalah Matematika Berdasarkan Gaya Kognitif Field Dependent Dan Field Independent. *MATHEdunesa*, *9*(3), 595–606. https://doi.org/10.26740/mathedunesa.v9n3.p595-606

Risdianah, E. (2022). *Analisis kemampuan berpikir kritis dalam pembelajaran matematika ditinjau dari self-efficacy pada siswa kelas V SDN Kutukulon Jetis Ponorogo*. http://etheses.iainponorogo.ac.id/19603/

Rochman, S. ., Algiranto, A., Ekasari, A. ., & Turaqulov, B. T. . (2024). Development of student worksheets integrated with pbl-stem on temperature and heat material. *EduFisika: Jurnal Pendidikan Fisika*, *9*(2), 237-246. https://doi.org/10.59052/edufisika.v9i2.36817.

Saputro, H. D., Rustaminezhad, M. A., Amosa, A. A., & Jamebozorg, Z. (2023). Development of e-learning media using adobe flash program in a contextual learning model to improve students' learning outcomes in junior high school geographical research steps materials. *Journal of Educational Technology and Learning Creativity*, *1*(1), 25-32. https://doi.org/10.37251/jetlc.v1i1.621.

Son, A. L., Darhim, & Fatimah, S. (2020). Studens' Mathematical Problem-Solving Ability Based On Teaching Models Intervention and Cognitif Style. *Journal on Mathematics Education*, *11*(2), 209–222.

Wardani, N. K., Rasiman, & Wulandari, D. (2021). Analisis Kemampuan Koneksi Matematis Siswa Dalam Menyelesaikan Masalah Matematika Ditinjau Dari Gaya Kognitif. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *3*(1), 1–6. https://doi.org/10.26877/imajiner.v3i6.8085

Yustitia, V., & Juniarso, T. (2020). Literasi Matematika Mahasiswa Dengan Gaya Belajar Visual. *Malih Peddas (Majalah Ilmiah Pendidikan Dasar)*, *9*(2), 100–109. https://doi.org/10.26877/malihpeddas.v9i2.5044

Yustitia, V., & Kusmaharti, D. (2024). Mathematics Critical Thinking Ability of Elementary School Students Based On Cognitive Style and Self-Efficacy. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, *8*(1), 183-197.