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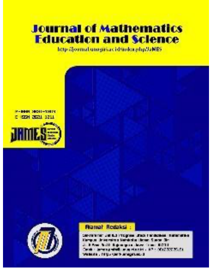

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REFLECTIVE THINKING OF JUNIOR HIGH SCHOOL STUDENTS IN SOLVING NUMERACY PROBLEMS VIEWED FROM MATHEMATICAL ABILITY

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ABSTRACT

This research aims to explore in depth the reflective thinking processes of junior high school students in solving numeracy problems based on mathematical ability. The study employed a qualitative approach with a case study design involving six female students from class IX H of SMP Negeri 31 Surabaya, consisting of two high-ability students, two medium-ability students, and two low-ability students selected through purposive sampling. Data collection was conducted through the Mathematical Ability Test, the Numeracy Problem Test in an algebraic context, and semi-structured interviews, and the data were analyzed descriptively and qualitatively following the Miles and Huberman model, with source triangulation to ensure data validity. The research findings reveal significant differences in reflective thinking characteristics across mathematical ability categories. High-ability students demonstrated comprehensive reflective thinking with strong metacognitive awareness, capable of accurately identifying variables, flexibly planning strategies, and conducting thorough evaluations, including exploration of alternatives. Medium-ability students had strong foundations in reflective thinking but tended to perform procedural checks without in-depth exploration, indicating a transitional stage in metacognitive awareness development. Low-ability students experienced significant limitations in reflective thinking and metacognitive awareness, exacerbated by low self-confidence. This research concludes that differentiated learning tailored to students' ability levels is necessary: low-ability students require intensive scaffolding, medium-ability students need guidance in transitioning from procedural to strategic reflection, and high-ability students require complex challenges to optimize their metacognitive abilities.

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INTRODUCTION

Mathematics education in the modern era demands more than procedural mastery; it requires students to develop higher-order thinking skills applicable to real-world problem-solving. Among these, reflective thinking has emerged as a fundamental cognitive competency that underpins students' capacity to reason mathematically and navigate complex problem situations (Dewey, 1981; Gürol, 2011). Reflective thinking is broadly defined as the ability to actively and deliberately examine one's own reasoning, evaluate problem-solving strategies, and draw meaningful conclusions from mathematical experiences. In the context of mathematics learning, this capacity enables students to move beyond surface-level computation toward deeper conceptual understanding, particularly when confronted with contextually embedded and non-routine problems.

The urgency of developing reflective thinking becomes increasingly evident in light of Indonesia's current mathematics education landscape. The results of the 2022 Programme for International Student Assessment (PISA) study show that the mathematical ability of Indonesian students ranks 65th out of 80 countries, with an average score of 366, far below the OECD average of 472 (OECD, 2019). This gap reflects not merely a deficit in content knowledge, but more fundamentally a weakness in students' ability to think reflectively and reason quantitatively in contextual situations - precisely the competencies assessed through numeracy-based tasks in PISA. In line with these findings, Sumarmo (2012) reported that the majority of students in Indonesia still struggle to solve problems that require critical and analytical thinking, suggesting a systemic gap in developing higher-order cognitive processes in mathematics classrooms.

Numeracy, as a critical competency within contemporary curriculum frameworks, encompasses the ability to use mathematical concepts flexibly and reflectively across diverse situational demands (OECD, 2019). Solving numeracy problems requires students not only to apply mathematical knowledge, but also to interpret real-world contexts, reason quantitatively, and communicate their thinking coherently. These demands place reflective thinking at the center of numeracy problem-solving, as students must continuously monitor their reasoning processes, identify errors, reconsider solution pathways, and evaluate the appropriateness of their answers within contextual constraints (Phan, 2009; Zehavi & Mann, 2011). Despite the recognized importance of this relationship, empirical studies that specifically examine how reflective thinking processes unfold during numeracy problem-solving remain limited, particularly in the Indonesian junior high school context.

A substantial body of research has examined problem-solving strategies and mathematical achievement outcomes, yet comparatively little attention has been directed toward understanding the qualitative nature of students' reflective thinking processes as they engage with numeracy tasks. Studies on the relationship between mathematical ability and thinking processes consistently demonstrate that students with varying levels of mathematical proficiency exhibit markedly different patterns in how they approach, monitor, and evaluate their problem-solving efforts (Kramarski & Mevarech, 2003; Sumarmo, 2012). Students with higher mathematical ability tend to engage more consistently in self-monitoring and solution verification, whereas those with lower ability often proceed without reflection or critical self-evaluation. These differences suggest that mathematical ability may serve as a significant factor shaping the depth and quality of students' reflective thinking during numeracy problem-solving. However, while these findings are instructive, the existing literature has yet to provide sufficiently detailed qualitative accounts of how reflective thinking processes specifically differ across students with high, medium, and low mathematical abilities when solving numeracy problems. This constitutes a meaningful research gap that warrants dedicated empirical inquiry.

Furthermore, most studies on reflective thinking in mathematics education have been conducted in decontextualized settings or have focused primarily on general problem-solving rather than numeracy-specific tasks (Gürol, 2011; Phan, 2009). The numeracy domain presents distinctive cognitive demands that differ from conventional mathematical problem-solving, as it requires the integration of real-world interpretation with mathematical reasoning. Understanding how reflective thinking operates within this specific domain - and how it varies according to students' mathematical ability - is therefore essential for developing more responsive and effective mathematics instruction.

Based on this background, this study aims to explore and describe the reflective thinking processes of junior high school students with varying mathematical abilities - high, medium, and low - when solving numeracy problems. By providing empirically grounded and qualitatively rich descriptions of how reflective thinking unfolds across different ability levels, this research is intended to contribute meaningful insights to the fields of mathematics education and numeracy learning and to inform instructional practices that better support the development of reflective mathematical thinking among junior high school students in Indonesia.

METHOD

This research employed a qualitative approach with a case study design aimed at exploring in depth the reflective thinking processes of junior high school students in solving numeracy problems based on mathematical ability. The research was conducted at SMP Negeri 31 Surabaya during the Odd Semester of the 2025/2026 Academic Year. The selection of this location was based on the consideration that the school has implemented numeracy-based learning and has students with diverse mathematical ability characteristics. The research subjects were six female students from class IX H selected using a purposive sampling technique, consisting of two high-ability students, two medium-ability students, and two low-ability students. Subject selection was carried out based on the results of the Mathematical Ability Test (MAT) given to all students in class IX H, taking into account ability equality, gender similarity, and communication skills to avoid data bias due to differences in subject characteristics.

The instruments used in this research included the researcher as the main instrument and three supporting instruments. The supporting instruments consisted of the MAT, containing 5 standard junior high school mathematics problems to categorize students' mathematical ability, the Numeracy Problem Test (NPT), containing 2 algebraic context problems to reveal reflective thinking processes, and a semi-structured interview guide to explore in-depth information about students' reasons and considerations in solving problems. The three supporting instruments had been validated by two mathematics education lecturers and one mathematics teacher after obtaining approval from the supervising lecturer. Data collection was carried out through two stages, namely the administration of MAT to all prospective subjects for research subject selection, then the administration of NPT to selected subjects, followed by interviews to obtain a deeper understanding of students' reflective thinking processes in solving numeracy problems.

Data analysis was conducted descriptively and qualitatively following the Miles & Huberman (1994) model, which includes three stages: data reduction, data display, and conclusion drawing. In the data reduction stage, the researcher filtered and focused data relevant to students' reflective thinking based on mathematical ability categories, then identified thinking patterns that emerged at each ability level. Data display was carried out in the form of narrative descriptions that describe students' thinking steps from understanding problems to conducting reflection, accompanied by tables, charts, and thinking flow diagrams that show differences in reflective processes across ability categories. To ensure the validity and consistency of research results, source triangulation was conducted by comparing data from two subjects in each mathematical ability category, so that if data consistency was found among subjects in the same category, the data was considered valid and reliable as a basis for drawing conclusions about students' reflective thinking characteristics based on their mathematical ability level.

This study employed a qualitative case study design, which was deemed most appropriate given the research objective of exploring and describing the depth and complexity of individual students' reflective thinking processes across varying mathematical ability levels. A case study approach allows for an in-depth, contextually rich examination of each participant's cognitive processes as they naturally unfold during numeracy problem-solving, which would not be adequately captured through quantitative or experimental designs (Creswell & Poth, 2016; Yin, 2018). Prior to data collection, all participants and their respective parents or legal guardians were fully informed about the purpose, procedures, and voluntary nature of the study. Written informed consent was obtained from both students and their parents or guardians before any data collection activities commenced, and participants were assured of their right to withdraw at any time without consequence. Confidentiality of all data was strictly maintained throughout the research process in accordance with established ethical standards in educational research.

RESULTS

Based on the results of data analysis obtained from the Mathematical Ability Test (MAT) of 30 students in class IX H of SMP Negeri 31 Surabaya, a distribution of mathematical abilities showing considerable variation was obtained. The MAT results showed that there were 8 students (26.67%) in the high ability category with a score range of 80-100, 14 students (46.67%) in the medium ability category with a score range of 60-79, and 8 students (26.67%) in the low ability category with a score range below 60. From these results, six female students were selected as research subjects, consisting of two high-ability students (ST1 and ST2 with scores of 92 and 88, respectively), two medium-ability students (SS1 and SS2 with scores of 74 and 68, respectively), and two low-ability students (SR1 and SR2 with scores of 52 and 48 respectively). Subject selection considering gender similarity and communication skills aimed to minimize data bias that might arise from differences in subject characteristics. The distribution data of students' mathematical abilities and selected research subjects are presented in Table 1.

Table 1. Distribution of Students' Mathematical Abilities and Research Subjects

Ability Category	Score Range	Number of Students	Selected Subjects (Score)
High	80-100	8 (26.67%)	ST1 (92), ST2 (88)
Medium	60-79	14 (46.67%)	SS1 (74), SS2 (68)
Low	< 60	8 (26.67%)	SR1 (52), SR2 (48)

Sumber: Data Primary 2025

Analysis of the Numeracy Problem Test (NPT) answers and interview transcripts showed differences in reflective thinking patterns among students with high, medium, and low mathematical abilities.

Reflective Thinking Patterns of High-Ability Students

High-ability students (ST1 and ST2) demonstrated the following characteristics in problem-solving stages: 1) *Understanding Problem Stage:* Both subjects identified involved variables, determined relationships between variables, and formulated questions clearly. 2) *Planning Stage:* ST1 and ST2 considered various alternative strategies and selected approaches before implementing solutions. 3) *Implementing Plan Stage:* Both subjects performed algebraic operations, applied procedures consistently, and monitored potential errors during the solution process. 4) *Reflecting on Results Stage:* ST1 and ST2 checked the correctness of answers procedurally, evaluated the reasonableness of results in the problem context, identified alternative methods, and explained the rationale for their chosen strategies.

Reflective Thinking Patterns of Medium-Ability Students

Medium-ability students (SS1 and SS2) demonstrated the following characteristics: 1) *Understanding Problem Stage:* Both subjects identified available information and distinguished between known data and what was asked, requiring more time to understand complex relationships between variables. 2) *Planning Stage:* SS1 and SS2 formulated solution strategies and chose familiar approaches without exploring alternative strategies. 3) *Implementing Plan Stage:* Both subjects performed basic algebraic operations but experienced difficulties when dealing with complex algebraic manipulations or integrating several concepts simultaneously. 4) *Reflecting on Results Stage:* SS1 and SS2 checked answer correctness by performing substitution or rechecking calculations. Their reflection focused on whether the answer was mathematically correct, with limited exploration of alternative approaches or contextual reasonableness of results.

Table 2. Characteristics of Reflective Thinking Based on Mathematical Ability

Stage	High Ability	Medium Ability	Low Ability
Understanding Problem	Complete and accurate identification	Fairly good identification with more time	Difficulty understanding relationships between variables
Planning Strategy	Systematic, considering alternatives	Tend to use familiar methods	Difficulty formulating appropriate strategies
Implementing Plan	Careful, consistent, and systematic	Good at basic operations, difficulty with complex ones	Frequently make procedural errors
Reflecting on Results	Comprehensive evaluation, exploring alternatives	Procedural checking, lack of exploration	Minimal or no reflection

Sumber: Data Primary 2025

Reflective Thinking Patterns of Low-Ability Students

Low-ability students (SR1 and SR2) demonstrated the following characteristics: 1) *Understanding Problem Stage:* Both subjects experienced difficulties identifying relevant information and distinguishing between what was known and what was asked in the problem. SR1 and SR2 focused on the numbers in the problem without clearly identifying underlying mathematical relationships. 2) *Planning Stage:* Both subjects showed confusion in formulating solution strategies, started with various approaches through trial and error without a clear rationale for method selection. 3) *Implementing Plan Stage:* SR1 and SR2 made procedural errors in algebraic operations and in applying mathematical concepts, often without awareness of the mistakes made. 4) *Reflecting on Results Stage:* Both subjects rarely checked the answers obtained. When asked to explain their solution process, SR1 and SR2 struggled to articulate their thoughts clearly. Interview results showed that both subjects expressed low confidence in their mathematical abilities.

DISCUSSION

The findings of this research reveal that there are significant differences in reflective thinking characteristics among students with high, medium, and low mathematical abilities in solving numeracy problems. The identified patterns align with the conceptualization of reflective thinking proposed by Dewey (1981) andBaron (1981), where reflective thinking involves a directed and systematic thought process for analyzing problems in depth. High-ability students demonstrate strong metacognitive awareness, as explained in metacognition theory, that individuals with good metacognitive awareness are able to monitor, regulate, and evaluate their own thinking processes (Nindiasari, 2014). Their ability to identify variables, plan strategies flexibly, and conduct comprehensive evaluations reflects high-level reflective thinking characteristics that enable them not only to find solutions but also to understand why a strategy is effective and how to optimize it. This aligns with research by Putri & Mampouw (2018), which found that students with high mathematical ability tend to engage in more comprehensive reflection at each stage of problem-solving. Furthermore, these findings also support Gürol (2011) view that reflective thinking involves the ability to analyze one's own thinking process and make necessary adjustments, which is a manifestation of mature metacognitive awareness.

The reflective thinking patterns of medium-ability students that show characteristics of procedural checking but lack exploration of alternatives reflect a transitional stage in the development of metacognitive awareness. This finding can be understood through the complex thinking framework proposed by Pacheco & Herrera (2021), which states higher-order thinking abilities develop gradually and require systematic practice. Students in this category have developed a good foundation of reflective thinking, but have not fully optimized their strategic evaluation capabilities. This condition aligns with research by Akdemir (2018), which identified that students at the intermediate level in reflective thinking are able to check results but tend to be limited to procedural aspects without in-depth exploration of strategy efficiency. Additionally, their tendency to choose familiar strategies rather than exploring alternatives can be explained through the cognitive load perspective, where medium-ability students may allocate most of their cognitive resources to understanding and solving problems, leaving less capacity for more complex reflection. These findings indicate the importance of learning interventions specifically designed to facilitate the transition from procedural reflection to strategic reflection, as suggested by Widodo & Kartikasari (2017), that problem-based learning can be an effective vehicle for developing students' reflective thinking abilities gradually.

The significant limitations demonstrated by low-ability students in the reflective thinking process underline the complexity of the relationship between mastery of mathematical concepts, metacognitive awareness, and academic self-confidence. The finding that low-ability students experience difficulties not only in procedural aspects but also in developing awareness of their own thinking processes aligns with research by Fuady (2016), which states that reflective thinking requires a strong foundation of conceptual understanding. Furthermore, the low self-confidence identified through interviews indicates the presence of affective factors that influence cognitive processes, as explained in research byJa'faruddin & Hamda (2025) which states mathematical resilience affects students' problem-solving abilities. The minimal reflection activity conducted by low-ability students can be understood through the cognitive load theory perspective proposed by Ratumanan (2004), which states students with limited conceptual understanding allocate all their cognitive capacity only to processing basic information, leaving no resources for higher-level reflection. This condition confirms the urgency of implementing differentiated learning approaches that provide intensive scaffolding for low-ability students, as suggested by Martin & Surya (2022), that learning adapted to students' abilities can enhance conceptual understanding and problem-solving abilities. Furthermore, these findings provide practical implications for educators to focus not only on developing cognitive abilities, but also to pay attention to affective aspects such as self-confidence and motivation which have proven to play an important role in developing students' reflective thinking habits, in line with Karli (2018) view that the implementation of reflective thinking in learning requires a psychologically supportive environment.

Despite the meaningful insights generated by this study, several limitations must be acknowledged in order to appropriately contextualize the findings and their generalizability. First, the participant sample was relatively small, consisting of six female students selected from a single junior high school, which inherently restricts the extent to which the findings can be generalized to broader student populations with different demographic, cultural, or institutional backgrounds. The exclusive inclusion of female participants, while methodologically intentional within the scope of this study, means that potential gender-based differences in reflective thinking processes remain unexamined and cannot be accounted for in the current conclusions. Additionally, confining data collection to one school limits the diversity of learning environments, teaching approaches, and institutional contexts that may meaningfully influence students' reflective thinking development. Future research is therefore strongly encouraged to expand the sample by including male students alongside female participants, recruiting subjects from multiple schools across different geographic and socioeconomic settings, and extending the study to different grade levels to examine how reflective thinking processes evolve across various stages of mathematical development. Such methodological expansions would substantially strengthen the transferability and theoretical generalizability of findings related to reflective thinking in numeracy problem-solving contexts.

CONCLUSION

This research identified significant differences in reflective thinking characteristics among middle school students with different mathematical ability levels when solving numeracy problems. High-ability students demonstrated comprehensive reflective thinking across all problem-solving stages, including accurate variable identification, flexible strategic planning, careful implementation, and thorough evaluation with alternative solution exploration. Medium-ability students showed adequate reflective thinking foundations with capabilities in procedural checking, yet relied on familiar strategies with limited alternative exploration. Low-ability students exhibited significant limitations in reflective thinking processes, particularly in metacognitive awareness development. These findings contribute to understanding the relationship between mathematical ability levels and reflective thinking patterns in numeracy problem-solving contexts. The study provides empirical evidence that reflective thinking characteristics vary systematically across ability levels, suggesting the need for differentiated approaches in mathematics education to support students' numeracy development according to their reflective thinking profiles.

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The authors declare that generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete this manuscript. The authors confirm that they are the sole authors of this article and take full responsibility for the content therein, as outlined in COPE recommendations.

INFORMED CONSENT

The authors have obtained informed consent from all participants.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCE

Akdemir, E. (2018). Investigating the Reflective Thinking Skills of Students for Problem Solving. *Online Submission*, *1*, 774–780.

Baron, J. (1981). Reflective thinking as a goal of education. In *Intelligence* (Vol. 5, Number 4, pp. 291–309). Elsevier.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Dewey, J. (1981). *Reflective Thinking in Social Studies Curricula*.

Fuady, A. (2016). Berfikir reflektif dalam pembelajaran matematika. *JIPMat*, *1*(2).

Gürol, A. (2011). Determining the reflective thinking skills of pre-service teachers in learning and teaching process. *Energy Education Science and Technology Part B-Social and Educational Studies*, *3*(3).

Ja'faruddin, J., & Hamda, H. (2025). Dampak Resiliensi Matematis dan Kemampuan Numerasi Terhadap Kemampuan Pemecahan Masalah Siswa SMP. *Journal of Mathematics Education and Local Wisdom*, *1*(1).

Karli, H. (2018). Implementasi berpikir reflektif dalam pembelajaran di sekolah dasar. *Jurnal Pendidikan Penabur*, *17*(31), 47–58.

Kramarski, B., & Mevarech, Z. R. (2003). Enhancing mathematical reasoning in the classroom: The effects of cooperative learning and metacognitive training. *American Educational Research Journal*, *40*(1), 281–310.

Martin, R., & Surya, E. (2022). Kemampuan Pemecahan Masalah Matematika Siswa Untuk Meningkatkan Pemahaman Konsep Pada Materi Geometri. *Prosiding Pendidikan Dasar*, *1*(1), 105–111.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. sage.

Nindiasari, H. (2014). Pendekatan metakognitif untuk meningkatkan kemampuan berpikir reflektif matematis siswa SMA. *Edusentris*, *1*(1), 80–90.

OECD. (2019). *Guiding Principles On Business And Human Rights: Implementing The United Nations "Protect, Respect And Remedy" Framework*. Paris: Oecd Publishing.

Pacheco, C. S., & Herrera, C. I. (2021). A conceptual proposal and operational definitions of the cognitive processes of complex thinking. *Thinking Skills and Creativity*, *39*, 100794.

Phan, H. P. (2009). Exploring students' reflective thinking practice, deep processing strategies, effort, and achievement goal orientations. *Educational Psychology*, *29*(3), 297–313.

Putri, A. S., & Mampouw, H. L. (2018). Profil berpikir reflektif siswa dalam menyelesaikan soal tipe-tipe perkalian ditinjau dari perbedaan kemampuan matematika dan gender. *Math Didactic: Jurnal Pendidikan Matematika*, *4*(1), 34–46.

Ratumanan, T. G. (2004). *Belajar dan pembelajaran*. Surabaya: UNESA university press.

Sumarmo, U. (2012). Pendidikan karakter serta pengembangan berfikir dan disposisi matematik dalam pembelajaran matematika. *Seminar Pendidikan Matematika*, *25*, 1–26.

Widodo, S., & Kartikasari, K. (2017). Pembelajaran pemecahan masalah matematis siswa sekolah dasar dengan model creative problem solving (CPS). *Prisma*, *6*(1), 57–65.

Yin, R. K. (2018). *Case study research and applications* (Vol. 6). Sage Thousand Oaks, CA.

Zehavi, N., & Mann, G. (2011). Development process of a praxeology for supporting the teaching of proofs in a cas environment based on teachers' experience in a professional development course. *Technology*, *Knowledge and Learning*, *16*(2), 153–181.