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Integration of Intrapersonal Intelligence and Reflective Learning to Improve Mathematical Problem-Solving Skills

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Abstract

The ability to solve mathematical problems is a fundamental competency that reflects students' higher-order thinking and metacognitive awareness. This study aims to enhance students' mathematical problem-solving skills through the integration of intrapersonal intelligence and reflective learning. The integration is based on the premise that intrapersonal intelligence—students' capacity for self-awareness, self-regulation, and reflection—plays a crucial role in managing cognitive and emotional processes during problem solving. Reflective learning, in turn, provides structured opportunities for students to analyze their thought processes, evaluate strategies, and construct new understanding from experience. The research employed a quasi-experimental design involving students of mathematics education, with learning interventions that combined reflective journal writing, guided self-assessment, and metacognitive questioning strategies. Data were collected through problem-solving tests, observation sheets, and student reflection logs. The results indicate a significant improvement in students' ability to identify problems, plan and implement solution strategies, and evaluate outcomes. Students also demonstrated greater self-regulation, confidence, and persistence when dealing with complex mathematical tasks. The findings suggest that integrating intrapersonal intelligence and reflective learning effectively fosters deeper understanding, critical thinking, and self-directed learning, which are essential components in developing mathematical problem-solving competence.

Keywords: Intrapersonal Intelligence, Reflective Learning, Problem Solving

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INTRODUCTION

Mathematical problem-solving ability is a fundamental competency that reflects students' higher-order thinking skills and metacognitive awareness. This ability not only involves procedural mastery in solving mathematical problems but also requires critical, analytical, creative, and reflective thinking to find solutions in complex and contextual situations. According to (Stern & Hertel, 2022; Toikka et al., 2024), problem solving lies at the core of mathematical learning, requiring students to understand problems, plan strategies, implement solutions, and evaluate the results. However, in practice, many students still struggle to understand problems, select appropriate strategies, and reflect on their reasoning processes, which ultimately hampers their problem-solving performance.

These difficulties often stem from a lack of students' awareness of their own thinking processes (metacognition) and their limited ability to recognize their own potential. In this context, intrapersonal intelligence becomes a crucial aspect to be developed in mathematics education. (Lyndgaard & Kanfer, 2024) defines intrapersonal intelligence as the ability to recognize and understand one's own feelings, motivations, strengths, and weaknesses. Students with strong intrapersonal intelligence are capable of managing emotions, setting learning goals, and reflecting on their progress. Within mathematics learning, this means that students can consciously monitor the strategies they use, evaluate errors, and refine less effective approaches to solving problems.

On the other hand, reflective learning serves as a relevant approach to nurturing self-awareness and critical thinking. Reflective learning emphasizes students' active engagement in thinking about their own learning experiences, allowing them to extract meaning, improve strategies, and build a deeper conceptual understanding. (Menekse et al., 2025; Zachariades et al., 2025) describes reflection as active, persistent, and careful consideration of one's beliefs or knowledge based on reasons and evidence. In mathematical contexts, reflective activities may include writing reflective journals, engaging in small-group discussions, or responding to feedback on problem-solving processes.

The integration of intrapersonal intelligence and reflective learning is expected to create a more meaningful, student-centered learning environment. When students are encouraged to recognize themselves and reflect on their thinking, they develop effective learning strategies, increase confidence, and foster learning autonomy. Such an approach aligns with the *Merdeka Belajar* (Freedom to Learn) paradigm, which emphasizes active student participation and self-regulated learning as essential components of educational transformation.

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Empirical studies have demonstrated that fostering intrapersonal intelligence contributes positively to learning outcomes and higher-order thinking (Lyndgaard & Kanfer, 2024). Students with strong self-awareness are better at managing study time, controlling academic stress, and adapting to challenges in solving mathematical problems. Similarly, reflective learning has been proven to enhance critical, metacognitive, and problem-solving abilities. Reflection enables students to understand the reasons behind their mistakes, recognize more effective reasoning patterns, and strengthen conceptual comprehension.

Despite its potential, the current practices in mathematics classrooms both in schools and universities tend to focus primarily on outcomes rather than processes. Teachers and lecturers often emphasize cognitive aspects such as completing exercises and mastering formulas, while affective and metacognitive aspects like self-regulation, emotional control, and self-evaluation receive little attention. Consequently, students often learn mechanically without fully understanding the meaning and purpose of the learning process. This lack of reflection limits their ability to connect mathematical concepts to real-world contexts and diminishes their perseverance when facing non-routine problems (Alayubi et al., 2024; Maslihah et al., 2021).

To address these challenges, it is essential to design innovative instructional models that integrate cognitive, affective, and metacognitive dimensions in a balanced manner. The integration of intrapersonal intelligence and reflective learning represents one promising strategy. In such a learning environment, students are not merely directed toward obtaining the correct answers but are guided to become aware of how they think, what they feel, and how they can improve their problem-solving processes. For example, through reflective journal writing after completing tasks, students can articulate the strategies they used, the difficulties they faced, and the emotions they experienced. This practice fosters self-assessment and the development of continuous reflective habits.

Furthermore, teachers or lecturers act as facilitators by posing reflective guiding questions such as: “What did you learn from your mistake?”, “How did you decide on that strategy?”, or “What would you do differently next time you face a similar problem?” Such questions prompt students to engage in deeper metacognitive thinking and enhance intrapersonal awareness. Consequently, the learning process becomes more dialogical, humanistic, and meaningful.

Theoretically, the integration of intrapersonal intelligence and reflective learning is strongly grounded in Constructivist Learning Theory and Self-Regulated Learning Theory (Michalsky, 2024). Constructivism emphasizes that knowledge is actively constructed by learners through interaction between experience and reflection. Meanwhile, self-regulated

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learning views students as individuals capable of controlling their behavior, motivation, and cognition to achieve learning goals. Therefore, combining these approaches not only improves mathematical problem-solving skills but also cultivates autonomous learners with self-awareness and reflective thinking abilities.

Based on the above considerations, this study aims to explore and implement a learning model that integrates intrapersonal intelligence and reflective learning to enhance students' mathematical problem-solving ability. The study seeks to provide an innovative pedagogical framework that promotes not only cognitive achievement but also self-awareness, intrinsic motivation, and reflective capacity. The results are expected to contribute to the development of innovative mathematics learning strategies in the digital era and support the national educational goal of producing intelligent, independent, and character-driven learners.

LITERATURE REVIEW

Intrapersonal Intelligence in Mathematics Learning

Intrapersonal intelligence is one of the eight intelligences proposed by Howard (Arteaga-Checa et al., 2023; Jin & Cutumisu, 2024) in his *Multiple Intelligences Theory*. It refers to an individual's ability to recognize and understand their own emotions, motivations, strengths, weaknesses, and values. Individuals with strong intrapersonal intelligence can perform introspection, self-control, and make decisions based on personal awareness and reflection.

In education, intrapersonal intelligence plays an important role in fostering self-directed learning and metacognitive awareness. According to (Mulbar & Assagaf, 2019), students who possess strong self-awareness can monitor their own thinking processes, plan effective learning strategies, and evaluate their own progress. This aligns with (Bui & Johnson, 2024) *Self-Regulated Learning (SRL)* theory, which emphasizes that self-awareness and self-regulation are central to successful learning.

In mathematics learning, intrapersonal intelligence helps students manage cognitive and emotional challenges, especially when solving complex problems. Students who can recognize frustration or confusion are more likely to adapt and find alternative strategies rather than giving up. Thus, developing intrapersonal intelligence allows students to balance cognitive and affective domains, resulting in more resilient and reflective problem solvers.

Reflective Learning and Metacognitive Development

Reflective learning originates from (Zachariades et al., 2025) conception of reflection as

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an *active, persistent, and careful consideration* of one's beliefs or actions in light of evidence and reasoning. Reflective learning encourages students to move beyond passive knowledge reception toward analyzing and evaluating their own learning experiences to construct meaningful understanding. (Menekse et al., 2025) defines reflection as a deliberate process in which learners critically examine their experiences, identify thought patterns, and understand the effects of their learning strategies. This process fosters metacognitive awareness, or the ability to think about one's own thinking. In mathematical learning, this means that students are capable of monitoring the steps they take when solving problems, assessing the effectiveness of those steps, and refining their strategies accordingly.

Reflective learning can be implemented through various techniques such as reflective journals, guided discussions, self-assessment, and reflective questioning. (Idris Effendi & Elmunsyah, 2024) asserts that reflective journals allow students to articulate their thoughts, emotions, and learning experiences, which helps them become more aware of their cognitive processes and reorganize knowledge structures independently. Moreover, reflective learning increases students' motivation, autonomy, and sense of responsibility for their learning. (Zachariades et al., 2025) emphasized that reflection enables learners to connect theory with practice, thus deepening conceptual understanding. In mathematics, reflection helps students identify conceptual errors, analyze problem-solving patterns, and develop higher-order reasoning skills.

Mathematical Problem-Solving Ability

Mathematical problem solving is a higher-order cognitive skill that involves the integration of conceptual, procedural, and metacognitive knowledge. (Sumirattana et al., 2017; Vessonen et al., 2025) outlined four key stages of problem solving: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. Each stage requires reflective thinking and self-awareness. According to (S. He & Xin, 2025; Rahman & Jumriani, 2023), successful problem solving depends not only on logical and mathematical competence but also on affective factors such as motivation, self-confidence, and attitudes toward mathematics. Students with strong self-awareness and emotional regulation tend to persist in the face of difficulties and display more adaptive strategies. This highlights the interrelationship between intrapersonal factors and problem-solving performance.

Empirical evidence supports the positive influence of reflection and self-awareness on problem-solving skills. (An & Cao, 2014; Hoorfar & Taleb, 2015) found that metacognitive and

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reflective interventions improved students' ability to select appropriate strategies and evaluate outcomes effectively. Similarly, (Deibl et al., 2023) reported that reflective discussions after problem-solving activities helped students identify conceptual misunderstandings and enhance their reasoning abilities.

Integration of Intrapersonal Intelligence and Reflective Learning

The integration of intrapersonal intelligence and reflective learning provides a synergistic framework for improving mathematical problem-solving ability. Intrapersonal intelligence enables students to understand themselves, regulate emotions, and sustain motivation, while reflective learning fosters metacognitive awareness and self-evaluation. Together, they create a holistic learning experience, allowing students not only to "learn mathematics" but also to "learn about themselves as mathematical thinkers."

From a theoretical standpoint, this integration aligns with constructivist learning theory (Gasong & Toding, 2020; E. He et al., 2023), which posits that knowledge is actively constructed through experience and reflection. It also reflects the principles of Self-Regulated Learning Theory (Zachariades et al., 2025), which views learners as active agents who plan, monitor, and evaluate their learning. When combined, these theories suggest that reflective and intrapersonal-oriented instruction enhances students' autonomy, persistence, and problem-solving competence.

Integrating intrapersonal intelligence with reflective learning thus represents an innovative pedagogical approach in mathematics education. It shifts the focus from outcomes to processes, emphasizing character development, emotional awareness, and metacognitive growth. Through such integration, students not only improve their cognitive performance but also develop critical, self-aware, and lifelong learning habits essential for facing the challenges of modern education.

METHOD

Research Design

This study employed a quantitative approach with a quasi-experimental design. This design was selected because the researcher could not fully control external variables that might influence the outcomes, yet it allows for the examination of causal relationships between the intervention and students' learning results. The specific model used was a One Group Pretest–Posttest Design, in which participants were given a pretest to measure their initial mathematical

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problem-solving ability, followed by an instructional treatment integrating intrapersonal intelligence and reflective learning, and finally a posttest to assess the improvement after the intervention.

Participants and Research Setting

The study was conducted with 30 undergraduate students enrolled in a Mathematics Education program at state university of Makassar, Indonesia. Participants were selected using a purposive sampling technique, based on the consideration that they had taken mathematics courses involving problem-solving components and represented a range of critical thinking abilities.

The research site was chosen because it provided an appropriate learning environment that supported reflective learning activities, including access to discussion spaces, digital tools, and instructors familiar with reflective-based learning practices.

Research Procedure

The research procedure consisted of three main stages:

Table 1. Research Procedure

- **Preparation Stage**
- Conducting a literature review and designing a learning plan that integrates intrapersonal intelligence and reflective learning. - Developing research instruments, including a mathematical problem-solving test, observation sheets, and an intrapersonal intelligence questionnaire. - Conducting instrument validation by experts to ensure clarity, appropriateness, and alignment with indicators.
- **Implementation Stage**
- Administering the pretest to all participants to measure their initial problem-solving skills. - Conducting the instructional intervention across several meetings following the integrated learning model, with the following key steps: 1. Self-Awareness Orientation: Students identify their strengths, weaknesses, and emotional responses in learning mathematics. 2. Reflective Practice: Students write reflective journals after each session to document their thinking processes, strategies, and learning experiences.

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3. Reflective Discussion: Students engage in group discussions to evaluate and improve their problem-solving strategies. 4. Self-Assessment: Students assess their own learning progress and identify factors influencing their success or difficulties. - After completing the intervention, students take a posttest to evaluate the improvement in their problem-solving ability.
c. Data Collection Stage
- Data were collected from pretests, posttests, and observations of learning activities.

Research Instruments

Four main instruments were used in this study:

- Mathematical Problem-Solving Test, consisting of open-ended questions based on Polya's indicators (understanding, planning, executing, and evaluating). The test was validated for content and reliability prior to use.
- Intrapersonal Intelligence Questionnaire, adapted from Gardner's framework, used to measure students' self-awareness, emotional regulation, and reflective ability.
- Reflective Activity Observation Sheet, used by the researcher and observers to document students' engagement in reflective activities during learning.
- Reflective Journals, written by students to record their experiences, thoughts, and strategies throughout the learning process.

Quantitative Data Analysis

Quantitative data were analyzed using statistical techniques to determine the effect of the intervention on students' mathematical problem-solving ability. The analysis included:

- Normality Test: To verify that the data were normally distributed.
- Homogeneity Test: To ensure the variance between pretest and posttest data was homogeneous.
- Paired Sample t-Test: To examine whether there was a significant difference between pretest and posttest mean scores, indicating improvement after the intervention.
- Effect Size (Cohen's d): To determine the magnitude of the effect of the integrated intrapersonal-reflective learning approach on students' mathematical problem-solving performance.

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RESULTS

Descriptive Statistics of Mathematical Problem-Solving Ability

This study aimed to examine the effect of integrating intrapersonal intelligence and reflective learning on students' mathematical problem-solving ability. Data were obtained from a pretest and a posttest administered before and after the instructional intervention. Overall, the results show a substantial increase in students' mathematical problem-solving performance following the treatment. The mean pretest score was 61.47 (SD = 7.83), while the mean posttest score increased to 83.20 (SD = 6.11). This improvement indicates that students made significant progress in understanding problems, planning strategies, and evaluating their solutions.

Table 2. Descriptive Statistics of Mathematical Problem-Solving Ability

Statistic	Pretest	Posttest
Minimum	45	70
Maximum	78	95
Mean	61.47	83.20
Standard Deviation	7.83	6.1

The table demonstrates that not only did the mean score increase notably, but the data dispersion also became smaller after the intervention. This suggests that the reflective intrapersonal learning model effectively enhanced students' overall performance in a consistent manner.

Normality and Homogeneity Tests

Before conducting the hypothesis test, the normality and homogeneity of the data were analyzed to verify the assumptions for parametric statistical testing.

Normality Test

The Kolmogorov–Smirnov test was applied to assess data distribution. The significance values for both pretest and posttest scores were greater than 0.05, indicating that the data were normally distributed.

Table 3. Normality Test

Test	Statistic	df	Sig. (p)	Description
Pretest	0.127	30	0.200	Normal

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Posttest	0.136	30	0.179	Normal

Homogeneity Test

Levene's test was conducted to ensure that the variances between the two data sets were homogeneous. The obtained significance value was greater than 0.05, confirming the homogeneity of variance.

Table 4. Homogeneity Test

Test	Levene Statistic	df1	df2	Sig. (p)	Description
Pretest–Posttest	1.480	1	58	0.232	Homogeneous

The results of both tests met the assumptions for conducting a paired-sample *t*-test.

Paired Sample *t*-Test

To determine whether the improvement in mathematical problem-solving ability was statistically significant, a paired-sample *t*-test was performed comparing the pretest and posttest scores.

Table 5. Paired Sample t-Test

Data Pair	Mean	t-value	Sig. (p)	Description
Pretest – Posttest	61.47 – 83.20	12.863	0.000	Significant

The results indicate that the significance value ($p = 0.000 < 0.05$) confirms a significant difference between pretest and posttest scores. Therefore, the integration of intrapersonal intelligence and reflective learning had a significant positive effect on students' mathematical problem-solving ability.

Effect Size Analysis

The *effect size* (Cohen's d) was calculated to determine the magnitude of the impact of the intervention. The obtained *effect size* value was 3.11, which is categorized as a very large effect. This finding suggests that the integrated reflective–intrapersonal learning approach produced a substantial influence on improving students' mathematical problem-solving skills.

DISCUSSION

The results of this study demonstrate that the integration of intrapersonal intelligence and

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reflective learning has a significant and positive impact on students' mathematical problem-solving ability. This finding confirms that when learners are guided to become aware of their emotions, thoughts, and learning processes, they are more capable of engaging in deep and meaningful problem solving. The integration of these two constructs self-awareness through intrapersonal intelligence and reflective practice provides a strong foundation for the development of metacognitive skills, which play a crucial role in mathematics learning.

Intrapersonal intelligence, as defined by (Okwuduba et al., 2021; Trusz, 2020), refers to the ability of individuals to understand their inner world, including emotions, motivations, and self-perceptions. In a mathematics learning context, this intelligence allows students to identify their own cognitive strengths and limitations when dealing with challenging problems. Students who possess self-awareness can recognize when they are confused, evaluate their progress, and decide on alternative strategies without external prompts. This internal regulation is essential in mathematical problem solving, where persistence, self-efficacy, and control over anxiety often determine success. The results of this study support previous findings by (Zachariades et al., 2025) on self-regulated learning, which emphasizes that learners who actively monitor and control their cognitive and affective processes achieve higher learning outcomes.

The reflective learning component complements the role of intrapersonal intelligence by providing structured opportunities for learners to think critically about their own learning experiences. Reflection enables students to analyze how they approached a problem, evaluate the strategies used, and consider how they could improve future performance. This aligns with (Zachariades et al., 2025) conception of reflection as a process of active and deliberate thinking based on evidence and reasoning. Through reflective practices such as journal writing, group discussion, and self-assessment, students are encouraged to transform their experiences into knowledge. This process fosters not only better understanding of mathematical concepts but also deeper insight into their personal learning habits and emotional responses.

The combination of intrapersonal awareness and reflection results in a powerful synergy. Reflection without self-awareness tends to be superficial, while self-awareness without reflection lacks structure for meaningful cognitive growth. By combining both, students engage in what (Dabarera et al., 2014; Villanueva, 2022) calls *reflection-in-action* and *reflection-on-action*. During *reflection-in-action*, students become aware of their thought processes as they occur, allowing them to adjust strategies in real time. During *reflection-on-action*, students evaluate their performance after completing a task, identifying what worked and what did not. This continuous reflective cycle strengthens metacognitive awareness, allowing learners to become more

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independent and self-directed problem solvers.

The improvement in students' mathematical problem-solving ability observed in this study can be attributed to the learning design that emphasizes reflective dialogue and self-regulation. Instead of focusing solely on finding correct answers, students were encouraged to question their reasoning, discuss their approaches, and articulate their understanding in written reflections. This approach mirrors constructivist learning principles (Amalina & Vidákovich, 2023; Sappaile et al., 2024), which posit that learners construct knowledge actively through experiences and reflection. By engaging in self-assessment and peer reflection, students internalized strategies that helped them analyze problems more effectively.

Moreover, the reflective learning process also contributed to affective growth. Many students developed greater confidence and motivation as they learned to view mistakes not as failures but as opportunities for improvement. This shift in mindset reflects the development of a growth-oriented attitude toward learning mathematics, consistent with Dweck's *growth mindset* theory. When students perceive challenges as learning opportunities, they are more resilient in facing complex mathematical tasks. Reflection thus acts as both a cognitive and emotional bridge, helping students regulate frustration and anxiety that often accompany problem solving.

The findings also provide evidence that affective and metacognitive domains are interrelated and mutually reinforcing. Intrapersonal intelligence helps learners recognize emotions such as anxiety, boredom, or overconfidence, which often influence their cognitive performance. Through reflection, these emotions are externalized and examined critically, allowing learners to reframe their attitudes and improve focus. This dynamic relationship supports the argument made by (Hartmann et al., 2024; Nguyen et al., 2025) that metacognitive and affective factors play an intertwined role in mathematical problem solving. Students who are emotionally aware and capable of reflective thinking tend to plan better, monitor their progress more effectively, and adapt strategies when encountering obstacles.

The observed improvement in problem-solving ability also indicates that students developed a stronger sense of autonomy in their learning. Reflective journals revealed that many students began setting personal goals, evaluating their understanding independently, and seeking additional resources to support their learning. These behaviors are hallmarks of self-regulated learners, as described by Zimmerman and Schunk. In other words, reflective–intrapersonal learning not only enhances cognitive achievement but also fosters essential lifelong learning skills.

In addition, the collaborative element embedded in reflective learning—such as group

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discussions and peer reflections—helped students articulate their thought processes and learn from others. This practice aligns with Vygotsky's concept of the *zone of proximal development* (ZPD), where learning occurs through social interaction and guided reflection. By explaining their reasoning to peers, students consolidate their understanding and simultaneously strengthen their communication and critical thinking skills.

From a pedagogical perspective, these findings highlight the importance of balancing cognitive and affective elements in mathematics instruction. Traditional mathematics teaching often prioritizes procedural fluency and accuracy, leaving little room for students to reflect or express their internal experiences. The reflective–intrapersonal approach shifts the focus from rote performance to personal meaning-making. When students see the relevance of mathematics to their own thinking processes, they develop intrinsic motivation and a more positive attitude toward learning.

Furthermore, integrating intrapersonal intelligence and reflective learning aligns with current educational paradigms that emphasize learner-centered instruction and 21st-century competencies. The ability to self-regulate, think critically, and reflect independently is highly valued in modern education systems that prepare students for lifelong learning and problem-solving in real-world contexts. Therefore, this model has strong implications for curriculum design, particularly in mathematics education, where conceptual understanding and reasoning are essential.

Theoretically, the findings reinforce the notion that cognitive, metacognitive, and affective processes in learning are inseparable. Successful problem solving requires not only logical reasoning but also emotional regulation, motivation, and reflective awareness. The integration of intrapersonal and reflective dimensions offers a holistic framework that nurtures all these components simultaneously. Practically, educators can adopt simple yet effective strategies such as reflective questioning, guided self-assessment, and emotion-awareness activities to foster similar outcomes.

In summary, the improvement in students' mathematical problem-solving ability in this study is a result of a learning environment that values introspection, reflection, and active engagement. The integration of intrapersonal intelligence and reflective learning empowers students to take ownership of their learning, regulate their emotions, and continuously refine their thinking strategies. This approach transforms mathematics learning from a mechanical process into a reflective, self-directed intellectual activity. It demonstrates that when learners are encouraged to understand both the mathematics and themselves as learners, they achieve

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deeper, more meaningful, and lasting learning outcomes.

CONCLUSION

Based on the findings and discussion presented, it can be concluded that the integration of intrapersonal intelligence and reflective learning is proven to be effective in enhancing students' mathematical problem-solving ability. The implementation of a learning approach that emphasizes self-awareness, reflective thinking, and evaluation of the learning process enables students not only to understand mathematical concepts more deeply but also to develop metacognitive skills and independent learning habits. Students who participated in this integrated learning model showed significant improvement in their ability to identify problems, plan effective solution strategies, and reflect on their problem-solving processes. In addition to cognitive gains, there was also a noticeable positive change in affective aspects, such as increased self-confidence, learning motivation, and emotional regulation when dealing with challenges. This indicates that reflective learning integrated with intrapersonal intelligence fosters a more holistic and meaningful learning experience. Theoretically, these findings reinforce the view that effective mathematics learning should not only focus on conceptual and procedural mastery but also on developing learners' self-awareness and reflective capacity. Practically, this learning model offers an innovative instructional alternative for mathematics educators to cultivate independent, reflective, and resilient learners capable of managing their own learning. Integration of intrapersonal intelligence and reflective learning not only improves mathematical problem-solving ability but also nurtures self-aware, critical, and lifelong learners prepared to face academic and real-world challenges.

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