

Self-Efficacy, Reflective Thinking, and Critical Thinking: A Structural Equation Modeling Study Among Adolescents

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Abstract

Students often face challenges in developing critical thinking (CT) in mathematics, largely due to low self-efficacy (SE) and limited reflective thinking (RT), while instructional approaches that integrate both aspects remain underutilized. This study investigates the interrelationships among SE, RT, and mathematical CT in Islamic and state middle schools. Employing a quantitative design, data were obtained from 260 students selected through simple random sampling and analyzed using Structural Equation Modeling (SEM). Validated and reliable instruments were administered to measure SE, RT, and CT. The results indicate that SE exerts a significant influence on RT ($\beta = .68$, $t = 5.55$) and directly enhances mathematical CT ($\beta = 1.12$, $t = 3.55$). RT also contributes significantly to mathematical CT ($t = 2.89$). The SEM model demonstrates strong fit indices ($\chi^2 = 30.88$, RMSEA = .034, $p = .15$), confirming the robustness of the findings. These results highlight SE as both a direct and indirect determinant of CT, mediated through RT. The study underscores the importance of incorporating RT-oriented strategies into mathematics instruction to simultaneously strengthen students' confidence and foster higher-order CT skills.

INTRODUCTION

Critical thinking (CT) is widely recognized as a vital competence in mathematics education, serving as a foundation for analyzing problems, evaluating arguments, formulating solutions, and making reasoned decisions (Bassham et al., 2012; Halpern, 1998; Weinstein & Preiss, 2017). Because mathematics often involves abstract and complex problem-solving, students are expected not only to recall facts or apply formulas but also to interpret information, recognize conceptual relationships, and construct logical conclusions (Fadzil & Osman, 2025; Ramnarain, 2013). These capabilities reflect the essence of CT (Abrami et al., 2015; Dekker, 2020). Nevertheless, numerous studies report that secondary-level students frequently struggle with high-level reasoning tasks, such as evaluating problems critically, selecting appropriate strategies, and justifying solutions, suggesting that CT remains underdeveloped in many learners. This situation underscores the need to cultivate CT as a fundamental skill, enabling students to think independently and address real-world challenges through logical reasoning and reflection.

In fostering CT, affective factors such as self-efficacy (SE) are equally important alongside cognitive strategies. SE, defined as individuals' confidence in their ability to

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complete specific tasks, has a well-established impact on academic motivation and achievement, particularly in demanding subjects such as mathematics (Mangundjaya et al., 2024; Sawtelle et al., 2012; Schunk & DiBenedetto, 2016). Students with high mathematical SE demonstrate confidence when tackling new or complex problems, show greater resilience in overcoming difficulties, and persist in seeking solutions (Hoffman, 2010; Hoffman & Spatariu, 2008; Suparman et al., 2024). They are also more inclined to reflect on their thought processes, thereby improving the quality of their reasoning. Conversely, students with low SE often experience anxiety and self-doubt (Aller & Almrwani, 2024; Sholihah et al., 2025; Yosef et al., 2023), avoid challenging tasks (Shim & Ryan, 2005), and easily give up even when possessing adequate skills (Margolis, 2005). Such tendencies hinder engagement in CT and impede deeper mathematical understanding. Therefore, enhancing SE is essential to strengthen students' willingness and capacity to engage in complex cognitive activities.

One promising pedagogical approach for supporting both SE and CT is reflective thinking (RT). RT involves evaluating one's thoughts, actions, and learning experiences to foster meaningful improvement (Dunn & Musolino, 2011; Muamar & Agustyarini, 2022; Orakçı, 2021; Rodgers, 2002). It enables learners to connect prior knowledge with new information, question assumptions, assess reasoning, and adjust problem-solving strategies (Chen et al., 2019; Kuiper & Pesut, 2004; Nursupiamin et al., 2025). RT typically unfolds across three phases: reacting (recognizing and responding to a challenge), elaborating (analyzing experiences and their underlying meaning), and contemplating (developing deeper understanding and insight) (Hong & Choi, 2011; Kholid et al., 2022). These stages foster metacognitive awareness, helping learners become more mindful of how they think and problem-solve (Salmon, 2015; Turky, 2017). Through RT, students are encouraged to take ownership of their learning, build confidence in addressing challenges, and refine their reasoning processes (Tamsir et al., 2025; Bobrowicz et al., 2022; Kohn, 2024; Nobutoshi, 2023). Thus, RT not only promotes CT by enhancing reasoning and decision-making but also strengthens SE by reinforcing students' confidence in their problem-solving abilities.

Despite the established importance of SE and CT in mathematics learning, existing studies often examine these constructs in isolation or emphasize cognitive outcomes while overlooking the affective and metacognitive dimensions underpinning them. Instructional practices generally prioritize procedural fluency or conceptual understanding without explicitly promoting reflection or self-regulation (Keazer & Phaiah, 2022; Lee, 2025). Moreover, little research explores how RT strategies can be systematically integrated into mathematics instruction to simultaneously support SE and CT. This gap is particularly evident in lower secondary education, where students are at a formative stage of developing foundational cognitive and emotional competencies.

Addressing this gap, the present study investigates a reflective thinking-based instructional approach as a means of enhancing both mathematical SE and CT. Specifically, it aims to (1) examine the effect of RT on students' CT in mathematics, and (2) assess whether RT can strengthen students' mathematical SE. It is hypothesized that students exposed to structured RT instruction will demonstrate higher levels of both CT and SE than those taught with traditional methods. By exploring the influence of RT on these domains, this study seeks to contribute to the development of more comprehensive pedagogical models that integrate cognitive, affective, and metacognitive dimensions of mathematics learning.

Rationale of the Study

CT in mathematics is crucial for enabling students to analyze arguments, solve complex problems, and make reasoned decisions. Yet, numerous studies indicate that secondary students continue to struggle with CT, largely due to low self-efficacy SE and limited RT. While SE has been widely associated with academic achievement and motivation, and RT is recognized for

strengthening cognitive processes, research that systematically integrates both constructs within mathematics education particularly in Islamic and public schools remains limited. Local contexts further reveal that students in these schools face persistent challenges in formulating mathematical arguments and problem-solving strategies. Therefore, this study aims to examine the impact of RT on CT and SE among junior secondary students in Islamic and public-school settings, with the expectation that a learning model emphasizing RT will foster improvements in both SE and CT.

Objectives of the Study

The objectives of this study are to investigate the effect of a reflective thinking approach on students' critical thinking in mathematics and to examine its role in enhancing their self-efficacy. Specifically, the study aims to determine whether structured reflective thinking practices can significantly improve students' ability to analyze problems, construct logical arguments, and make reasoned decisions, while simultaneously strengthening their confidence in handling mathematical challenges.

METHODS

Design

This study employed a quantitative research design using a path analysis approach within the framework of Structural Equation Modeling (SEM). The design was chosen to test both the direct and indirect effects among the variables, allowing for a comprehensive examination of the relationships between self-efficacy (SE), reflective thinking (RT), and critical thinking (CT). Two independent variables, SE and RT, were examined in relation to CT as the dependent variable. This design is considered appropriate for modeling complex associations among psychological constructs in mathematics education.

Participants

The population of this study consisted of 332 seventh-grade students drawn from one Islamic middle school and two state middle schools in Indonesia. Seventh graders were selected as the target group because this stage represents a critical period in which cognitive skills such as SE, RT, and CT begin to develop more prominently (Pressley et al., 2006). Using a simple random sampling technique, 260 students were selected as participants. The sample size was considered adequate and methodologically sound, as it falls within Roscoe's (1975) rule of thumb, which suggests that sample sizes between 30 and 500 are appropriate for behavioral research. This sampling strategy ensured that the participants were representative of the population and provided sufficient statistical power for the analysis.

Instruments

The research instruments consisted of a self-efficacy questionnaire and mathematics thinking ability test items. Data collection involved two components: (1) a self-efficacy questionnaire comprising three indicators designed to categorize students' self-efficacy levels (high, medium, or low), and (2) PISA-based test questions consisting of two essay items aimed at assessing reflective and critical thinking skills. The first essay item was developed to measure reflective thinking, focusing on three phases: reacting, comparing, and contemplating. The second essay item was designed to capture critical thinking skills, covering elementary clarification, decision-making foundations, inference, advanced clarification, as well as strategies, tactics, and reflection. The complete test item grid, which integrates the self-efficacy questionnaire along with the reflective and critical thinking ability components, is presented in Table 1.

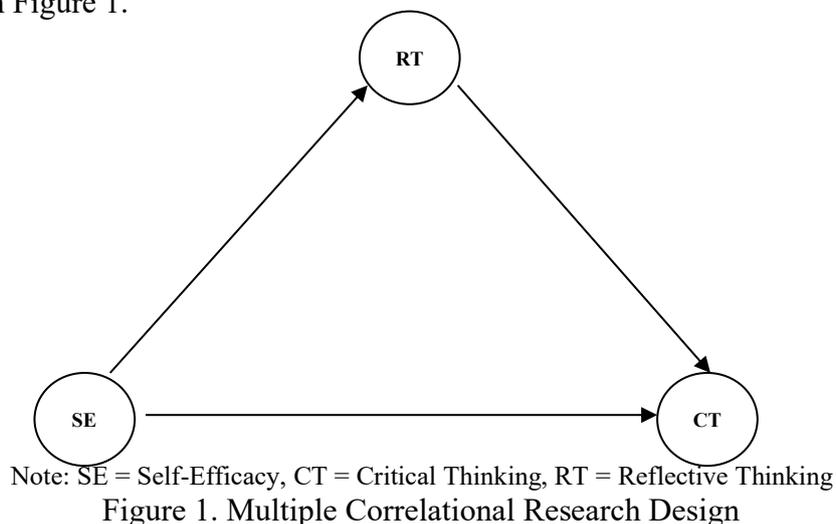
Table 1. Constructs, Indicators, and Sample Items for SE, RT, and CT

Constructs/Aspects	Indicators	Sample Item/Task
Self-Efficacy (SE)	Level: SE1 – Confidence in facing mathematics questions depending on difficulty; SE2 – Efficacy in selecting appropriate strategies for problem-solving. Strength: SE3 – Confidence in competence in mathematics; SE4 – Confidence in efforts to solve problems; SE5 – Confidence in studying mathematics. Generality: SE6 – Confidence in applying mathematics to various problems; SE7 – Exhibiting efficacy across all stages of the mathematics learning process.	Respond to mathematics problems of varying levels of difficulty and justify chosen strategies.
Reflective Thinking (RT)	RT1 – State what is known, asked, and the relationship between them. RT2 – Explain strategies considered effective. RT3 – Create and interpret mathematical models. RT4 – Solve problems and draw conclusions.	Solve a contextual problem related to the comparison of congruent flat shapes and explain the reasoning process.
Critical Thinking (CT)	CT1 – Demonstrate understanding of the problem. CT2 – Choose an appropriate approach or strategy. CT3 – Analyze connections with prior problems. CT4 – Solve problems using the determined strategy. CT5 – Detect and correct errors. CT6 – CT7 Draw conclusions from the problem.	Determine the surface area of a prism combining two geometric shapes and justify the solution process.

Data Analysis

The data analysis followed a multi-step procedure. First, preliminary assumption testing was conducted, including assessments of normality, linearity, and homoscedasticity. A univariate normality test was applied to examine whether the distributions of SE, RT, and CT met the normality requirement. This assumption is essential for parametric statistical methods such as Structural Equation Modeling (SEM), which rely on normally distributed data for accurate parameter estimation and valid inferences. Normality was assessed using skewness and kurtosis values, complemented by visual inspections of histograms and Q-Q plots, with all variables meeting the criteria.

Subsequently, path analysis was performed using LISREL software to estimate the structural relationships among SE, RT, and CT. Model fit was evaluated using multiple indices, including Chi-square, RMSEA, CFI, and TLI, to ensure robustness of the analysis. To further confirm measurement quality, the instruments underwent testing for convergent and discriminant validity, as well as internal consistency reliability. The proposed structural model is illustrated in Figure 1.



RESULTS AND DISCUSSION

Results

Assumptions Test

As shown in Table 2, most variables violated the normality assumption, as indicated by p-values < 0.05 in the Skewness, Kurtosis, and combined Chi-Square tests. A low Skewness p-value indicates significant asymmetry, while a low Kurtosis p-value reflects deviations in “flatness” or “peakedness” from a normal distribution. The combined Chi-Square test confirms that the overall distribution is non-normal.

Due to non-normality, the Maximum Likelihood (ML) method in SEM could not be applied directly. Therefore, LISREL 8.80 was used with the Robust Maximum Likelihood (RML) method, which accommodates non-normal data (Li, 2016; Maydeu-Olivares, 2017). The linearity assumption was tested between the independent variables (reflective thinking and self-efficacy) and the dependent variable (mathematical critical thinking). Results showed that linearity was satisfied ($p = 0.763$ and 0.663 , respectively). Homoscedasticity was also confirmed, as residuals were randomly distributed without any discernible pattern.

The suitability for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett’s Test of Sphericity. The KMO value of 0.844 indicated high sampling adequacy, while Bartlett’s test ($\chi^2 = 1141.392$, $df = 136$, $p < 0.001$) confirmed significant correlations among variables, justifying factor analysis.

Principal Component Analysis (PCA) revealed that communalities for critical thinking items ranged from 0.390 to 0.699, for reflective thinking from 0.318 to 0.631, and for self-efficacy from 0.530 to 0.660. Most items had adequate communalities, although one item in reflective thinking (0.318) showed relatively low representation. Overall, the results indicate that the constructs, particularly self-efficacy and critical thinking, are well represented by their components, while some reflective thinking items may require further attention.

Model Measurement

The measurement (outer) model illustrates how each observed variable represents its underlying latent construct. This relationship was evaluated using confirmatory factor analysis (CFA) to assess the validity and reliability of the measurement indicators.

Table 2. Univariate and Multivariate Normality Tests

Variable	Skewness Z	P-Value	Kurtosis Z	P-Value	Chi-Square	P-Value
SE ₁	-9.383	0.000	5.666	0.000	120.145	0.000
SE ₂	-6.245	0.000	1.587	0.113	41.513	0.000
SE ₃	-7.598	0.000	3.484	0.000	69.877	0.000
RT ₁	-7.131	0.000	2.863	0.004	59.055	0.000
RT ₂	-4.564	0.000	-1.293	0.196	22.505	0.000
RT ₃	-4.646	0.000	-0.925	0.355	22.444	0.000
CT ₁	-4.576	0.000	-1.001	0.317	21.946	0.000
CT ₂	-5.858	0.000	0.930	0.352	35.186	0.000
CT ₃	-6.679	0.000	2.238	0.025	49.614	0.000
SE ₄	-3.656	0.000	-3.087	0.002	22.893	0.000
SE ₅	-4.564	0.000	-1.293	0.196	22.505	0.000
SE ₆	-3.656	0.000	-3.087	0.002	22.893	0.000
RT ₄	-4.323	0.000	-1.539	0.124	22.056	0.000
RT ₅	-4.197	0.000	-1.816	0.069	20.913	0.000
RT ₆	-4.323	0.000	-1.539	0.124	21.056	0.000
CT ₄	-4.197	0.000	-1.816	0.069	20.913	0.000
CT ₅	-6.179	0.000	1.390	0.165	40.112	0.000
CT ₆	-5.680	0.000	-0.298	0.766	32.356	0.000
CT ₇	-6.179	0.000	1.390	0.165	40.112	0.000

Validity

Convergent validity examines the extent to which indicators intended to measure the same construct are correlated. In Figure 2, several indicators exhibited factor loadings below 0.50, the minimum recommended threshold in CFA analysis (Fornell & Larcker, 1981; Hair et al., 2013; Kline, 2023). Indicators below this threshold are considered insufficiently representative of their constructs.

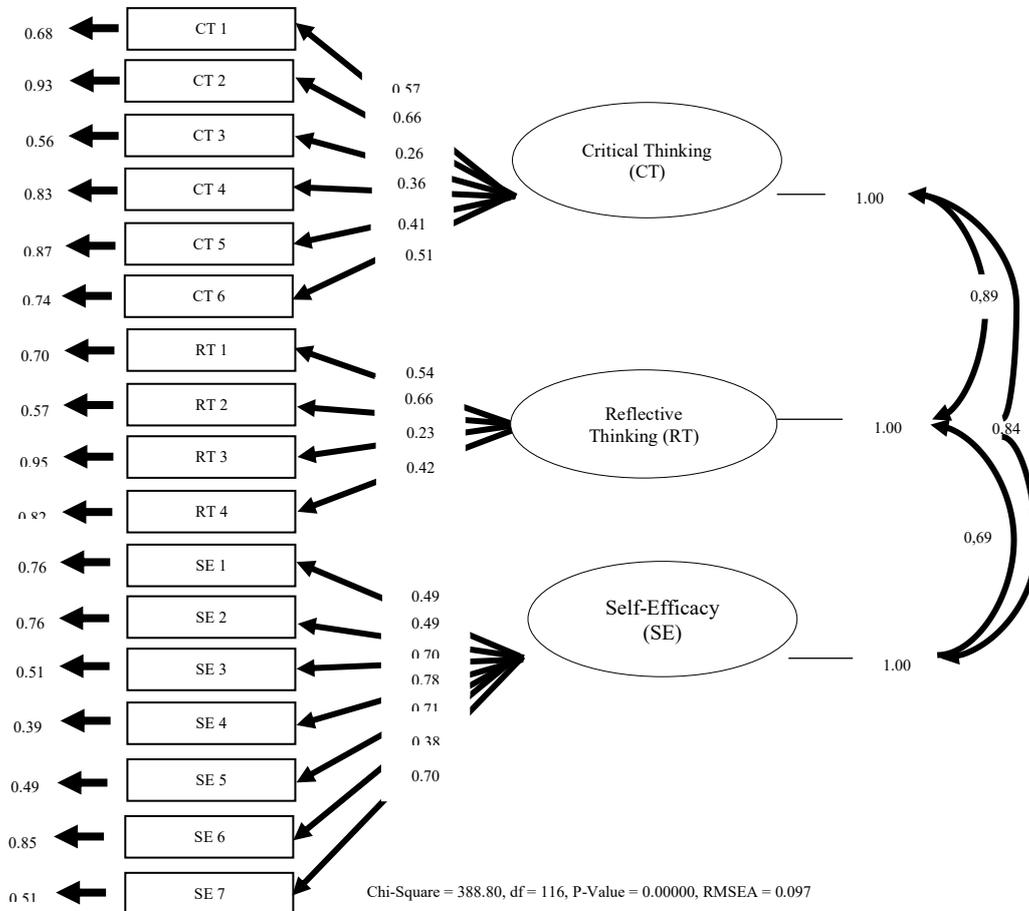


Figure 2. CFA Validity Test

To improve model accuracy and parsimony, indicators with low loadings were removed: Self-efficacy items SE₂, SE₄, SE₅; Reflective Thinking items RT₃, RT₄; Critical Thinking items CT₁, CT₂, and CT₆ (Hancock & Mueller, 2001).

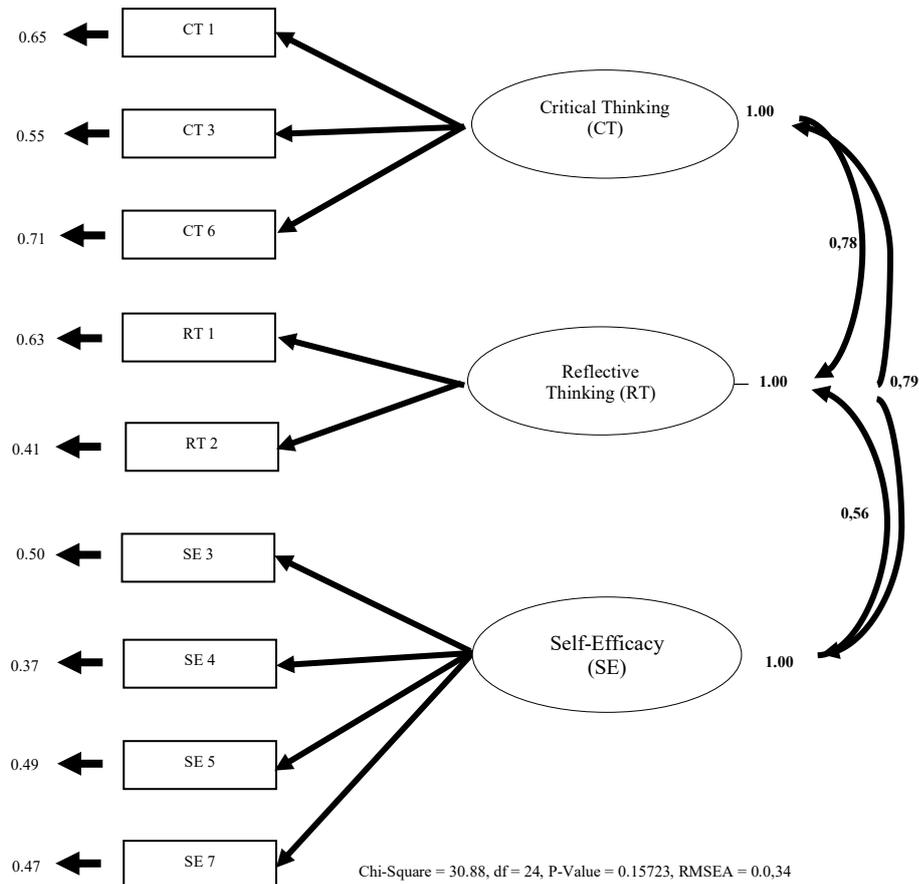


Figure 3. Reanalysis of CFA Validity Test

Figure 3 presents the reanalysis after omitting these indicators. All remaining indicators had factor loadings above 0.50, confirming that they are valid measures of their respective latent constructs.

Reliability Test

Reliability evaluates the extent to which the items consistently measure the underlying latent construct (Hancock & Mueller, 2001; Viladrich et al., 2017). Reliability test using Composite Reliability (CR) (Hair et al., 2013; Hancock & Mueller, 2001; Raykov, 1997) and Average Variance Extracted (AVE) tests (Fornell & Larcker, 1981; Hair et al., 2013). Test Standard CR > 0.7 is based on the principle that the reliability of a latent construct should be high enough to ensure that the construct is measured with good internal consistency (Fornell & Larcker, 1981; Hair et al., 2013; Nunnally & Bernstein, 1994). The CR test is .87 (> .7) and AVE of .52 (> .5) indicate that the latent construct has good reliability. This means that the indicators consistently measure the same construct, and the construct is reliable.

Feasibility Model (Goodness of Fit)

The model is considered acceptable if it demonstrates a good Goodness of Fit. Below is an illustration of the model under analysis, with the Absolute Fit Indices being used to evaluate how well the model aligns with the data gathered, comparing the theoretical fit to the observed data.

Table 3. Goodness of Fit Model

No	Goodness of Fit	Results		
		Cut of Value	Value	Decision
1	Chi-Square	$\leq 2 \times df$ $\leq 2 \times 24$	30.88	Good
2	RMSEA	< 0.05	003	Good
3	P-Value	≥ 0.05	0.15	Good
4	GFI	≥ 90	0.97	Good
5	AGFI	≥ 90	0.95	Good
6	CFI	≥ 90	0.99	Good

Figure 4, alongside Table 3, presents the Goodness of Fit (GoF) results for this model. The analysis shows that the model fits the data well, with a Chi-Square value of 30.88, 24 degrees of freedom (df), and a p-value of .15723. In SEM analysis, a p-value above .05 suggests no significant difference between the theoretical model and the observed data, indicating a good fit. Here, the p-value confirms that the model appropriately fits the data.

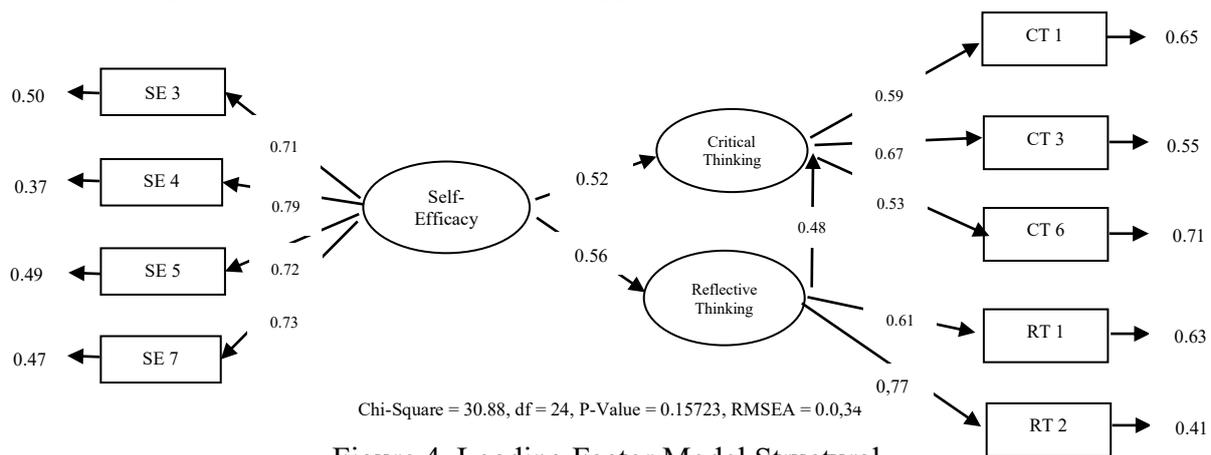


Figure 4. Loading Factor Model Structural

Additionally, the Root Mean Square Error of Approximation (RMSEA) value of .034 offers further evidence of the model's good fit. RMSEA is a widely used index for evaluating how well a model aligns with the population data. An RMSEA value below .05, as demonstrated here, indicates that the model has a very low level of approximation error, suggesting that it effectively captures the data with high accuracy.

In general, this model has a strong Goodness of Fit, as evidenced by the good Chi-Square and RMSEA results. The Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit Index (AGFI) both exceed 90. Thus, this model can be considered as a valid and accurate representation of the relationship between latent variables such as SE, RT, CT in the context of this study.

In summary, the GoF analysis results support the conclusion that the SEM model effectively captures the relationships between the latent variables without significant discrepancies from the observed data. This suggests that the model can be reliably used to understand and predict how self-efficacy, reflective thinking, and mathematical critical thinking interact among students. The SEM analysis showed a significant relationship between SE, RT, and CT in junior high school students. In the initial model, both Reflective Thinking and Self-Efficacy positively influenced Critical Thinking. The regression coefficients of .86 for Reflective Thinking and 1.12 for Self-Efficacy highlight their important roles in enhancing students' critical thinking skills in mathematics. Specifically, increases in students' self-efficacy not only directly strengthen their critical thinking abilities but also encourage them to engage in reflective thinking, which in turn further boosts their critical thinking skills.

Furthermore, the R^2 value of .78 indicates that 78% of the variation in Mathematical Critical Thinking can be explained by the combination of Reflective Thinking and Self-Efficacy. This indicates that the model has excellent predictive power, explaining most of the variation in students' mathematical critical thinking ability based on these two variables. The t-values of 2.89 for Reflective Thinking and 3.55 for Self-Efficacy also confirm that the effects of both variables are statistically significant, confirming their importance in improving mathematical critical thinking ability.

In the second model, the results show that Self-Efficacy has a significant effect on Reflective Thinking with a regression coefficient of .68. This means that students' self-belief in their mathematical ability encourages them to use the reflective thinking approach more often. Although the R^2 value of .32 indicates that only 32% of the variation in Reflective Thinking can be explained by Self-Efficacy, this effect is still significant with a T-value of 5.55, indicating that self-efficacy is an important factor, although there are other factors that also influence the use of reflective thinking approaches, such as learning styles (Marlena et al., 2022; Nurul et al., 2020; Zahara et al., 2020) and math anxiety (Erdem & Arikan, 2023).

Overall, these results highlight the crucial role of enhancing students' self-efficacy in order to boost their mathematical critical thinking skills. Additionally, the application of reflective thinking approaches also significantly contributes to this improvement. Hence, educational strategies designed to increase students' self-efficacy and promote reflective thinking can greatly benefit their ability to think critically in mathematics. Nevertheless, the study has some limitations. Factors like students' prior knowledge, motivation, socio-economic background, and learning environment may have affected the results. These factors were not controlled in this study and should be addressed in future research to achieve a more comprehensive understanding of the influences on mathematical critical thinking.

Furthermore, in Structural Equation Modeling (SEM) analysis using LISREL, T-values are one of the important indicators used to determine whether a regression parameter or factor loading is statistically significant. In general, T-values are employed to test whether a parameter coefficient is significantly different from zero, indicating a meaningful relationship between the variables in the model.

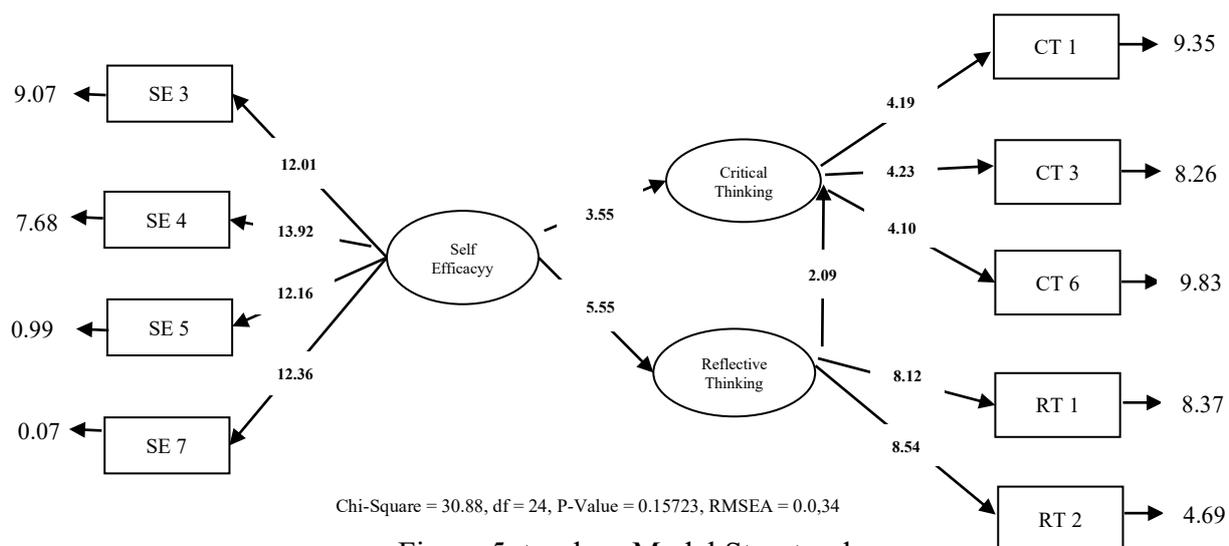


Figure 5. t-values Model Structural

Figure 5 shows that t-values greater than or equal to 1.96 at the 5% significance level indicate a statistically significant relationship. In contrast, t-values below 1.96 suggest that the relationship is not significant. In the visualized model, several relationships between latent variables are significant based on their t-values. For instance, the relationship between Self-

Efficacy (SE) and Reflective Thinking (BR) has a t-value of 5.55, indicating a statistically significant connection. Likewise, the link between SE and CT has a t-value of 3.55, also significant at the 5% level. Additionally, the relationship between Reflective Thinking (BR) and CT has a t-value of 2.89, confirming its statistical significance.

Overall, all the t-values presented in this model are greater than 1.96, indicating that the relationships between the latent variables are statistically significant. This indicates that Self-Efficacy, Reflective Thinking, and Mathematical Critical Thinking are significantly interconnected, in accordance with the hypotheses proposed in the study. These findings provide strong support to the proposed conceptual model, where Self-Efficacy not only influences Reflective Thinking but also directly contributes to the improvement of students' Mathematical Critical Thinking.

The significant relationship between Self-Efficacy, Reflective Thinking, and Mathematical Critical Thinking can be seen in the results of student work in the following Figure 8.

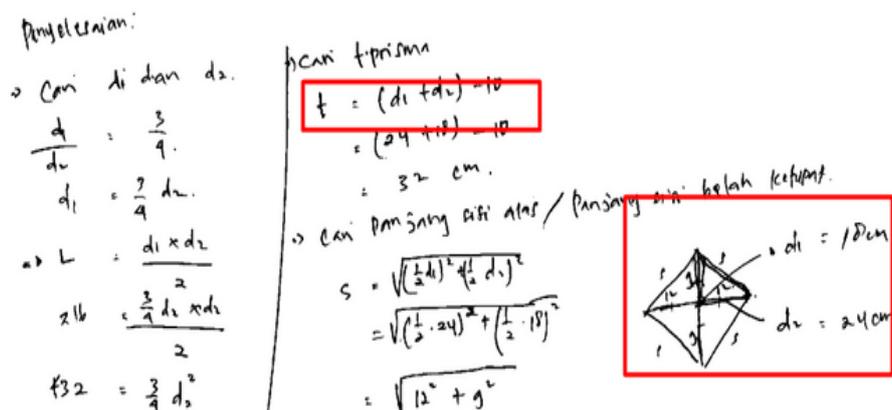


Figure 6. Student Work Results

Figure 6 shows part of a geometric calculation that appears to be related to a prism or other three-dimensional shape. It shows several steps involving calculations of diagonals, sides, and rib lengths. To the right of the image, there is a diagram depicting the prism or other shape with its diagonals, along with calculations involving the lengths of the diagonals (d_1 and d_2) and their heights. When linked to the findings of research discussing the relationship between self-efficacy, reflective thinking, and mathematical critical thinking, this image could be an example of how reflective thinking and critical thinking are applied in a mathematical context. Essentially, students' ability to understand and solve mathematical problems involving multiple calculation steps such as this one requires the ability to critically analyze, visualize and relate various elements of geometry. In this study, increasing students' self-efficacy or confidence in their abilities in mathematics can help them solve problems more confidently and effectively. Reflective thinking, on the other hand, helps students to evaluate their steps, consider alternative solutions, and correct errors that may occur during the problem-solving process. This shows the importance of both variables in helping students understand more complex mathematical concepts, as reflected in this figure.

Discussion

The results of this study indicate that Self-Efficacy (SE) has a significant influence on Reflective Thinking (RT) and Critical Thinking (CT) in mathematics among junior high school students. The positive and significant relationship can be explained by the fact that students with higher self-efficacy are more confident in their ability to solve mathematical problems, which increases their persistence when encountering challenges. This confidence motivates them to reflect more deeply on problem-solving strategies, evaluate errors, and refine their

approaches. Reflective thinking, in turn, strengthens the ability to analyze, question assumptions, and draw logical conclusions, which ultimately enhances critical thinking. Thus, self-efficacy functions not only as a motivational factor but also as a catalyst for the development of higher-order thinking skills in mathematics.

This finding aligns with socio-cognitive motivation theory, which posits that self-efficacy is a central determinant of academic performance, particularly in subjects that demand complex reasoning such as mathematics (Ziegler & Opdenakker, 2018). It is also consistent with Bandura and Zimmerman's argument that students' confidence significantly impacts learning outcomes, as well as with Pajares (Chen & Pajares, 2010), who emphasizes that self-efficacy enhances motivation and cognitive engagement in mathematical activities. Similarly, Byrne (2013) and Hu & Bentler (1999) highlight that strategies aimed at improving students' self-efficacy contribute to the cultivation of critical thinking. Therefore, this study reinforces previous evidence while extending the understanding of how reflective thinking mediates the relationship between self-efficacy and critical thinking in mathematics learning.

Specifically, the impact of Self-Efficacy on Reflective Thinking, with a regression coefficient of 0.68 and t-value of 5.55, shows that students' confidence fosters the use of reflective thinking strategies. Reflective thinking is essential for effective problem-solving because it allows students to critically evaluate the steps they have taken, recognize errors, and adjust their approaches accordingly. Through this process, students are able to connect prior knowledge with new concepts, explore alternative strategies, and generate more accurate and innovative solutions. In the context of mathematics learning, reflective thinking strengthens conceptual understanding and equips students with the flexibility to adapt when faced with unfamiliar or complex problems (Bandura, 1978; Demirel et al., 2015; KholiD et al., 2020; Durak, 2018; Zimmerman & Schunk, 2013).

The direct effect of Self-Efficacy on Critical Thinking, with a regression coefficient of 1.12, indicates that students with higher confidence in mathematics demonstrate stronger critical thinking skills. This occurs because students with strong self-efficacy are more willing to engage with challenging tasks, persist when facing difficulties, and evaluate problems from multiple perspectives. Their confidence also reduces fear of failure, enabling them to take intellectual risks that stimulate deeper analysis. As a result, high self-efficacy directly nurtures the dispositions necessary for critical thinking, such as logical reasoning, careful evaluation, and effective decision-making. This supports Phan (2009) findings that high self-efficacy encourages critical reflection, leading to deeper learning and improved problem-solving.

Moreover, Reflective Thinking significantly affects Mathematical Critical Thinking (t-value = 2.89), highlighting its role in strengthening students' higher-order reasoning skills. This is because reflective thinking enables learners to pause, reconsider their problem-solving processes, and examine the accuracy and logic of their strategies. Through this self-evaluation, students are able to identify mistakes, refine their reasoning, and connect prior knowledge with new insights, which are essential aspects of critical thinking. These results are consistent with ErdoĖAn (2020), who emphasizes the importance of reflection in critical thinking development, and with Ghanizadeh (2016), who shows that reflective processing enhances students' ability to analyze problems in depth.

Finally, the model demonstrates good Goodness of Fit (GoF). Indicators including Chi-Square, RMSEA, GFI, AGFI, and CFI all meet recommended criteria, confirming that the model accurately represents the relationships among SE, RT, and CT. This finding can be explained by the fact that self-efficacy provides the motivational foundation for students to persevere in mathematical problem-solving, while reflective thinking equips them with the cognitive tools to evaluate, refine, and improve their reasoning. When these two factors interact, students not only develop the confidence to tackle challenging tasks but also the capacity to analyze problems critically and generate effective solutions. These results are consistent with

previous studies, such as Ghanizadeh (2016) and ErdoĖAn (2020), who highlight the role of reflection in cultivating critical thinking, and with Chen & Pajares (2010) and Byrne (2013), who emphasize that self-efficacy significantly contributes to students' motivation and higher-order cognitive engagement.

Implications

Overall, this research reinforces prior studies highlighting the significance of self-efficacy in math education and contributes new insights regarding the role of reflective thinking as a mediator in enhancing critical thinking skills in mathematics. It also offers practical guidance for teachers and educators, suggesting that interventions should aim not only at building mathematical skills but also at boosting students' self-efficacy and promoting reflective thinking strategies.

Over-reliance on memorization and routine procedures can impede students' decision-making abilities when solving math problems. True critical thinking in mathematics goes beyond applying memorized steps it involves understanding, interpreting, and considering multiple solution approaches, as well as connecting mathematics to real-world contexts (Dolapcioglu & DoĖanay, 2020). Moreover, critical thinking can be cultivated both cognitively and socially through reflective thinking, a metacognitive process that allows students to analyze, evaluate, and reach logical conclusions during problem-solving (Dwyer & Walsh, 2019; Ennis, 1996; Kuntze et al., 2017; Tempelaar, 2006). Therefore, fostering reflective thinking is essential for enhancing students' self-efficacy and critical thinking skills in math.

Limitation

This study did not employ a formal power analysis to determine the sample size. Instead, the sample size was based on Rascoe's rule of thumb. While this guideline is widely accepted in social science research, the absence of a statistical power calculation may limit the precision in detecting potential effect sizes, and thus represents a limitation of the study.

CONCLUSIONS

This study concludes that self-efficacy and reflective thinking have a significant positive effect on mathematical critical thinking among middle school students. Self-efficacy influences critical thinking both directly and indirectly through reflective thinking, while reflective thinking itself also contributes significantly to enhancing critical thinking skills. The findings highlight that students' confidence in their mathematical abilities not only strengthens their critical thinking directly but also promotes reflective thinking strategies that further improve critical thinking. Additionally, self-efficacy plays an important role in fostering deep reflective thinking, although other factors may also contribute. Overall, these results underscore the importance of educational interventions that enhance self-efficacy and reflective thinking, as they can substantially improve students' mathematical critical thinking skills. The study aligns with previous research emphasizing the role of self-efficacy and reflective thinking in supporting academic success and the development of critical thinking.

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