

HIGH AWARENESS, LOW SCORES: UNVEILING THE CONTRADICTION BETWEEN METACOGNITIVE REFLECTION AND WRITTEN MATHEMATICS TEST PERFORMANCE

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Abstract: *This study aims to describe students' levels of metacognitive reflection and their written test performance in mathematics learning, as well as to analyze the relationship between the two. The study employed a mixed-method approach with a descriptive–correlational design involving 24 seventh-grade junior high school students selected through purposive sampling. Data were collected using a 10-item metacognitive reflection questionnaire (4-point Likert scale) and a written mathematics test consisting of two open-ended questions. The questionnaire demonstrated acceptable reliability (Cronbach's Alpha = 0.768). Descriptive analysis indicated that most students were categorized at moderate to high levels of metacognitive reflection. However, Pearson correlation analysis revealed no significant relationship between metacognitive reflection and written test performance ($r = -0.152$, $p = 0.479$). These findings suggest that students reported metacognitive reflection does not necessarily correspond to their performance on written mathematical tasks. The results highlight the need for further investigation using multiple data sources to better understand the relationship between metacognitive reflection and mathematical performance.*

Keywords: Metacognitive Reflection, Written Test, Mathematics Learning, Academic Performance, Awareness

INTRODUCTION

Reflection involves a structured and consistent thinking process that includes observation, analysis, in-depth review, exploration, and refinement of thought or action in order to gain a clear understanding and achieve optimal outcomes (Fat'hi & Behzadpour, 2011; Nguyen et al., 2014; Clarà, 2015). Reflection is a crucial component in the learning process, as it enables students to actively evaluate and derive meaning from their experiences, as

emphasized by educational theorist Dewey (Rodgers, 2002). Given the essential role of reflection, various efforts and methods have been employed to foster and enhance students' reflective thinking skills (Hasanah, Turmudi, & Juandi, 2024), such as through outdoor play and game-based contextual learning activities (Hasanah et al., 2025). Reflection demonstrates that thoughts or ideas should be critically questioned and that no concept is entirely free from evaluation. Furthermore, metacognition is defined as

thinking about one's own thinking (Dimmitt & McCormick, 2012). It refers to the monitoring and regulation of one's cognitive processes (Martinez, 2006). Literature reviews provide strong evidence that metacognitive learning, when effectively implemented in schools, has a positive impact on students' academic achievement (Ku & Ho, 2010; Perry et al., 2019; Cromley & Kunze, 2020). In the field of cognitive science, the concept of metacognition is primarily limited to individuals' cognitive processes and their awareness of knowledge and personal experiences (Cornoldi, 2014; Azevedo, 2020).

Referring to the perspectives of Chick et al. (2009), Wald (2015), and Merkebu et al. (2023), metacognitive reflection encompasses deep self-observation, conscious awareness, and regulation of emotions, knowledge, and experiences through the critical examination of cognitive processes and emotional responses, with the aim of continuously improving perspectives and the quality of decision-making (Merkebu et al., 2024). Metacognitive reflection facilitates shifts in perspective and can support lifelong learning through recontextualization (Merkebu et al., 2024). The literature in the field of education indicates that this concept continues to be utilized in various studies concerning both reflection and metacognition (Zohar & Barzilai, 2013; Azevedo, 2020; Belenkova, 2020; Merkebu et al., 2023; Nobutoshi, 2023). Meaningful metacognitive reflection comprehensively integrates elements of metacognition, reflection, and the emotional aspects inherent within them.

Ideally, a high level of metacognitive reflection should align with strong academic performance in written test results, as suggested in several studies. In practice, teachers often use questionnaires as

instruments to measure students' metacognitive reflection. However, field observations reveal a discrepancy between students' metacognitive reflection levels as measured by questionnaires and their academic performance as indicated by mathematics written test scores. Some students with high metacognitive reflection levels scored poorly on written tests, while others who performed relatively well on the tests demonstrated low or moderate levels of metacognitive reflection. This raises the question of whether metacognitive reflection, as assessed through questionnaires, truly reflects students' academic performance in written tests, or whether other factors contribute to the contradiction between metacognitive reflection levels and mathematics test performance.

Previous studies have extensively examined the impact of metacognitive instruction and metacognitive reflection on students' performance, critical thinking skills, and outcomes in the teaching and learning process (Kuiper & Pesut, 2004; Kaune, 2006; Kane et al., 2014; Alt & Raichel, 2020; Azevedo, 2020; Pedrosa et al., 2021; Nobutoshi, 2023). Research by Veenman et al. (2006) also emphasized the importance of mastering metacognitive skills in enhancing academic performance. Other studies have noted that reflection can strengthen self-regulation in learning (Efklides, 2008). However, most of these studies have focused more on metacognitive abilities, while research examining the relationship between metacognitive reflection measured through questionnaires and academic performance in mathematics written tests remains limited.

Previous studies have indicated that students' self-reported metacognitive reflection may not always align with their academic performance (Knight et al., 2022). However, limited research has specifically

examined this discrepancy in mathematics learning through written tests. The novelty of this study lies in examining the relationship between students' metacognitive reflection and their written test results, as well as exploring cases in which high levels of metacognitive reflection are not accompanied by high academic performance. This study also considers possible factors contributing to this mismatch.

The aim of this study is to describe students' levels of metacognitive reflection and their written test performance in mathematics learning, as well as to analyze the relationship between the two.

METHOD

This study employed a mixed-method descriptive–correlational design, integrating quantitative and qualitative data to obtain a comprehensive understanding of the research problem (Creswell & Creswell, 2017). The descriptive–correlational design was used to examine the direction and strength of the relationship between variables without manipulation (Fraenkel et al., 2022). The quantitative component measured students' levels of metacognitive reflection and written test performance, while the qualitative component explored contradictory patterns between these variables through cross-tabulation and visual analysis.

The research subjects consisted of 24 seventh-grade junior high school students. The participants were selected using purposive sampling based on two criteria: (1) students who had completed mathematics instruction on the topic of plane geometry, and (2) students who were willing to complete the metacognitive reflection questionnaire and participate in the written mathematics test.

Two instruments were used for data collection. The first instrument was a

metacognitive reflection questionnaire consisting of 10 items measured using a 4-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly Agree). The questionnaire was developed by the authors based on established theoretical frameworks of metacognition, particularly the components of planning, monitoring, and evaluation (Schraw & Dennison, 1994). The development process involved identifying key indicators of metacognitive reflection from the literature and translating them into questionnaire items relevant to students' mathematical problem-solving experiences.

The second instrument was a written mathematics test consisting of two open-ended problem-solving questions on plane geometry, administered to 24 seventh-grade students and scored on a scale of 0–100. The items required students to demonstrate their reasoning, present solution steps systematically, and justify their answers. The written test scores were categorized into three levels based on predetermined score intervals: low ($0 \leq x \leq 60$), moderate ($60 < x \leq 75$), and high ($75 < x \leq 100$), adapted from Hasanah et al. (2024), to facilitate further analysis.

Data analysis was conducted in several stages. First, Cronbach's Alpha was calculated to examine the reliability or internal consistency of the metacognitive reflection questionnaire. Second, descriptive statistical analysis was performed to describe students' levels of metacognitive reflection and their written mathematics test performance. Third, Pearson correlation analysis was used to determine the direction and strength of the linear relationship between the two variables. To further investigate contradictory phenomena, a cross-tabulation analysis was conducted between the categories of metacognitive reflection levels and students' written test performance. Additionally, a

scatter plot was generated to visually illustrate the correlation between the variables.

The levels of metacognitive reflection were classified into three categories: high (total score 32–40), medium (24–31), and low (below 24). This categorization followed the Likert scale classification commonly used in quantitative research (South et al., 2022).

The reliability of the questionnaire was interpreted using the Cronbach's Alpha criteria proposed by Hair Jr et al. (2010) and Tavakol and Dennick (2011), as shown in Table 1.

Table 1 Questionnaire Reliability Criteria

Cronbach's Alpha Value	Criteria
$\alpha \geq 0,90$	Excellent
$0,80 \leq \alpha < 0,90$	Good
$0,70 \leq \alpha < 0,80$	Acceptable
$0,60 \leq \alpha < 0,70$	Marginal
$0,50 \leq \alpha < 0,60$	Poor
$\alpha < 0,50$	Very Poor

An alpha value ranging from 0.70 to 0.95 is considered acceptable and depends

on the research context (Tavakol & Dennick, 2011). In the field of social and educational research, a value above 0.70 is generally regarded as meeting the criteria for acceptable reliability.

RESULT AND DISCUSSION

This section presents the research findings, including the results of the instrument reliability test, the analysis of students' metacognitive reflection levels and written test scores, the analysis of the relationship between the two, cross-tabulation analysis, and the visualization of the relationship using a scatter plot. The research data are presented comprehensively and accompanied by tables to facilitate data interpretation. Before the metacognitive reflection questionnaire was used, a reliability test was conducted to ensure the appropriateness of the research instrument. The reliability test for this questionnaire was performed using SPSS. The results are presented in Table 2.

Table 2 Reliability Test of the Metacognitive Reflection Questionnaire

N of Items	Cronbach's Alpha	N of Participants	Valid (%)	Excluded
10	0.768	24	100	0

The instrument consisted of 10 items/statements answered by 24 participants, with 100% valid data (no data excluded). The Cronbach's Alpha value of 0.768 indicates that the metacognitive reflection questionnaire has a fairly good reliability criterion (Hair Jr et al., 2010; Tavakol & Dennick, 2011). Therefore, this metacognitive reflection questionnaire can be considered consistent and suitable for use in the study.

Next is the descriptive statistical analysis using SPSS on the students'

responses to the metacognitive reflection questionnaire, as presented in Table 3. Based on Table 3, the strongest items based on the mean scores are P10, P6, and P9. This indicates that students tend to frequently review their answers before being confident of their correctness, often evaluate their mistakes when solving problems, and actively compare their answers with peers to find the best approach. The weaker items that require improvement and follow-up are P1 and P8, where students struggle to connect new mathematical concepts with previous ones

and have difficulty identifying patterns or relationships between different mathematical concepts. Items P2, P5, P6, P9, and P10 have a coefficient of variation (CV) below 20%, indicating that student responses to these items are relatively homogeneous and consistent. Items P1, P2, P3, and P7 have CV values above 20%, suggesting a considerable degree of variability in responses. This indicates that students' answers are not entirely homogeneous but still within a reasonable range. Such variation

may reflect differences in understanding, experience, or levels of reflection among students, and it is advisable to consider reviewing these items for potential revision in the future. The average CV across all items is 21%, showing that students' responses are generally not overly homogeneous and exhibit moderate variability, without extreme divergence. This condition suggests possible differences in students' experiences, understandings, or levels of metacognitive reflection.

Table 3 Descriptive Statistics Test

Item	Mean	Std. Deviation	Coefficient of Variation (CV)/item	Average CV
P1	2.88	0.850	0.30	0,21
P2	3.42	0.504	0.15	
P3	3.25	0.737	0.23	
P4	3.25	0.897	0.28	
P5	3.33	0.565	0.17	
P6	3.46	0.588	0.17	
P7	3.25	0.794	0.24	
P8	2.92	0.717	0.25	
P9	3.46	0.658	0.19	
P10	3.50	0.659	0.19	

Based on the descriptive statistical analysis, the highest average score was found in item P10, indicating that students tend to frequently review their answers before being confident of their correctness. Meanwhile, the lowest average was observed in item P1, suggesting that students tend to struggle in connecting newly learned mathematical concepts with previously acquired ones. This indicates a strong consistency in the aspect of answer review or

evaluation, but relatively high variability in the ability to relate concepts. These findings highlight the importance of strengthening conceptual connections in mathematics instruction.

The next section presents the frequency analysis of students' metacognitive reflection scores based on their questionnaire responses. The categories are divided into three levels: 1 = low, 2 = medium, 3 = high. The SPSS results are shown in Table 4.

Table 4 Frequency of Metacognitive Reflection Score Categories

Category	Level	Frequency	Percent	Valid Percent
1	Low	0	0	0
2	Medium	10	41.7	41.7
3	High	14	58.3	58.3

Based on the frequency analysis, most students (58.3%) fell into the high level of metacognitive reflection, while 41.7% were at the moderate level, and 0% at the low level. No students were found in the low metacognitive reflection category. This indicates that students' metacognitive reflection levels in mathematics learning are generally good. More than half of the students already demonstrated high levels of metacognitive reflection, suggesting that the learning process was quite effective in fostering metacognitive reflection. However,

since some students are still in the moderate category, teachers may consider strengthening metacognitive reflection, particularly on items with lower average scores.

After identifying the students' metacognitive reflection level tendencies, the next analysis focuses on their academic performance in the mathematics written test, which will then be compared with each student's level of metacognitive reflection. The results of the written test are presented in Table 5.

Table 5 Mathematics Written Test Results

Category	Level	Frequency	Percent	Valid Percent
1	Low	17	70.8	70.8
2	Medium	5	20.8	20.8
3	High	2	8.3	8.3

Based on Table 5, the majority of students, namely 70.8%, fall into the low category in the test results. Only 20.8% are in the medium category, and a minority of students, just 8.3%, managed to reach the high category. These findings indicate that most students have not achieved optimal performance in the written test, even though it was previously found that more than half of the students had a high level of metacognitive reflection.

Next, to determine whether there is a relationship and to what extent between students' levels of metacognitive reflection and their written test results in mathematics learning, a Pearson correlation analysis was conducted. The correlation test aimed to examine whether an increase in students' metacognitive reflection level is associated with improved academic performance in mathematics written tests. The results of the Pearson correlation test are presented in Table 6.

Table 6 Pearson Correlation Test

Variable	N	Correlation Coefficient (r)	Sig. (p)	Description
Metacognitive Reflection vs Written Test Scores	24	-0.152	0.479	Not significant

Based on the results of the Pearson correlation test in Table 4, the correlation coefficient (r) was found to be -0.152 with a significance value (p) = 0.479 . The p -value, which is greater than $\alpha = 0.05$, indicates that there is no statistically significant relationship between students' level of metacognitive reflection and their written test scores. The very weak negative correlation coefficient suggests that an increase in metacognitive

reflection does not directly correlate with an improvement in written test performance.

Furthermore, to analyze the relationship between levels of metacognitive reflection and mathematics written test scores, a cross-tabulation was performed using SPSS based on the categories of both variables. The percentage distribution of students across each category combination is presented in Table 7 below.

Table 7 Crosstab: Metacognitive Reflection × Written Test Score

Metacognitive Reflection Category	Low Test Score (%)	Medium Test Score (%)	High Test Score (%)
Moderate	50	40	10
High	85,7	7.1	7.1
Total	70.8%	20.8%	8.3%

Interpretation of the crosstab results between categories of metacognitive reflection and written mathematics test scores (Table 7): Students with a moderate level of metacognitive reflection had low written test scores in 50% of cases, medium scores in 40%, and high scores in only 10% of cases. This means that the majority of students at the moderate reflection level scored in the low-to-medium range, with only a small portion (10%) achieving high test scores. Interestingly, students with a high level of metacognitive reflection mostly had low written test scores, with 85.7% falling into this category. This contradictory finding suggests that the majority of students who self-reported high levels of metacognitive reflection through the questionnaire actually scored low on the mathematics written test. Although most students demonstrated high levels of metacognitive reflection, 70.8% of them received low test scores, and only 8.3% of all

students in the class achieved high scores on the written test. This reinforces the contradiction between metacognitive reflection levels and written test performance. A high level of metacognitive reflection does not necessarily guarantee high academic performance in written assessments. This may indicate possible errors in self-assessment, where students believe they possess strong metacognitive reflection skills, yet such abilities are not fully reflected in their actual test performance. To further illustrate the relationship between students' metacognitive reflection levels and written test results, a scatter plot visualization was created. Figure 1 displays the distribution of students' written test scores in relation to their metacognitive reflection scores obtained from the questionnaire. Each point on the graph represents an individual student, allowing for a visual observation of the pattern between the two variables.

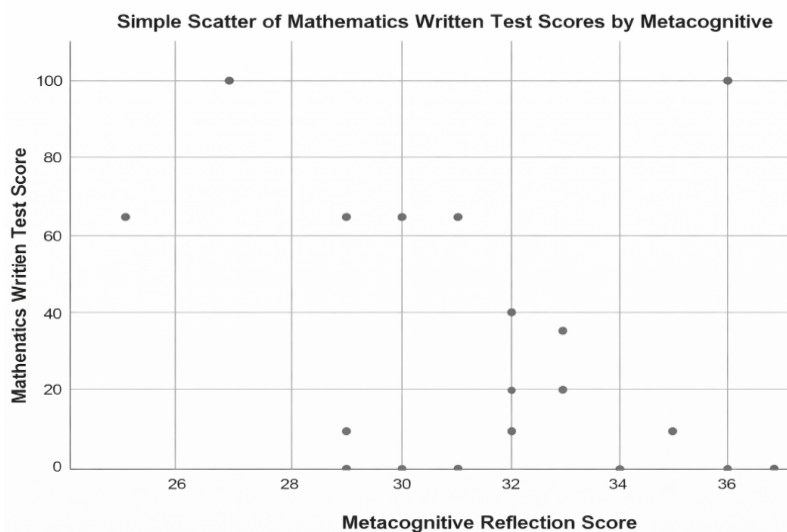


Figure 1 Scatter Plot of Mathematics Written Test × Metacognitive Reflection Scores

The scatter plot in Figure 1 reinforces the previous findings from the crosstab analysis. The distribution of data points shows that although some students with high levels of metacognitive reflection achieved high scores on the written test, there are also students in the high reflection group who received low scores. This indicates that the level of metacognitive reflection is not always directly proportional to cognitive performance in mathematics written tests. The correlation between the two variables tends to be weak, suggesting that other factors may influence students' academic achievement in written assessments.

The contradiction in this non-significant relationship can be explained through several possible factors. First, students may exhibit a high level of metacognitive reflection, but it has not yet been effectively reflected in their academic performance, particularly in solving written mathematics test problems that require procedural skills and conceptual mastery. This is supported by interview findings with students who scored low on the written math

test but self-assessed their metacognitive reflection as high. One such student mentioned experiencing difficulties in understanding the concepts and solving the problems. This finding contrasts with previous studies by Ward and Butler (2019), who reported that metacognitive awareness is positively correlated with student performance, and by Reinhard et al. (2022), who found that metacognitive reflection enhances problem-solving retention.

However, it aligns with the study by Knight et al. (2022), which concluded that an increase in the frequency of a student's metacognitive responses over time does not always predict an improvement in academic scores. Second, the contradiction may also result from potential bias in the questionnaire responses, such as students' tendency to provide answers perceived as "good" or socially desirable as conveyed in several studies (Fisher, 1993; Braun et al., 2001; Steenkamp et al., 2010; Bergen & Labonté, 2020). As a result, the reported level of metacognitive reflection may not accurately reflect their actual performance on the written test. This is supported by the

researcher's observations during the test and questionnaire administration, where some students were seen filling out the questionnaire hastily without deeply engaging with the statements.

In general, the findings of this study do not show a significant linear relationship, but they offer a perspective that a high level of metacognitive reflection is an important factor that cannot function optimally without the support of other aspects, such as consistent problem-solving practice that reinforces conceptual understanding and mathematical skills, as well as other factors that need further exploration. This research opens opportunities for more in-depth investigation, for instance through data triangulation and more diverse approaches (e.g., student perception questionnaires with open-ended questions) to comprehensively explore the relationship between metacognitive reflection and learning outcomes, both in written test performance and other aspects of academic achievement.

CONCLUSION

The findings revealed no significant linear relationship between metacognitive reflection and written test performance, indicating that higher levels of self-reported reflection do not necessarily correspond to better academic outcomes. This suggests that metacognitive reflection, as measured through self-report instruments, may not fully capture students' actual cognitive performance in mathematics problem-solving contexts. These findings highlight the complexity of the relationship between metacognitive reflection and academic performance, emphasizing the need to consider additional cognitive and contextual factors that may influence students' learning outcomes.

This study has several limitations, including the relatively small sample size and the reliance on self-reported measures of metacognitive reflection. Future research is recommended to employ more comprehensive approaches, such as mixed-methods designs incorporating interviews or process-oriented assessments, to better capture students' metacognitive processes. Further studies with larger and more diverse samples are also needed to enhance the generalizability of the findings and to explore other contributing variables in this relationship.

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