Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS) eISSN 2581-253X
Volume 9, No.3, Desember 2025, pp: 352-364
DOI: https://doi.org/10.33369/jp2ms.9.3.352-364

THE RELATIONSHIP BETWEEN THE LEVEL OF METACOGNITIVE SKILLS AND THE LEVEL OF PERFORMANCE IN SOLVING MATHEMATICAL PROBLEMS AMONG FORM FOUR STUDENTS

Mohamad Amir Farhan Roslan[1*], Nur Hamiza Adenan[2], Siew Wei Tho[3], Zeng Zhaofeng[4]
[1,2,3]Fakulti Sains Matematik, Universiti Pendidikan Sultan Idris, Tanjung Malim, Malaysia, [4]Hanjiang Normal University School of Physics and Electronic Engineering, Hubei Province, China
email: hamieza@fsmt.upsi.edu.my
*Corresponding author

Abstract

This study aims to identify the relationship between the level of metacognitive skills and the performance of form four students in solving mathematical problems at Sekolah Menengah Kebangsaan Keratong, Bandar Tun Razak, Pahang. This correlational study involves 33 students from three classes selected as the study sample using convenience sampling techniques. Data were collected through questionnaires and a mathematical problem-solving test, then analyzed using descriptive and Pearson correlation statistical methods. The instruments used demonstrated a high level of validity, with a Content Validity Index (CVI) of 1.00 as assessed by four experts. Additionally, a pilot study showed that the instruments had high reliability, as evidenced by Cronbach's Alpha value of 0.89. The analysis revealed that students' overall metacognitive skill levels were high ($M = 2.99$, $SD = 0.67$). However, students' performance in solving mathematical problems was very low, with an average score of 34.47%. The findings also indicated a moderate and significant relationship between students' metacognitive skill levels and their performance in solving mathematical problems ($r = 0.43$, $p < 0.05$). In conclusion, students with higher metacognitive skills tend to perform better in solving mathematical problems. The study highlights the need to incorporate metacognitive elements comprehensively into the mathematics curriculum to improve student performance, particularly in Mathematics.

Keywords: Mathematics Problem-Solving, Metacognitive Skills

How to write citation: Roslan, M. A. F., Adenan, N. H., & Siew, W. T., & Zeng, Z. (2025). The relationship between the level of metacognitive skills and the level of performance in solving mathematical problems among form four students. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS)*, *9*(3), 352-364.

INTRODUCTION

Mathematical problem-solving is a critical competency that secondary school students must acquire to achieve academic success, particularly in mathematics. Mastery of this skill enhances students' understanding of mathematical concepts and significantly influences their performance in solving real-life mathematical problems (Gurat, 2018). A study by Chew and Masingan (2021) revealed that problem-solving plays a central role in determining students' mathematical achievement through the development of metacognitive awareness. Additionally, according to Incebacak and Ersoy (2016), examining students' problem-solving skills and the strategies they employ is essential for evaluating their proficiency and performance in this domain. Research conducted by McLoughlin and Hollingworth (2001) emphasized that effective problem-solving can be achieved by providing students with opportunities to apply their metacognitive strategies while tackling problems.

Furthermore, Bakar et al. (2021) findings indicated that students' mathematical abilities significantly affect their success in solving word problems effectively. The study also found that each student employs different thinking processes or strategies in problem-solving, depending on their level of mathematical ability. Hence, metacognitive skills are deemed vital for students in solving mathematical problems.

A review of past studies indicates that individuals with high levels of metacognitive awareness tend to be more proficient in comprehending what they read. Such heightened awareness enables them to process and utilize acquired information more effectively, thereby improving their ability to solve mathematical problems (Güner & Erbay, 2021). Their research findings also concluded a significant relationship between metacognitive skills and mathematical problem-solving ability. This relationship positively impacts students' achievement in problem-solving, underscoring the critical role that metacognitive skills play in enhancing student performance. These findings are consistent with other studies in the literature (Arsuk & Memnun, 2020).

Students who possess strong metacognitive skills are more likely to provide accurate solutions in problem-solving tasks, as they can employ various strategies based on their awareness of the problem's requirements and objectives. Additionally, such students are more inclined to verify the validity of their answers, ensuring that their solutions are both accurate and logically sound (Güner & Erbay, 2021). In contrast, students who lack metacognitive competence tend to produce incorrect answers and face difficulties understanding the questions' demands, selecting appropriate solving strategies, and identifying or correcting their errors, especially in non-routine problems.

In 2019, Malaysia participated in two major international assessments: the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). However, the performance of Malaysian students was disappointing, as their scores remained below the targeted international average (Omar & Karim, 2022). This underperformance has been attributed to the students' weak mastery and limited mathematical problem-solving skills, particularly in items that require mathematical reasoning (Mahmud et al., 2020). A major contributing factor is Malaysian students' lack of knowledge and ability to solve word problems effectively (Mahmud et al., 2020). Additionally, Malaysia's concerning position in international assessments such as TIMSS and PISA has highlighted the urgent need for reforms in the national education system, particularly to enhance the quality of students and mathematics education (Wan Jaafar & Maat, 2020).

The influence of metacognitive skills on mathematical problem-solving ability presents a critical concern. Studies have shown that students with poor metacognitive skills struggle to understand problems, select appropriate strategies, and identify correct solutions in mathematical problem-solving tasks (Güner & Erbay, 2021). Furthermore, students lacking strong metacognitive skills often fail to recognize the importance of articulating problem-solving strategies and rely heavily on teacher and peer feedback during the learning process (Ramadhanti et al., 2019). Sihotang and Hutagalung (2020) also found that weak metacognitive skills can negatively impact students' performance in solving mathematical problems, particularly among those with lower mathematical ability. This suggests that an individual's ability to solve mathematical problems is influenced by their understanding of mathematical concepts and their metacognitive capacity to manage, monitor, and regulate their thinking processes.

Poor metacognitive skills can disrupt the learning process, as metacognition functions as a self-regulatory mechanism to ensure consistency during teaching and learning sessions. Concina (2019) found that weak metacognitive skills may impair mathematics achievement because metacognition plays a key role in fostering interest, self-control, and engagement in learning. Additionally, according to Ramadhanti et al. (2019), individuals who struggle with metacognitive skills tend to perform lower academically compared to their peers and may lack confidence in completing assigned tasks. This often leads to increased anxiety and self-doubt, ultimately resulting in a decline in mathematics achievement (Hasrin & Maat, 2022). Abdelrahman (2020) similarly concluded that students with low metacognitive

Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS) eISSN 2581-253X
Volume 9, No.3, Desember 2025, pp : 352-364
DOI: https://doi.org/10.33369/jp2ms.9.3.352-364

awareness tend to achieve lower academic success than those with high metacognitive awareness. This indicates that a deficiency in metacognitive skills can be a significant barrier to educational success, particularly in mathematics. Failure to manage interest, self-control, and self-awareness can lead to doubt and hinder attaining desired academic outcomes.

Therefore, metacognitive skills are critical in determining students' performance in mathematical problem solving. In conclusion, this study is designed to assess how much metacognitive skills can help students improve their performance in solving mathematical problems, particularly among Form Four students. Hopefully, this research will provide a more detailed understanding of metacognitive skills in the context of mathematical problem solving among Form Four students. Previous research by Bakar et al. (2021) has explored the relationship between metacognitive skills and problem-solving performance in mathematics among matriculation students. However, there is still a lack of studies focusing on the relationship between metacognitive skills and problem-solving performance, specifically among secondary school students. Therefore, this study aims to address the gap in existing research by investigating the specific impact of metacognitive skills on the performance of Form Four students in solving mathematical problems at Sekolah Menengah Kebangsaan Keratong.

METHODOLOGY

Expert review established the test's and questionnaire's content validity. The items were assessed by four seasoned lecturers, especially those with expertise in mathematics, to make sure they were clear and pertinent (Lee, 2021). Excellent content validity was indicated by the evaluation's Content Validity Index (CVI) of 1.00. When evaluated by five or fewer experts, a CVI of 1.00 is regarded as excellent (Polit and Beck, 2007). Items that don't meet this standard are usually eliminated from the instrument.

Five Form Four students were chosen as the sample for a pilot study that was carried out after content validation. For each of the 21 questionnaire items, the reliability analysis revealed a Cronbach's Alpha coefficient of 0.893. Strong internal consistency is indicated by this high value, which implies that the items are well-correlated and able to generate stable and consistent responses when given to comparable samples. These results attest to the instrument's suitability for use in the real study.

This study used a quantitative framework with a correlational research design. The main goal was to find out how students' performance in solving mathematical problems related to their metacognitive abilities. Because it made it possible to gather numerical data and examine the direction and strength of the relationship between the two variables, a quantitative approach was suitable (Price & Lovell, 2018).

Students in Form Four at Sekolah Menengah Kebangsaan (SMK) Keratong, Bandar Tun Razak, Pahang, made up the study's population. Due to notable differences in the Form Four students' performance in mathematics, SMK Keratong was chosen as the study site. Fraenkel and Wallen (2009) state that in order to prevent erroneous relationship estimation, a correlational study should include at least 30 participants. Thus, 43 Form Four students at SMK Keratong were the focus of this study. 33 students who were easily accessible to the researcher were chosen using a convenience sampling technique. According to Stratton (2021), the sample size ought to comprise over 80% of the population. Because the study was carried out close to the researcher's home, the convenience sampling strategy also contributed to time and cost savings.

Two primary research tools were used in the study: a metacognitive skills questionnaire and a test of mathematical problem-solving abilities. Five structured items covering important subjects in the Form Four Mathematics curriculum made up the mathematical problem-solving test: one item on linear inequalities, two on networks in graph theory, and two on quadratic equations. These questions were created to assess students' comprehension of problem requirements, strategy planning, application of

pertinent mathematical techniques, and justification of their conclusions. For instance, students had to find the shortest path in a network diagram, solve an inequality and graphically depict the solution, or solve a quadratic equation while describing the approach they used. This made sure that every test item elicited aspects of metacognitive engagement during problem-solving in addition to procedural understanding.

A 21-item metacognitive skills questionnaire was utilised in conjunction with the test to evaluate students' awareness, planning, monitoring, and evaluation processes during the completion of mathematical problems. A four-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree," was used to rate each item. Statements like "I am aware of my own thinking while solving mathematics problems," "I review my working steps while solving mathematics problems," "I am aware of the need to plan when solving mathematics problems," "I monitor the progress of my problem-solving and change strategies when necessary," and "I review the accuracy of my work throughout the process of solving mathematics problems" were examples of sample items.

Analysis of Metacognitive Skill Levels in Mathematical Problem Solving

To address the first research question, descriptive analysis was employed, using mean score values to measure the level of students' metacognitive skills. A 4-point Likert scale was used in the questionnaire, consisting of four categories: Strongly Disagree, Disagree, Agree, and Strongly Agree, which were coded numerically as 1, 2, 3, and 4, respectively. The interpretation of the mean scores was adapted from Hamzah et al. (2013). Table 1 below shows the classification of students' metacognitive skill levels based on the mean score obtained.

Table 1: Interpretation of Mean Scores for Students' Metacognitive Skill Levels

Mean Score	Description
0.0 - 0.8	Very Weak
0.9 - 1.6	Weak
1.7 - 2.4	Moderate
2.5 - 3.2	High
3.3 - 4.0	Very High

Analysis of Performance Levels in Mathematical Problem Solving

To address the second research question, students' performance in solving mathematical problems was evaluated based on the score distribution and performance levels adapted from Lee et al. (2013). Table 2 presents the classification of students' scores and their corresponding performance levels in the mathematical problem-solving test.

Table 2: Classification of Performance Levels in Mathematical Problem Solving

Percentage (%)	Performance Level

0.00 to 36.72	Very Low
36.73 to 46.68	Low
46.69 to 56.75	Moderate
56.76 to 66.86	High
66.87 to 100.00	Very High

The researcher will analyze the frequency and percentage of students according to their performance levels to provide a more detailed overview of their achievement in mathematical problem solving. Students' performance will be categorized into five levels—Very Low, Low, Moderate, High, and Very High—to facilitate more precise analysis and comparison.

Analysis of the Relationship Between Metacognitive Skill Levels and Performance in Mathematical Problem Solving

The Pearson correlation coefficient was used to measure the strength and direction of the linear relationship between two continuous variables. The coefficient ranges from -1 to 1, where 1 indicates a perfect positive linear relationship, -1 indicates a perfect negative linear relationship, and 0 indicates no linear relationship between the variables (Schober et al., 2018). Table 3 presents the interpretation of the Pearson correlation coefficient values.

Table 3: Interpretation of Pearson Correlation Coefficient Values

Pearson Correlation Coefficient (r)	Interpretation
0.00 - 0.10	Negligible correlation
0.10 - 0.39	Weak correlation
0.40 - 0.69	Moderate correlation
0.70 - 0.89	Strong correlation
0.90 - 1.00	Very strong correlation

The null hypothesis is assessed using the significance value (p-value). The null hypothesis is rejected if the p-value is less than 0.05 ($p < 0.05$), indicating a statistically significant relationship between the variables.

RESULTS AND DISCUSSION

The results of the study are presented in this section in accordance with the three research objectives and are based on descriptive and correlational analyses. Supported by pertinent tables and statistical summaries, the results give a clear picture of students' metacognitive abilities, their performance in solving mathematical problems, and the relationship between these variables. The chapter also lays the groundwork for the discussion that follows, which analyses the results, takes into account how they affect teaching and learning, and provides suggestions for raising students'

mathematical proficiency. To direct further investigation in this field, the study's limitations and future research directions are also noted.

Results

Respondent Demographics

Form Four students from SMK Keratong, Pahang, were selected as the sample for this study, involving students from three different classes: 4 Al-Bukhari, 4 Al-Ghazali, and 4 Al-Khawarizmi. Each class had a different number of respondents, with 33 participating in the study. According to Fraenkel and Wallen (2009), a sample size of at least 30 individuals is considered sufficient for correlational studies, as a smaller sample size may yield inaccurate estimates of the relationship. Therefore, the selection of 33 respondents is deemed adequate for this study.

The findings reveal that the majority of respondents, 63.64% or 21 students, obtained Grade G in the 2024 Mid-Year Mathematics Examination. Additionally, 12.12% of respondents (4 students) obtained Grade E, 9.09% (3 students) achieved Grade D, and another 9.09% (3 students) obtained Grade C. Only one respondent (3.03%) scored Grade C+, and another one (3.03%) obtained Grade B. Overall, these results reflect an unsatisfactory level of mathematical achievement among the respondents.

Analysis of Metacognitive Skill Levels Among Form Four Students in Solving Mathematical Problems

The overall mean score for each variable was obtained by averaging the mean scores of all corresponding items, which aligns with the approach outlined by Martinez and Bartholomew (2017). Table 1 was used as a reference to determine students' levels of metacognitive skills based on predefined mean score intervals. This categorization enables the researcher to identify whether students demonstrate very low, low, moderate, high, or very high levels of metacognitive ability.

Table 4: Summary of Metacognitive Skill Levels by Item

Metacognitive Skill Level	Item Numbers	Descriptions of Skills Represented
Very High	4, 17, 20	These items demonstrate how well students are able to comprehend the requirements of a mathematical problem before attempting to solve it. Before attempting a solution, students showed a very high level of awareness in interpreting questions, determining what is necessary, and making sure they fully understood the material.
High	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 21	A wide range of metacognitive behaviours are covered by the items in this category, such as being conscious of one's own thought processes (Items 1 and 13), keeping an eye on and reviewing the steps involved in solving problems (Items 2, 6, 18), recognising the key concepts and requirements in questions (Items 3, 7, 8, 19), organising and planning strategies (Items 5, 9, 14, 15, 16), and guaranteeing comprehension throughout the problem-solving process (Items 10, 11, 12, 21).
Overall Mean	2.99 (High)	The overall mean score of 2.99 places students' metacognitive skills at a high level.

Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS) eISSN 2581-253X
Volume 9, No.3, Desember 2025, pp : 352-364
DOI: https://doi.org/10.33369/jp2ms.9.3.352-364

Table 4 summarises the levels of metacognitive skills demonstrated by Form Four students based on the 21 questionnaire items. Descriptive statistical analysis was conducted to examine the mean scores and standard deviations for each item, culminating in an overall mean of 2.99 with a standard deviation of 0.67 (M = 2.99, SD = 0.67). According to the interpretation framework outlined in Table 1, this overall mean places students’ metacognitive skills within the high category.

As shown in Table 4, Items 4, 17, and 20 fall under the Very High category, indicating that students exhibit exceptionally strong skills in comprehending and interpreting mathematical problems before attempting to solve them. Meanwhile, the remaining items—spanning Items 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, and 21—are categorised as High, reflecting consistent proficiency across a wide range of metacognitive behaviours such as planning, monitoring, evaluating, and maintaining awareness during mathematical problem-solving. Collectively, these findings demonstrate that Form Four students at SMK Keratong possess a strong overall level of metacognitive skill, enabling them to engage effectively with mathematical problem-solving tasks.

Analysis of the Performance Level of Form Four Students in Solving Mathematical Problems

Table 5 shows the distribution of students' scores and their performance levels in solving mathematical problems related to quadratic equations, networks in graph theory, and linear inequalities. The findings indicate that 20 of the respondents had a very low performance level, followed by 7 with a low performance level. Only 2 and 4 of the respondents demonstrated moderate and very high-performance levels, respectively. This suggests that most respondents in this study exhibited low performance in solving mathematical problems involving quadratic equations, networks in graph theory, and linear inequalities. Overall, the students' performance in solving mathematical problems was very low, with an average score of 34.47%, and only 6 of them achieved satisfactory results in the test.

Table 5: Distribution of Students' Scores Based on Performance Levels in the Mathematical Problem-Solving Test

Score Range (%)	Performance Level	Frequency
0.00 to 36.72	Very Low	20
36.73 to 46.68	Low	7
46.69 to 56.75	Moderate	2
56.76 to 66.86	High	0

Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS) eISSN 2581-253X
Volume 9, No.3, Desember 2025, pp : 352-364
DOI: https://doi.org/10.33369/jp2ms.9.3.352-364

66.87 to 100.00	Very High	4

Analysis of the Relationship Between Students' Metacognitive Skills and Their Performance in Solving Mathematical Problems

Pearson's correlation analysis was employed to address the third research question, which sought to determine the relationship between students' metacognitive skills and their performance in solving mathematical problems. Table 3 presents the interpretation of the Pearson correlation coefficient, while Table 6 interprets the significance values.

Based on Table 6, Pearson's correlation analysis revealed a significant relationship between the students' metacognitive skills and their performance in solving mathematical problems. The correlation coefficient, r = 0.43, indicates a moderate, positive relationship between the two variables. The significance value obtained was p = 0.01, which is less than 0.05, indicating that the relationship is statistically significant, thus providing strong evidence to reject the null hypothesis.

Therefore, the null hypothesis, which stated that "there is no significant relationship between metacognitive skills and performance in solving mathematical problems among Form Four students," is rejected. Instead, this study supports the notion that a significant, positive, and moderate relationship exists between students' metacognitive skills and their performance in solving mathematical problems. This finding suggests that students with higher metacognitive skills tend to perform better in solving mathematical problems.

Table 6: Correlation Test Between Students' Metacognitive Skills and Their Performance in Solving Mathematical Problems

Variable	N	Pearson Correlation Coefficient, r	t	df	Significance, p (2-tailed)	Relationship Significance
Metacognitive Skills and Performance in Solving Mathematical Problems	33	0.43	2.59	31	0.01	Significant, providing strong evidence to reject the null hypothesis

Discussion

Metacognitive Skills of Form Four Students

The findings of this study indicate that the level of metacognitive skills among Form Four students is high, with a mean score of 2.99 and a standard deviation of 0.67 (M = 2.99, SD = 0.67). According to Karnain et al. (2014), students with adequate metacognitive training will better understand facts, plan their learning, verify the accuracy of facts and answers, and adapt strategies to solve problems more effectively. Therefore, in problem-solving, metacognitive skills are essential for students, as these skills help them organize the learning process more systematically and improve their performance in

Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS) eISSN 2581-253X
Volume 9, No.3, Desember 2025, pp : 352-364
DOI: https://doi.org/10.33369/jp2ms.9.3.352-364

solving mathematical problems. Metacognitive skills enable students to plan, monitor, and evaluate the strategies they use in solving problems, which ultimately helps them arrive at accurate and efficient solutions (Bakar et al., 2021).

Performance Level of Students in Solving Mathematical Problems

The findings of this study reveal that students' problem-solving performance is very poor, with an average score ranging between 0.00 and 33.88. This indicates that most Form Four students at SMK Keratong are still not proficient in solving mathematical problems. Only four students demonstrated very high performance, while two others showed moderate performance. These students also exhibited very high metacognitive skills. This suggests that students with very high-performance levels also possess high metacognitive skills, thus establishing a close relationship between the two factors.

Most students showed significant weaknesses in quadratic equations and linear inequalities, as evidenced by the high percentage of students who scored zero on related questions. Nineteen students failed to answer the first question on quadratic equations, while 25 students scored zero on the second question, which was also related to this topic. Student performance was even lower in linear inequalities, with 26 out of 33 students scoring zero. These results suggest weaknesses in understanding the basic concepts and applying these topics among the students.

In contrast, in the topic of networks in graph theory, student performance showed a slight improvement. No students scored zero on the third question, indicating that they better understood this topic than others. However, four students still failed to answer subsequent questions on the same topic, reflecting that although the basic understanding was better, in-depth insight and application of the concepts still need improvement. Student performance in solving mathematical problems reveals a significant imbalance across different topics. For example, in the third question related to networks in graph theory, all students scored, reflecting a better understanding of the topic. This contrasts with other topics, where the percentage of students scoring zero was much higher.

Previous research by Abdullah et al. (2017) also found differences in metacognitive skills between students who demonstrated very high, moderate, low, and very low performance levels, as metacognitive skills influence their problem-solving performance. Studies from Zan (2000) further support this statement, suggesting that students' metacognitive skills affect their performance in mathematics, particularly in problem-solving tasks. Desoete et al. (2006) found that metacognitive skills contributed 37% to the performance in solving mathematical problems.

The Relationship Between Metacognitive Skill Level and Performance in Solving Mathematical Problems Among Form Four Students

This study also addresses the third research question by showing a significant, positive, and moderate relationship between students' metacognitive skill levels and their performance in solving mathematical problems. The correlation coefficient was $r = 0.43$, indicating a moderate and positive relationship between the two variables. The significant value, $p = 0.01$, is less than the significance level of $p < 0.05$. Therefore, the null hypothesis of the study is rejected. This study supports the conclusion that a positive, moderate, and significant relationship exists between students' metacognitive skills and their performance in solving mathematical problems. These findings confirm that metacognitive skills are crucial for student performance in solving mathematical problems.

This result aligns with previous studies by Bayat and Tarmizi (2010), who found a significant positive and moderate relationship between metacognitive skills and student performance in mathematical problem-solving. Various studies have also revealed a positive relationship between metacognition and success in mathematics (Kitsansas, 2002; Rysz, 2004). However, a Young (2010) study examined the relationship between metacognition and academic achievement. It concluded that a strong relationship exists between students' mathematical achievement and their metacognitive skills in the problem-solving process. This is further supported by the study of Sevgi and Caglikose (2019), which found that sixth-grade students who used metacognitive skills were more successful in solving problems. Lastly, a survey by Safari and Meskini (2015) also showed that metacognitive skills significantly impact students' problem-solving success, where students with higher metacognitive levels tend to perform better.

One factor that may contribute to low performance despite high metacognitive skills, and the existence of a moderate correlation, could be the students' cognitive tendencies when solving mathematical problems. Research by Moreno et al. (2021) indicates that metacognitive confidence will affect performance differently, depending on whether an individual uses positive or negative thinking. Students with positive thinking will likely perform excellently because their metacognitive skills help support their strategic thinking. On the other hand, students with negative thinking may struggle, even if they have equally high metacognitive skills, because their negative thinking is validated by their beliefs.

Other factors, such as the nature of the problem-solving task and individual abilities, also influence the relationship between metacognitive skills and performance in solving mathematical problems. Each task in mathematical problem-solving has its uniqueness, affecting how students use their metacognitive skills (Güner & Erbay, 2021). More difficult tasks, situations, or problems involving different topics, such as algebra and geometry, may prompt students to use various strategies, affecting their outcomes or performance. A second factor is the uniqueness of each student, such as their knowledge, thinking abilities, and motivation level, all of which affect how they utilize their metacognitive skills in solving mathematical problems (Stanton et al., 2021). Students with high self-confidence and strong metacognitive skills are typically better at managing their learning processes and adapting strategies to achieve better results (Stanton et al., 2021).

CONCLUSION

Overall, this study found that the performance level of Form Four students in solving mathematical problems is very low, while their metacognitive skill level is high. A moderate and significant relationship exists between the students' metacognitive skill levels and their performance in solving mathematical problems. These results have a number of significant ramifications. They emphasise how crucial metacognitive abilities are to improving students' comprehension of mathematical assignments, planning strategies for solutions, keeping an eye on their thought processes, fixing errors, and assessing their answers. These abilities aid in the development of higher-order thinking skills (KBAT), which are becoming more and more important in today's educational environment.

Therefore, instead of focussing primarily on textbook-based exercises, teachers are urged to expose students to a greater variety of mathematical tasks, especially non-routine and problem-solving questions. This method can lessen students' reliance on well-known question formats and increase their capacity for strategic thought. To further aid students' learning, structured educational activities that purposefully foster metacognitive processes should be incorporated.At the same time, students need to enhance their metacognitive skills, as these skills help them understand, plan, implement strategies, correct mistakes, and evaluate answers while solving mathematical problems.

There are some limitations to this study as well. The results' generalisability was limited by the sample size, which was comparatively small and limited to a particular group of Form Four students. Additionally, the study did not look at other important variables like motivation, prior knowledge, or classroom context; instead, it concentrated solely on metacognitive abilities and problem-solving performance.

It is advised that future research employ focused interventions meant to improve metacognitive abilities in order to evaluate their direct influence on mathematical performance. Future studies should take into account other factors that might influence students' mathematical performance as well as larger and more varied sample sizes. A more thorough understanding of how metacognitive abilities interact with more general cognitive and contextual factors to affect learning outcomes would result from such work.

ACKNOWLEDGMENTS
The author would like to express sincere appreciation to Dr. Hamiza for her guidance, support, and valuable insights in completing this conceptual research paper.

REFERENCES

Abdelrahman, R. (2020). Metacognitive awareness and academic achievement. *Heliyon*, *6*(9), e04192. https://doi.org/10.1016/j.heliyon.2020.e04192

Abdullah, A., Rahman, S., & Hamzah, M. (2017). Metacognitive skills of Malaysian students in non-routine mathematical problem solving. *Bolema: Boletim de Educação Matemática, 31*(57), 310–322. https://doi.org/10.1590/1980-4415v31n57a15

Arsuk, S., & Memnun, D. S. (2020). The effect of problem-solving strategy instruction supported by metacognitive strategies on seventh-grade students' problem-solving success and metacognitive skills. *Journal of Social Sciences of Mus Alparslan University, 8*(2), 559–573. https://doi.org/10.18506/anemon.634989

Chew, F. P., & Masingan, N. J. (2021). Pengetahuan, sikap dan kesediaan pelajar terhadap kemahiran berfikir aras tinggi dalam kemahiran menulis. *Pendeta Journal of Malay Language, Education and Literature, 12*(2), 29–43. https://doi.org/10.37134/pendeta.vol12.2.3.2021

Concina, E. (2019). The role of metacognitive skills in music learning and performing: Theoretical features and educational implications. *Frontiers in Psychology, 10*, 1583. https://doi.org/10.3389/fpsyg.2019.01583

Desoete, A., & Roeyers, H. (2006). Metacognitive macroevaluations in mathematical problem solving. *Learning and Instruction, 16*(1), 12–25. https://doi.org/10.1016/j.learninstruc.2005.12.003

Du, Z., Wang, B., He, J., & Zhang, H. (2023). Brief pain inventory and pain detection questionnaire based on WeChat and paper versions: Validity and reliability for herpes zoster–induced neuralgia. *Medicine, 102*(32), e34542. https://doi.org/10.1097/MD.0000000000034542

Fraenkel, J. R., & Wallen, N. E. (2005). *How to design and evaluate research in education.* McGraw-Hill.

Gomez, J., Patino, J., Duque, J., & Passos, S. (2019). Spatiotemporal modeling of urban growth using machine learning. *Remote Sensing*, *12*(1), 109. https://doi.org/10.3390/rs12010109

Güner, P., & Erbay, H. N. (2021). Metacognitive skills and problem-solving. *International Journal of Research in Education and Science*, 715–734. https://doi.org/10.46328/ijres.1594

Gurat, M. G. (2018). Mathematical problem-solving strategies among student teachers. *Journal on Efficiency and Responsibility in Education and Science, 11*(3), 53–64. https://doi.org/10.7160/eriesj.2018.110302

Hamzah, M. S. G., Paim, L., Haron, S. H., & Abdullah, M. F. N. L. (2013). *Buku panduan pembinaan instrumen "Anda dan Kepenggunaan".* Emeritus Publications.

Hasrin, N., & Maat, S. M. (2022). Kebimbangan dan kepercayaan matematik serta hubungan dengan pembelajaran matematik. *Malaysian Journal of Social Sciences and Humanities, 7*(4), e001437. https://doi.org/10.47405/mjssh.v7i4.1437

Hinojosa, L. M. M., Rodriguez, M. C., & Paez, C. A. O. (2020). Measurement of metacognition: Adaptation of metacognitive state inventory in Spanish. *European Journal of Educational Research, 9*(1), 413–421. https://doi.org/10.12973/eu-jer.9.1.413

Idris, N., Abdullah, N., & Sembak, S. (2015). Kesedaran metakognisi dan pemahaman konsep dalam penyelesaian masalah matematik. *Jurnal Pendidikan Sains & Matematik Malaysia, 5*(2), 23–40. https://ejournal.upsi.edu.my/index.php/JPSMM/article/view/2149/1770

Incebacak, B., & Ersoy, E. (2016). Problem-solving skills of secondary school students. *China-USA Business Review, 15*(6). https://doi.org/10.17265/1537-1514/2016.06.002

Karnain, T., Bakar, M. N., Siamakani, S. Y., Mohammadikia, H., & Candra, M. (2014). Exploring metacognitive skills used during problem posing. *Jurnal Teknologi, 67*(1). https://doi.org/10.11113/jt.v67.1847

Lee, J. H., Abdullah, F. A. P., & Bunyamin, M. A. H. (2013). Aplikasi konsep fizik dalam menyelesaikan masalah STEM bagi pelajar tingkatan enam atas. In *Proceedings of the 2nd International Seminar on Quality and Affordable Education* (pp. 470–481).

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). *Problem solving in mathematics education.* ICME-13 Topical Surveys. https://doi.org/10.1007/978-3-319-40730-2

Loh, M. Y., & Lee, N. H. (2019). Evaluating metacognitive strategies in mathematical problem solving. In *ICME-13 Monographs* (pp. 155–176). https://doi.org/10.1007/978-3-030-10472-6_8

Lunenburg, F., & Irby, B. (2008). Quantitative research designs. https://doi.org/10.4135/9781483329659.n3

Mahmud, M. S., Yunus, A. S. M., Ayub, A. F. M., & Sulaiman, T. (2020). Enhancing mathematical language through oral questioning. *International Journal of Learning, Teaching and Educational Research, 19*(5), 395–410. https://doi.org/10.26803/IJLTER.19.5.24

Martinez, M., & Bartholomew, M. (2017). Interpreting and calculating means and standard deviations. *Pharmaceutics, 9*(2), 14. https://doi.org/10.3390/pharmaceutics9020014

Mcloughlin, C., & Hollingworth, R. (2001). The weakest link: Web-based learning and metacognition. In *Proceedings of the 18th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*.

Mohamad, N. A., & Mahamod, Z. (2014). Tahap kemahiran metakognitif murid tingkatan empat. *Malay Language Education Journal*, *4*(1), 41–47. https://spaj.ukm.my/jpbm/index.php/jpbm/article/view/73

Mohd Khalid, F. A., Rozaimi, N. N., & Taha, H. (2020). Metacognitive behaviour of Form Four students in problem solving. *Journal of Science and Mathematics Letters*, *8*(2), 74–85. https://doi.org/10.37134/jsml.vol8.2.10.2020

Moreno, L., Briñol, P., & Petty, R. E. (2021). Metacognitive confidence and academic performance. *Metacognition and Learning*, *17*(1), 139–165. https://doi.org/10.1007/s11409-021-09270-y

O'Neil, H. F., & Abedi, J. (1996). Reliability and validity of a state metacognitive inventory. *Journal of Educational Research*, *89*(4), 234–245. https://doi.org/10.1080/00220671.1996.9941208

Omar, M. F., & Abdul Karim, A. (2022). Kemahiran penyelesaian masalah matematik berayat. *Malaysian Journal of Social Sciences and Humanities*, *7*(12), e002010. https://doi.org/10.47405/mjssh.v7i12.2010

Price, O., & Lovell, K. (2018). Quantitative research design. https://doi.org/10.7765/9781526136527.00008

Ramadhanti, D., Ghazali, A. S., Hasanah, M., & Harsiati, T. (2019). Students' metacognitive weaknesses in academic writing. *International Journal of Emerging Technologies in Learning*, *14*(11), 41–57. https://doi.org/10.3991/ijet.v14i11.10213

Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. *Anesthesia & Analgesia*, *126*(5), 1763–1768. https://doi.org/10.1213/ANE.0000000000002864

Sihotang, R. K., & Hutagalung, E. (2020). Metacognition skills of gifted students. *Journal of Physics: Conference Series*, *1521*, 032017. https://doi.org/10.1088/1742-6596/1521/3/032017

Singh, P. (2013). P value, statistical significance and clinical significance. *Journal of Clinical and Preventive Cardiology*, *2*(4), 202–206. https://www.jcpcarchives.org/full/p-value-statistical-significance-and-clinical-significance-121.php

Stanton, J. D., Sebesta, A. J., & Dunlosky, J. (2021). Fostering metacognition to support learning. *CBE—Life Sciences Education*, *20*(2), fe3. https://doi.org/10.1187/cbe.20-12-0289

Stratton, S. J. (2021). Convenience sampling strategies. *Prehospital and Disaster Medicine*, *36*(4), 373–374. https://doi.org/10.1017/s1049023x21000649

Wan Jaafar, W. N., & Maat, S. M. (2020). Motivasi dan pencapaian matematik murid luar bandar. *Jurnal Pendidikan Sains dan Matematik Malaysia*, *10*(1), 39–48. https://doi.org/10.37134/jpsmm.vol10.1.5.2020

Zakaria, E., & Zaini, N. (2009). Conceptual and procedural knowledge of rational numbers in trainee teachers. *European Journal of Social Sciences*, *9*(2), 202–217.

Zan, R. (2000). A metacognitive intervention in mathematics at university level. *International Journal of Mathematical Education in Science and Technology*, *31*(1), 143–150. https://doi.org/10.1080/002073900287462