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Research Article

Metacognitive Awareness and Mathematics Achievement Among Secondary-Level Students in Nepal

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ABSTRACT
Mathematics achievement at the secondary school level is a critical determinant of students' academic progression and future career opportunities. Although international studies have consistently highlighted metacognitive awareness as an important factor influencing mathematics learning, empirical evidence from the Nepalese context, particularly at the secondary level, remains limited. This study aimed to examine the relationship between metacognitive awareness and mathematics achievement among secondary-level students in Bhaktapur District, Nepal. A quantitative correlational design was employed, involving 450 students from Grades 9 to 12 enrolled in both public and private schools. Metacognitive awareness was measured using an adapted Metacognitive Awareness Inventory, while mathematics achievement was obtained from students' most recent test scores. Data was analyzed using descriptive statistics, Pearson correlation, and simple linear regression. The results revealed a moderate and statistically significant positive relationship between metacognitive awareness and mathematics achievement, with metacognitive awareness explaining a substantial proportion of variance in students' mathematics performance. No statistically significant differences were observed across gender or school type. These findings confirm the importance of metacognitive awareness as a meaningful correlation and predictor of mathematics achievement in the Nepalese secondary school context. The study highlights the need for integrating metacognitive strategy instruction, including planning, monitoring, and reflective evaluation, into secondary mathematics classrooms to enhance academic achievement and support the development of self-regulated learning skills.

Keywords: *Mathematics Achievement; Metacognitive Awareness; Quantitative Correlational Study; Secondary Students; Self-Regulated Learning.*

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1. Introduction

Mathematics achievement at the secondary level plays a crucial role in shaping students' future educational pathways and career opportunities. Strong numeracy skills are associated with improved employability, enhanced problem-solving abilities, and active participation in an increasingly data-driven society. Despite its importance, international evidence consistently indicates that many adolescents fail to reach expected levels of mathematics performance. This persistent gap has prompted researchers to explore not only cognitive factors but also metacognitive processes that may explain individual differences in learning outcomes (Muncer et al., 2021).

Metacognition, commonly defined as thinking about one's own thinking, has emerged as a key psychological construct linked to successful learning and academic achievement. It encompasses two main components: metacognitive knowledge, which refers to awareness of one's cognitive processes, and metacognitive regulation, which involves planning, monitoring, and evaluating learning activities (Flavell, 1979). Empirical studies across diverse educational settings have consistently shown that students with higher levels of metacognitive awareness tend to demonstrate better academic performance, including achievement in mathematics (Catador, 2024; Dorji & Subba, 2023; Naik & Panda, 2024).

In the context of mathematics learning, metacognition enables students to interpret problem demands, select appropriate strategies, monitor their progress, and evaluate the accuracy and efficiency of their solutions. When these regulatory processes are underdeveloped or inconsistently applied, students may possess sufficient content knowledge yet struggle with complex or non-routine mathematical tasks (Kuzle, 2013). This issue is particularly salient during adolescence, a developmental stage in which learners are expected to assume greater responsibility for their own learning and to develop more advanced problem-solving and self-regulation skills (Tian et al., 2018).

The theoretical foundations of this study draw on Flavell's theory of metacognition and the self-regulated learning perspective. Flavell (1979) conceptualized metacognition as knowledge and cognition about cognitive phenomena, emphasizing learners' active control over their thinking processes. This view highlights the role of higher order thinking in enabling students to take ownership of their learning and to improve learning outcomes (Livingston, 2003; Marantika, 2021; Quynh, 2025). Metacognitive knowledge involves understanding oneself as a learner, recognizing task demands, and identifying effective strategies for specific learning situations. Metacognitive regulation, on the other hand, refers to the processes of planning, monitoring, and evaluating one's learning and problem-solving behaviors. Within mathematics learning, these processes help students select strategies suited to different types of problems and adjust their approaches when difficulties arise (Mertasari et al., 2023). Research on mathematical problem solving has demonstrated that successful learners consistently employ metacognitive monitoring and control throughout all phases of problem solving, leading to more accurate and effective solutions (Kuzle, 2013).

Similarly, self-regulated learning models portray learners as active and goal-oriented individuals who plan their learning strategies, monitor their progress, and reflect on their performance. Zimmerman (1990) described self-regulated learners as those who proactively seek information and take deliberate steps to master academic tasks. Within this framework, metacognitive knowledge and regulation are central components, as they enable learners to regulate cognitive activities, sustain effort, and persevere in challenging tasks. Empirical evidence further suggests that metacognitive knowledge may influence mathematics achievement indirectly by enhancing motivational factors such as self-efficacy and intrinsic motivation, which in turn promote sustained engagement and persistence in problem solving (Tian et al., 2018).

A substantial body of empirical research has documented positive associations between metacognitive awareness and mathematics achievement. Studies conducted with secondary and tertiary students have reported that higher metacognitive awareness is associated with more strategic learning behaviors and stronger academic outcomes (Akpur, 2024; Baguin & Janiola, 2024; Xie et al., 2024). Research by Naik and Panda (2024) found a significant positive relationship between metacognition and mathematics achievement among secondary students, with minimal variation across gender. Similar findings were reported by Baguin and Janiola (2024), who concluded that metacognition is a critical determinant of academic success in mathematics. Evidence from Indonesia also indicates that both metacognitive knowledge and regulation are positively correlated with mathematics achievement and play an important role in meeting higher-order thinking demands (Abidin et al., 2025). At a broader level, a meta-analysis by Muncer et al. (2021), synthesizing findings from 29 studies, confirmed a significant positive association between metacognition and mathematics performance, with stronger relationships observed in tasks requiring higher complexity.

Intervention studies provide further support for the role of metacognition in mathematics learning. Research has shown that metacognitive training can significantly improve mathematics achievement, mathematical reasoning, and higher-order thinking skills, particularly when instruction is explicit and structured (Akbar & Ullah, 2020; Badolo et al., 2025; Maier, 2017). Nevertheless, the literature also suggests that the relationship between metacognitive awareness and achievement is not always straightforward. Some studies have found that motivational and affective factors, such as attitudes toward mathematics, may exert stronger predictive effects than metacognitive awareness alone (Agrawal et al., 2025; Ajisuksmo & Saputri, 2017). These findings indicate that contextual and instructional factors may moderate the strength of the relationship between metacognition and academic performance.

Although international research on metacognitive awareness is extensive, empirical evidence from Nepal remains limited, particularly at the secondary school level. Existing studies in Nepal suggest that students' awareness of their learning processes is positively associated with academic achievement (Paudel, 2024) and that higher-grade students tend to exhibit greater metacognitive awareness in reading contexts (Khatri, 2021). However, research specifically examining the relationship between metacognitive awareness and mathematics achievement in the context of Bhaktapur district is scarce. This lack of localized empirical evidence presents a challenge for educators, school leaders, and policymakers seeking to design instructional strategies and professional development programs that address students' learning needs effectively.

In response to this gap, the present study investigates the level of metacognitive awareness and mathematics achievement among secondary-level students in Bhaktapur district, Nepal, and examines whether metacognitive awareness predicts mathematics achievement across gender and school type. By providing context-specific empirical evidence, this study aims to contribute to the growing body of research on metacognition and mathematics learning, while also offering insights that may inform instructional practices and educational policy in the Nepali secondary education context.

2. Literature Review

2.1 Conceptualization of Metacognitive Awareness

Metacognition is broadly defined as individuals' awareness and control of their own cognitive processes (Flavell, 1979; Livingston, 2003; Quynh, 2025). It is generally conceptualized as comprising two interrelated components, namely knowledge of cognition and regulation of cognition. Knowledge of cognition refers to learners' understanding of themselves as learners, task demands, and available strategies, while regulation of cognition involves planning, monitoring, and evaluating one's learning behaviours. Research using MAI-based instruments has consistently demonstrated high reliability and strong internal consistency across secondary and tertiary student populations. Empirical evidence further suggests that students with higher levels of metacognitive awareness tend to employ more strategic and self-regulated approaches in learning mathematics (Baguin & Janiola, 2024; Bulut, 2021).

2.2 Metacognitive Awareness and Mathematics Achievement

A substantial body of empirical research has established a positive relationship between metacognitive awareness and mathematics achievement. Studies involving secondary school students have shown that higher levels of metacognitive awareness are associated with better mathematics performance (Hassan & Rahman, 2017). Similar findings have been reported among university students, where metacognitive knowledge and regulation were identified as important determinants of academic success in mathematics (Baguin & Janiola, 2024). Evidence from Indonesia also supports this relationship, indicating that both metacognitive knowledge and regulation are positively correlated with mathematics achievement and contribute to meeting higher-order thinking demands in standardized assessments (Abidin et al., 2025).

At a broader level, a meta-analysis synthesizing findings from 29 studies confirmed a significant positive association between metacognition and mathematics performance, with stronger correlations observed when tasks involved higher cognitive complexity or when online measures of metacognition were employed (Muncer et al., 2021). Beyond mathematics, metacognitive strategies such as planning, monitoring, and evaluating have also been shown to enhance learning achievement in other disciplines, including English and language learning (Marantika, 2021; Quynh, 2025) as well as biology education (Olop et al., 2024).

2.3 Metacognition, Problem Solving, and Higher-Order Thinking

Metacognition plays a critical role in mathematical problem solving and the development of higher order thinking skills. Research on non-routine problem solving in geometry revealed that successful problem solvers consistently engaged in sense-making, strategic planning, self-questioning, and solution verification, whereas unsuccessful learners lacked these regulatory skills (Kuzle, 2013). Empirical studies among middle school students further demonstrated strong positive relationships between reflective thinking, metacognitive awareness, and mathematics achievement, with both reflective thinking and metacognition serving as significant predictors of performance (Toraman et al., 2020).

Intervention studies provide additional evidence supporting the instructional value of metacognition. Metacognitive training has been shown to significantly improve mathematical achievement among learning-disabled students, particularly when instruction is individualized (Maier, 2017). Similar results were reported by Akbar and Ullah (2020), who found that metacognitive strategy instruction enhanced mathematical reasoning abilities among secondary students. More recently, structured metacognitive strategy interventions have been associated with substantial gains in higher order thinking skills in mathematics, highlighting the effectiveness of such approaches in fostering advanced mathematical competencies (Badolo et al., 2025).

2.4 Inconsistent Findings and Contextual Moderators

Despite the predominance of positive findings, some studies present a more nuanced picture of the relationship between metacognitive awareness and academic achievement. Ajisuksmo and Saputri (2017) reported that attitudes toward mathematics were stronger predictors of achievement than metacognitive skills, with metacognitive awareness showing no significant direct correlation in their sample. Similarly, Agrawal et al. (2025) found that although preservice teachers demonstrated above-average levels of metacognitive awareness, its relationship with academic achievement was weak and non-significant. These findings suggest that metacognition may not automatically translate into higher achievement unless supported by favourable motivational, instructional, and classroom contexts.

Overall, the literature suggests several key conclusions. Metacognitive awareness is generally positively associated with learning achievement, particularly in tasks requiring complex or non-routine problem solving. Metacognitive interventions have demonstrated considerable potential in enhancing mathematics achievement and higher order thinking skills. At the same time, contextual factors such as motivation, attitudes, and learning environments may moderate the strength of this relationship (Agrawal et al., 2025; Ajisuksmo & Saputri, 2017).

2.5 Empirical Evidence from Nepal and Research Gap

In the Nepali context, empirical studies examining metacognitive awareness are limited but informative. Paudel (2024) found that students' awareness of their learning processes in mathematics positively influenced academic achievement. Similarly, Khatri (2021) reported that higher-grade students demonstrated greater metacognitive awareness in reading contexts. Despite these contributions, empirical evidence specifically addressing the relationship between metacognitive awareness and mathematics achievement at the secondary level in Bhaktapur district remains scarce.

This study addresses this gap by examining the relationship between metacognitive awareness and mathematics achievement among 450 secondary-level students in Bhaktapur using locally collected data. By providing context-specific empirical evidence, the study contributes to the broader literature on metacognition and mathematics learning while offering insights relevant to instructional practice and educational decision-making in the Nepali secondary education context.

3. Method

A quantitative, cross-sectional correlational research design was adopted to determine the relationship between metacognitive awareness and mathematics achievement among the secondary level students of Bhaktapur District, Nepal. This design was appropriate because the purpose of the study was to investigate the variation in metacognitive awareness and academic achievement as they occur naturally without any manipulation of variables. Correlational designs are widely used in educational research because they aid in the determination of the strength and direction of the relationships between psychological constructs and academic outcomes.

The population included the students who were enrolled from Grades 9 to 12 in both public and private secondary schools in the district of Bhaktapur. Stratified sampling was performed to ensure proportional representation of each grade and school type to produce a final sample of 450 students. Of these 224 or 49.8% were male, 214 or 47.6% were female, and 12 or 2.7% were considered "Other" or preferred not to specify their gender. Grade-level representation was represented in Grade 9 (121 students), Grade 10 (111 students), Grade 11 (108 students) and Grade 12 (110 students). In regards to the type of school, 265 (58.9%) students were from public schools and 185 (41.1%) from private schools. Additionally, 237 students (52.7%) reported that they attend mathematics tuition classes, while 213 students (47.3%) did not. This sampling method ensured that there was a varied distribution amongst demographic groups.

Data collection was conducted using a structured questionnaire which had three sections in total, namely demographic data, metacognitive awareness, and mathematics achievement. The demographic section contained questions pertaining to gender, age, grade, school type, academic stream, education background of parents, tuition attendance, and amount of time spent in daily self-study. Metacognitive awareness was assessed based on 30 items adapted from the Metacognitive Awareness Inventory (MAI) which was designed to correspond to the developmental level of secondary students. Responses were reported using a 5-point Likert scale between 1 (strongly disagree) and 5 (strongly agree). Sample items included: "I know what strategies are most helpful when I study mathematics", "I have specific goals that I set before I begin studying mathematics" and "During the course of solving problems, I check if I am doing them correctly". A composite metacognitive awareness score (MA_Total) was obtained as the mean of the 30 items, where the higher the score, the better the metacognitive awareness. There were excellent results in internal consistency analysis (Cronbach's alpha =.95).

Mathematics achievement was measured using the self-reported most recent mathematics test score by students in marks obtained out of 100. In the Nepali school context, the mathematics marks are generally either expressed as whole numbers or with half-marks (e.g., 39.5, 40). These reported values were used as continuous variable (Math_Score) directly for statistical analysis. Although the questionnaire also contained self-ratings of mathematical ability and confidence, only the test score in number form was used for statistical purposes due to its higher degree of precision.

Data collection was done in regular school hours with permission from school administrators. Students were informed of the purpose of the study and assurances of confidentiality and voluntary participation were given. The questionnaire was applied in the classroom setting, and took about 40-45 minutes to complete. Completed questionnaires were checked for completion prior to inclusion into the data set.

Data cleaning and statistical analyses were performed using the appropriate statistical software. Descriptive statistics (mean, standard deviation, minimum, and maximum values) were computed for both the metacognitive awareness and mathematics achievement. To measure internal consistency, Cronbach's alpha was used. Pearson's product moment correlation coefficient was used to measure the relationship between MA_Total and Math_Score. Independent samples t-tests were used to compare differences in the mean values of metacognitive awareness and mathematics achievement according to gender (male, female) and school (public, private). Finally, a simple linear regression analysis was conducted to investigate the degree to which metacognitive awareness was a predictor of mathematics achievement. A significance level of $\alpha = .05$ was used for all inferential tests.

4. Results

Descriptive statistics found that the students who participated totaling 450 students were at a moderate level of metacognitive awareness. The mean score on the metacognitive awareness composite (MA_Total) was 3.06 (SD = 0.59) with scores varying between 1.27 and 4.80 on a 5-point Likert scale. Mathematics achievement (measured with the latest test scores of students) also shared considerable variability and the values ranged from 9.50 to 71.00 with an overall mean of 40.36 (SD = 11.22) based on the cleaned scoring procedure. These results suggest large individual differences both in metacognitive awareness and mathematics performance.

To further examine these patterns, students were placed in 3 equal tertile groups by how much they were aware of their metacognitive awareness. The results showed a consistent increase in mean mathematics scores across the different groups - students in the lowest metacognitive awareness tertile had an average score of 33.89, students in the middle tertile scored on average 41.66 and those in the highest of the tertiles scored 45.91. This growing trend indicates a tight positive association between metacognition and mathematics achievement.

Reliability analysis supported the use of the composite score (MA_Total) as a reliable measure with excellent internal consistency (Cronbach's alpha = .95) for the 30-item scale.

Pearson correlation analysis revealed a moderate, positive, and statistically significant relationship between the metacognitive awareness and the mathematics achievement, r (448) = .53, $p < .001$. This does suggest that students with a higher metacognitive awareness tend to do better in mathematics.

Independent samples t-tests were performed to test for group differences based on gender and school type. Male and female students did not differ significantly on metacognitive awareness (M = 3.07 and 3.05, respectively) or mathematics achievement (M = 40.14 and 40.87, respectively). Similarly, students from public and private schools showed similar levels of metacognitive awareness and mathematics achievement. All t-tests showed non-significant differences for both variables.

Finally, a simple linear regression analysis was undertaken to assess the predictive power of the metacognitive awareness on mathematics achievement. This general model was statistically significant with $F(1, 448) = 177.50$, $p < .001$, accounting 28 percent of the variance of mathematics achievement ($R^2 = .28$). The regression coefficient showed that a one unit increase in metacognitive awareness was related to a 10.14 point approximate increase in mathematics score. This suggests that metacognitive awareness is a meaningful predictor of mathematics achievement of secondary students of Bhaktapur.

Table 1. Descriptive Statistics for Metacognitive Awareness and Mathematics Achievement

Variable	Mean	SD	Minimum	Maximum
Metacognitive Awareness (MA_Total)	3.06	0.59	1.27	4.80
Mathematics Achievement (Math_Score)	40.36	11.22	9.50	71.00

Table 1 presents the central tendency and dispersion indices for metacognitive awareness (MA_Total; 5-point Likert scale) and mathematics achievement (Math_Score; out of 100), showing moderate metacognitive awareness and wide variability in performance.

Table 2. *Mathematics Achievement by Metacognitive Awareness Tertile*

Metacognitive Group	N	Mean Math Score	Interpretation
Low MA	~150	33.89	Lowest achievement
Moderate MA	~150	41.66	Moderate achievement
High MA	~150	45.91	Highest achievement

Table 2 shows a progressive increase in mathematics achievement across metacognitive awareness tertiles, with mean scores rising from 33.89 (low) to 41.66 (moderate) to 45.91 (high), illustrating a clear stepwise relationship between metacognition and math performance.

Table 3. *Independent-Samples t-Test Results for Gender*

Variable	Male M	Female M	t-value	p-value
MA_Total	3.07	3.05	0.29	.77
Math_Score	40.14	40.87	–0.68	.50

Table 3 presents the comparison of mean metacognitive awareness and mathematics achievement scores between male and female students, showing no statistically significant differences ($p > .05$) for either variable.

Table 4. Independent-Samples t-Test Results for School Type

Variable	Public M	Private M	t-value	p-value
MA_Total	3.05	3.06	–0.22	.82
Math_Score	40.01	40.86	–0.79	.43

Table 4 presents the comparison of mean metacognitive awareness and mathematics achievement scores between students from public and private schools showing no statistically significant differences ($p > .05$) for either variable.

Table 5. *Pearson Product–Moment Correlation between Metacognitive Awareness and Mathematics Achievement*

Variables	1	2
1. Metacognitive Awareness (MA_Total)	—	.53*
2. Mathematics Achievement (Math_Score)	.53*	—

Table 5 shows a moderate, positive, and statistically significant correlation ($r = .53$, $p < .001$), indicating that students with higher metacognitive awareness tend to achieve higher scores in mathematics.

Table 6. *Simple Linear Regression Predicting Mathematics Achievement from Metacognitive Awareness*

Predictor	B	SE	β	t	p
Intercept	9.37	—	—	—	—
MA_Total	10.14	—	—	*Significant*	< .001

Model summary: $R^2 = .28$, $F(1, 448) = 177.50$, $p < .001$

Table 6 summarizes the regression model in which metacognitive awareness significantly predicted mathematics achievement ($B = 10.14$, $p < .001$), explaining 28% of the total variance ($R^2 = .28$). This indicates that for every one-unit increase in metacognitive awareness, mathematics scores increased by approximately 10.14 points.

5. Discussion

The primary objective of this study was to examine the effect of metacognitive awareness on mathematics achievement among secondary-level students in Bhaktapur district, Nepal. The findings provide strong evidence of a positive relationship between these two variables, which supports the proposed hypothesis. Overall, students demonstrated a moderate level of metacognitive awareness ($M = 3.06$). This result is consistent with previous studies showing that secondary and tertiary learners generally exhibit moderate to high levels of metacognitive awareness when assessed using MAI-based instruments (Baguin & Janiola, 2024; Bulut, 2021). The very high internal consistency of the metacognitive awareness scale ($\alpha = .95$) further confirms the robustness and contextual suitability of the instrument used in this study.

One of the most notable findings is the moderate and statistically significant positive correlation between metacognitive awareness and mathematics achievement ($r = .53$). This effect size is stronger than the average relationship reported in earlier meta-analytical studies. For example, Muncer et al. (2021) reported an average correlation of approximately .37 between metacognition and mathematics performance among adolescents. Similar positive relationships have also been identified in empirical studies conducted across different educational contexts (Abidin et al., 2025; Baguin & Janiola, 2024; Naik & Panda, 2024; Tuburan et al., 2025), although the magnitude of the effects has varied. The regression analysis in the present study further supports this association by demonstrating that metacognitive awareness explained 28 percent of the variance in mathematics achievement, which represents a substantial contribution for a single psychological predictor. In addition, the tertile analysis revealed a clear performance gradient, showing that students with higher levels of metacognitive awareness consistently achieved higher mathematics scores than those with moderate or low levels.

These findings align with theoretical perspectives on self-regulated learning, which emphasize the central role of metacognitive knowledge and regulation in academic success. Students who understand how they learn, plan and select appropriate strategies, monitor their comprehension, and evaluate their progress tend to perform better academically. Previous research suggests that metacognition may influence achievement through both direct mechanisms, such as strategic cognitive engagement, and indirect mechanisms, including motivational factors like self-efficacy and persistence (Bulut, 2021; Tian et al., 2018). Therefore, the present study provides additional empirical support for the view that metacognition functions as a foundational component in the development of mathematical competence.

Another important finding is the absence of statistically significant differences in metacognitive awareness or mathematics achievement across gender and school type. This result is consistent with prior studies indicating that, when contextual variables are adequately controlled, metacognitive awareness tends to be relatively evenly distributed across demographic groups (Bulut, 2021; Naik & Panda, 2024). This pattern suggests that both strengths and weaknesses in metacognitive skills are widespread among students in Bhaktapur rather than being concentrated within specific subgroups. Consequently, instructional interventions aimed at enhancing metacognitive awareness are likely to be broadly applicable and beneficial across diverse student populations.

Although the correlational design employed in this study does not allow for causal conclusions, the observed magnitude of the relationship between metacognitive awareness and mathematics achievement is comparable to that reported in experimental and quasi-experimental studies on metacognitive training. Previous research has shown that structured metacognitive instruction can significantly improve mathematical learning, reasoning, and higher order thinking skills (Akbar & Ullah, 2020; Badolo et al., 2025; Maier, 2017). When interpreted alongside these findings, the present results suggest that enhancing students' metacognitive awareness is not only associated with improved mathematics performance but may also represent a meaningful instructional strategy for deepening conceptual understanding, strengthening problem-solving processes, and supporting learning across academic domains.

From a practical standpoint, these findings highlight several implications for mathematics instruction. Mathematics teachers are encouraged to integrate explicit metacognitive strategy instruction into regular classroom practice, including modelling goal setting, planning, monitoring, and evaluation processes during problem solving. The use of metacognitive questioning, such as encouraging students to reflect on problem requirements, strategy selection, and solution verification, may help foster reflective learning habits (Badolo et al., 2025; Toraman et al., 2020). Schools may also consider using metacognitive assessment tools, such as adapted versions of the Metacognitive Awareness Inventory, to identify students' metacognitive strengths and weaknesses and to inform targeted instructional support (Baguin & Janiola, 2024). Moreover, mathematics classrooms that emphasize explanation, justification, strategic reasoning, and reflection, rather than routine computation, are more likely to promote deeper engagement and understanding, as suggested by research on non-routine problem solving (Kuzle, 2013; Toraman et al., 2020). Given the lack of significant demographic differences, metacognitive instruction should be viewed as a universal pedagogical approach rather than a remedial strategy, with the potential to benefit all learners.

Several limitations should be considered when interpreting these findings. The cross-sectional correlational design restricts the ability to draw causal inferences regarding the relationship between metacognitive awareness and mathematics achievement. In addition, the reliance on self-reported measures, particularly students' recall of their most recent mathematics test scores, may introduce bias related to memory accuracy and social desirability. The sample was also limited to secondary schools in Bhaktapur district, which may constrain the generalizability of the findings to other regions of Nepal or different educational contexts. Finally, the use of a single composite score for metacognitive awareness, while useful for capturing an overall index, does not allow for analysis of the differential contributions of specific subcomponents, such as knowledge of cognition and regulation of cognition.

Building on these findings, future research could employ experimental or quasi-experimental designs to examine the causal effects of metacognitive training on mathematics achievement within the Bhaktapur context. Further studies may also disaggregate metacognitive awareness into its sub-dimensions to determine which components are most strongly associated with specific aspects of mathematics performance, such as procedural fluency and problem solving. In addition, incorporating motivational and affective variables, including self-efficacy, mathematics anxiety, and attitudes toward mathematics, may help clarify potential mediating mechanisms, as suggested by Tian et al. (2018). Longitudinal research designs would also be valuable for capturing developmental trends and examining the long-term effects of metacognitive growth on mathematics achievement over time.

6. Conclusion

This study investigated the effect of metacognitive awareness on mathematics achievement among 450 secondary-level students in Bhaktapur District, Nepal. The findings indicate that students generally demonstrated a moderate level of metacognitive awareness and that metacognitive awareness was positively and significantly associated with mathematics achievement. Metacognitive awareness accounted for a meaningful proportion of variance in mathematics performance, highlighting its role as an important psychological predictor of academic success. In addition, the absence of significant differences across gender and school type suggests that metacognitive awareness functions as a broadly relevant factor across diverse student groups.

These results contribute to the growing body of evidence emphasizing the importance of metacognitive processes in mathematics learning, particularly within under-researched educational contexts. In the context of Bhaktapur, the findings underscore the potential value of integrating metacognitive approaches into regular mathematics instruction. Incorporating metacognitive strategy instruction, employing diagnostic tools to identify students' metacognitive strengths and weaknesses, and fostering classroom environments that support reflective and self-regulated problem solving may enhance mathematics achievement. More broadly, strengthening students' metacognitive awareness may help equip them with essential cognitive and self-regulatory skills needed for sustained academic success and lifelong learning.

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