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WHAT MATTERS MOST IN MATHEMATICS ACHIEVEMENT? MOTIVATION, METACOGNITION, AND ANXIETY AMONG MALDIVIAN SECONDARY STUDENTS

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ABSTRACT
Mathematics achievement is influenced by a combination of cognitive, motivational, and emotional factors. This study examined the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance among secondary school students in Addu City, Maldives, with particular emphasis on the potential mediating role of mathematics anxiety. Guided by self-regulated learning theory, the study adopted a quantitative survey design involving 251 Grade 9 and Grade 10 students. Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM. The measurement model demonstrated satisfactory reliability, convergent validity, and discriminant validity. The structural model showed that motivation was the strongest positive predictor of mathematics performance, while metacognition also had a significant, although smaller, positive effect. Metacognition was significantly associated with mathematics anxiety, whereas motivation was not significantly related to anxiety. Contrary to much of the existing literature, mathematics anxiety did not significantly predict mathematics performance and did not mediate the effects of either motivation or metacognition on performance. These findings suggest that, within the Maldivian secondary-school context, students' motivational and self-regulatory resources may have a more direct relationship with mathematics achievement than mathematics anxiety. The study extends the application of self-regulated learning theory to a Small Island Developing State and highlights the importance of strengthening students' motivation and metacognitive regulation as part of mathematics education.

Keywords: mathematics anxiety, motivation, metacognition, mathematics performance, self-regulated learning, Maldives

1. INTRODUCTION
Mathematics plays an important role in students' academic development and has implications for further education, employment opportunities, and participation in an increasingly knowledge-based society (Núñez-Peña & Suárez-Pellicioni, 2021; Schunk & DiBenedetto, 2020). However, mathematics achievement is not determined by cognitive ability alone. Students' motivation, metacognitive regulation, and emotional experiences can influence how they approach mathematical tasks, maintain effort, respond to difficulties, and ultimately perform (Pekrun et al., 2021; Ramirez-Arellano & González, 2024). Motivation can encourage students to remain engaged and persist when faced with challenging problems, while metacognition enables them to plan, monitor, and adjust their learning strategies. In contrast, mathematics anxiety may interfere

with attention and working-memory processes, potentially making it more difficult for students to perform effectively (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007).

Previous research has generally identified positive relationships between motivation, metacognition, and academic achievement, while mathematics anxiety has more often been associated with poorer mathematics outcomes (Trigueros et al., 2020; Barroso et al., 2021). However, these relationships may not operate in the same way across educational contexts. Students' learning environments, instructional practices, and wider social and cultural circumstances may influence how motivation and metacognition relate to anxiety and academic performance (Putwain et al., 2021; Pekrun et al., 2021). This issue is particularly important in Small Island Developing States (SIDS), where educational systems function within distinctive geographical, cultural, resource, and policy environments.

The Maldives provides a relevant context in which to examine these relationships. National assessment evidence has identified continuing challenges in mathematics achievement among Maldivian students (Ministry of Education, 2017). At the same time, relatively limited empirical research has examined how motivational, metacognitive, and emotional factors interact within the Maldivian secondary-school setting. Much of the existing evidence has been generated in other educational and cultural contexts, meaning that relationships established elsewhere cannot automatically be assumed to operate in the same way among Maldivian students.

The present study therefore examines the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance among secondary school students in Addu City. More specifically, the study investigates whether motivation and metacognition are associated with mathematics anxiety, whether mathematics anxiety predicts mathematics performance, and whether anxiety mediates the relationships between motivation, metacognition, and mathematics performance. The study is primarily informed by self-regulated learning (SRL) theory, which views learning as an active process involving motivational, cognitive, and regulatory components (Zimmerman, 2002; Schunk & DiBenedetto, 2020).

By bringing these variables together within a Maldivian SIDS context, the study addresses an important contextual gap in the literature. Rather than if mathematics anxiety universally acts as the mechanism linking students' cognitive and motivational resources with achievement, the study empirically tests this proposition among secondary school students in Addu City. The findings therefore provide evidence about whether strengthening motivation and metacognitive regulation may offer a more direct approach to improving mathematics performance than focusing primarily on anxiety reduction.

The study makes three main contributions to the existing literature. First, it extends research on mathematics learning to the relatively under-researched Maldivian educational context. Second, it examines motivational, metacognitive, and affective factors together within a single empirically tested model. Third, it provides empirical evidence regarding the proposed mediating role of mathematics anxiety.

The finding that mathematics anxiety did not significantly mediate the relationships between motivation, metacognition, and mathematics performance challenges the assumption that anxiety necessarily represents the main pathway through which these factors influence mathematics achievement. The study therefore provides a context-specific perspective on the interaction between cognitive, motivational, and emotional processes in mathematics learning.

2. LITERATURE REVIEW

Mathematics achievement involves more than the ability to perform calculations or recall mathematical procedures. Students' performance is also influenced by how they regulate their thinking, sustain effort, respond to challenging tasks, and manage emotional reactions to mathematics. Within the self-regulated learning (SRL) perspective, motivation and metacognition are particularly important because they influence both students' willingness to engage in learning and their ability to plan, monitor, and adjust their strategies (Zimmerman, 2002; Schunk & DiBenedetto, 2020). Mathematics anxiety represents an additional affective dimension that may interfere with these processes by placing demands on cognitive resources and encouraging avoidance of mathematics-related activities (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007). For this reason, the three constructs are best considered together when examining mathematics performance.

2.1 Theoretical Foundation

2.1.1 Motivation

Motivation is an important force underlying the initiation and continuation of learning behaviour. Self-Determination Theory proposes that the satisfaction of autonomy, competence, and relatedness needs supports intrinsic motivation and promotes persistence, engagement, and adaptive learning behaviours (Ryan & Deci, 2000). Similarly, Expectancy-Value Theory explains achievement-related behaviour in terms of students' expectations of success and the value they place on a particular task (Eccles & Wigfield, 2002). In mathematics, students who are motivated are more likely to persist when they encounter difficult problems, invest effort in learning activities, and use strategies that promote deeper understanding.

Recent research continues to demonstrate the importance of motivation in mathematics learning and achievement. Wang et al. (2024) found that interventions based on self-determination theory can strengthen students' motivational resources, while Hidayat et al. (2025) reported positive effects of metacognitive instruction on mathematics achievement. Motivation may also encourage students to monitor their understanding and change ineffective strategies, thereby linking motivational processes with metacognitive regulation.

The relationship between motivation and mathematics anxiety, however, is more complex. Although motivated students may be better prepared to cope with challenging academic tasks, the type of motivation and the surrounding learning environment may influence whether motivation protects students from anxiety. Existing evidence generally suggests an inverse relationship between motivation and mathematics anxiety, although the strength of this relationship varies across different motivational dimensions and educational contexts (Li et al., 2023; Wang et al., 2024).

H2: Motivation negatively influences mathematics anxiety.

2.1.2 Metacognition

Metacognition refers to students' awareness of and ability to regulate their own cognitive processes. It includes activities such as planning, monitoring, evaluating understanding, selecting appropriate strategies, and modifying strategies when they are no longer effective (Schraw & Dennison, 1994; Zimmerman, 2002). These processes are particularly important in mathematics because solving a problem often requires students to understand the problem, select an appropriate strategy, monitor their progress, identify errors, and evaluate whether their final solution is reasonable.

Metacognition is closely related to SRL because it helps translate students' intentions and motivation into organised learning behaviour (Schunk & DiBenedetto, 2020). Research has shown that metacognitive regulation can support mathematical problem solving and achievement, particularly when learners encounter complex or unfamiliar problems (Muncer et al., 2022; Thi-Nga et al., 2024). Zhang et al. (2024) likewise highlighted the importance of metacognition in understanding the relationship between anxiety and mathematics achievement.

The relationship between metacognition and mathematics anxiety is also theoretically important. Students who can monitor their thinking and regulate their attention may be better able to manage the cognitive demands associated with anxiety. The RAMPS framework proposed by Scheibe et al. (2023), for example, highlights the importance of metacognitive cues and attentional regulation in protecting working-memory processes during mathematical problem solving.

H1: Metacognition negatively influences mathematics anxiety.

H4: Mathematics anxiety mediates the relationship between metacognition and mathematics performance.

2.1.3 Mathematics Anxiety

Mathematics anxiety refers to feelings of tension, apprehension, worry, or fear that arise in response to mathematical tasks or situations (Ashcraft & Krause, 2007). Cognitive interference theory proposes that anxiety consumes working-memory resources that would otherwise be available for mathematical reasoning and problem solving, potentially reducing students' efficiency and accuracy (Ashcraft & Kirk, 2001). Mathematics anxiety may also encourage students to avoid mathematics-related activities, reducing opportunities for practice and potentially reinforcing existing difficulties (Carey et al., 2016).

Evidence from meta-analytic studies generally supports a negative relationship between mathematics anxiety and mathematics achievement. Barroso et al. (2021) identified a consistent negative association between the two constructs, while Namkung et al. (2019) similarly found that higher mathematics anxiety was associated with lower mathematics performance. Nevertheless, the strength of this relationship is not necessarily consistent across all students and settings. Mathematics anxiety may vary according to individual characteristics, task demands, instructional practices, and broader educational circumstances (Balt et al., 2022; Scheibe et al., 2023).

Research on interventions also indicates that mathematics anxiety is not necessarily a fixed characteristic. Supportive instruction, emotional regulation strategies, and interventions designed to improve students' coping and learning skills can reduce anxiety, although their effects on mathematics achievement differ across contexts (Balt et al., 2022; Sammallahti et al., 2023).

H3: Mathematics anxiety negatively influences mathematics performance.

2.1.4 Mathematics Performance
Mathematics performance reflects students' ability to understand mathematical concepts, apply procedures, solve problems, and reason logically. From an SRL perspective, academic achievement is both an outcome of learning and a source of feedback that can influence subsequent motivation and self-regulation (Zimmerman, 2002; Schunk & DiBenedetto, 2020). Successful performance may strengthen students' confidence and willingness to engage, whereas repeated difficulties may contribute to disengagement and anxiety.

Previous research indicates that motivation and metacognition are both relevant to mathematics achievement. Metacognitive strategies help students organise, monitor, and evaluate their problem-solving processes, while motivation provides the effort and persistence required to apply these strategies consistently (Muncer et al., 2022; Hidayat et al., 2025). Mathematics anxiety, in contrast, has generally been associated with poorer performance, although the strength of this relationship may depend on the cognitive and motivational resources available to students.

2.2 Empirical Relationships Among the Constructs
2.2.1 Motivation and Mathematics Anxiety
Previous research generally suggests that students with stronger motivation tend to report lower levels of mathematics anxiety. Motivation may encourage students to persist when mathematics becomes difficult and to view challenging tasks as opportunities for learning rather than as threats. A large meta-analysis by Li et al. (2021), for example, identified a moderate negative association between motivation to learn mathematics and mathematics anxiety among K–12 students. The relationship was particularly evident for competence-related beliefs.

However, motivation does not necessarily eliminate anxiety in every learning situation. Li et al. (2023) found that motivational processes can interact with individual characteristics and stressful learning conditions, indicating that the relationship between motivation and anxiety is sensitive to context. Therefore, although motivation is theoretically expected to reduce mathematics anxiety, this relationship should be empirically tested rather than assumed.

2.2.2 Metacognition and Mathematics Anxiety
Metacognitive regulation may assist students in managing the cognitive demands associated with mathematical tasks. Planning allows students to approach problems in a more systematic way, while monitoring helps them recognise confusion, detect errors, and adjust their strategies. These processes may reduce uncertainty and help protect working-memory resources during problem solving (Scheibe et al., 2023).

Research has also established a relationship between metacognition and mathematics achievement. Muncer et al. (2022) reported a meaningful association between metacognition and mathematical performance among adolescents, while Thi-Nga et al. (2024) identified metacognition as an important area within mathematics education research. These findings suggest that metacognition may contribute to mathematics performance directly and may also have an indirect role through its relationship with mathematics anxiety.

2.2.3 Mathematics Anxiety and Mathematics Performance
The relationship between mathematics anxiety and mathematics achievement is one of the most extensively examined relationships in the proposed model. Mathematics anxiety can interfere with attention, working memory, and problem-solving processes, providing a theoretical explanation for why anxious students may perform less well in mathematics (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007). Meta-analytic research has generally confirmed a negative relationship between mathematics anxiety and performance, although the effect is typically modest rather than deterministic (Barroso et al., 2021; Namkung et al., 2019).

Importantly, intervention research indicates that reducing mathematics anxiety does not necessarily result in equivalent improvements in academic achievement. Balt et al. (2022) and Sammallahti et al. (2023) found that the effectiveness of anxiety-focused interventions varies according to intervention characteristics and learner factors. These findings reinforce the importance of examining mathematics anxiety alongside students' motivational and cognitive resources rather than treating anxiety as an isolated determinant of performance.

2.2.4 Motivation and Mathematics Performance
Motivation is consistently associated with academic achievement because it influences students' effort, persistence, engagement, and willingness to undertake challenging learning activities. In mathematics education, learning environments that support students' psychological needs and encourage autonomous forms of motivation can promote deeper engagement and greater persistence (Ryan & Deci, 2000; Wang et al., 2024).

Motivational beliefs also contribute to achievement during secondary education, particularly when students develop confidence in their ability to succeed and recognise the value of learning activities (Lazarides et al., 2022). Accordingly, motivation is expected to have a direct and positive relationship with mathematics performance.

2.2.5 Metacognition and Mathematics Performance
Metacognition provides students with mechanisms for managing and improving their own learning. Through planning, monitoring, and evaluation, students can identify ineffective approaches and replace them with more appropriate strategies. Research involving adolescents has demonstrated that stronger metacognitive abilities are associated with better mathematical performance (Muncer et al., 2022).

Intervention research provides additional support for this relationship. Mathematics instruction that explicitly incorporates metacognitive strategies can strengthen problem solving and higherorder mathematical thinking (Thi-Nga et al., 2024; Zhang et al., 2024). Metacognition is therefore expected to have a direct positive effect on mathematics performance.

2.3 Synthesis and Research Gap

The existing literature provides a strong theoretical basis for examining motivation, metacognition, mathematics anxiety, and mathematics performance within a single framework. Motivation provides the willingness to engage and persist in learning, while metacognition provides the cognitive mechanisms needed to plan, monitor, and regulate learning. Mathematics anxiety represents an affective factor that may interfere with these processes and potentially influence academic achievement.

Despite the existing body of research, several issues remain insufficiently addressed. First, much of the available evidence concerning these relationships comes from educational contexts outside the Maldives. Second, although motivation and metacognition are frequently examined as predictors of academic achievement, fewer studies have investigated mathematics anxiety as a potential mechanism connecting these cognitive-motivational factors with performance. Third, existing findings do not establish that these relationships necessarily operate in the same way across different cultural and educational environments.

This gap is particularly important in the Maldivian context. Existing theory provides reasons to expect motivation and metacognition to influence mathematics anxiety and performance, but whether anxiety actually functions as an intervening mechanism among secondary school students in Addu City remains an empirical question. The present study addresses this gap by simultaneously examining the direct and indirect relationships among the four constructs using PLS-SEM.

Drawing on SRL theory and the empirical literature reviewed above, the study proposes that motivation and metacognition may influence mathematics performance directly and may also influence performance indirectly through mathematics anxiety. The proposed hypotheses are as follows:

H1: Metacognition negatively influences mathematics anxiety.

H2: Motivation negatively influences mathematics anxiety.

H3: Mathematics anxiety negatively influences mathematics performance.

H4: Mathematics anxiety mediates the relationship between metacognition and mathematics performance.

H5: Mathematics anxiety mediates the relationship between motivation and mathematics performance.

The conceptual framework positions motivation and metacognition as the predictor variables, mathematics anxiety as the proposed mediating variable, and mathematics performance as the outcome variable. This framework allows the study to determine whether mathematics anxiety provides a meaningful pathway through which motivational and metacognitive factors influence achievement or whether these factors are more strongly associated with performance through direct relationships.

The proposed framework is consistent with SRL research, which conceptualises effective learning as an interaction among motivational, cognitive, metacognitive, and affective processes. Previous research also indicates that interventions combining motivational and metacognitive approaches can improve mathematics-related outcomes, although the magnitude of these effects varies across learner groups and educational settings.

Importantly, the conceptual framework does not assume that mathematics anxiety must function as a mediator. Instead, it treats mediation as an empirical proposition that can be tested within the specific context of Maldivian secondary mathematics education. This approach allows the study to determine whether the relationships identified in previous research are also evident among students in Addu City and whether the proposed role of mathematics anxiety is supported by the data.

3. METHODOLOGY

This study examined the cognitive and affective factors associated with mathematics learning among secondary school students in Addu City, Maldives. Specifically, it investigated the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance within the context of a Small Island Developing State (SIDS). A total of 251 students from Grades 9 and 10 participated in the study. Participants were selected using stratified random sampling to ensure appropriate representation across schools, gender, and relevant demographic groups. This sampling approach was chosen to strengthen the representativeness and generalisability of the findings to secondary school students in the Maldivian context. The sample size was also considered adequate for Partial Least Squares Structural Equation Modelling (PLS-SEM), as it exceeded the commonly recommended minimum of 200 participants for analysing complex models involving multiple relationships and mediation pathways (Hair et al., 2019).

3.1 Instruments

Data were collected using a structured, self-administered questionnaire consisting of four established measures. Motivation was measured using a modified version of the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). The scale focused on students' interest in mathematics, persistence when completing mathematical tasks, and engagement in learning activities. Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Metacognition was assessed using the Metacognitive Knowledge and Regulation Questionnaire (MKMQ; Schraw & Dennison, 1994). The measure captured students' use of planning, monitoring, and strategy-regulation processes when approaching mathematical problems. Mathematics anxiety was measured using a modified version of the Mathematics Anxiety Rating Scale (MARS; Richardson & Suinn, 1972), which assessed students' feelings of tension, worry, and apprehension when dealing with mathematics-related tasks.

Mathematics performance was measured using students' most recent mathematics test scores. These scores were obtained from school records and matched with the corresponding survey responses. Using school-based achievement data provided an objective measure of mathematics performance and complemented the self-reported measures used for the other constructs.

The instruments demonstrated satisfactory psychometric properties. Internal consistency was established through Cronbach's alpha and composite reliability, with values exceeding 0.90 across all constructs. Convergent validity was supported by Average Variance Extracted (AVE) values ranging from 0.643 to 0.721. Discriminant validity was examined using the heterotrait–monotrait (HTMT) ratio, with all values below the recommended threshold of 0.85. Taken together, these results indicated that the measures were sufficiently reliable and valid for use in the present study.

3.2 Pilot Study

Before the main data collection, a pilot study was conducted with 30 students from a secondary school with characteristics similar to those of the schools included in the main study. The purpose of the pilot study was to assess the clarity, cultural relevance, and suitability of the questionnaire items for Maldivian secondary school students. Feedback from the participants led to minor changes in wording to ensure that the items were clear and consistent with local educational practices and linguistic conventions. The pilot study also provided preliminary evidence of the reliability of the instruments and supported their use in the main study.

3.3 Data Collection

The main data collection was conducted in all public secondary schools in Addu City with the support of school administrators. The questionnaires were distributed in paper-based form during regular class periods. To maintain consistency across schools, the researcher provided standardised instructions, responded to students' questions when necessary, and followed the same administration procedures at each location.

Students completed the questionnaires anonymously and were not required to provide their names. This approach was adopted to reduce concerns about disclosure and minimise the potential influence of social desirability on responses. Participation was voluntary, and students were informed that they could withdraw from the study at any point without facing any negative consequences.

3.4 Data Analysis

The data were analysed using SmartPLS 4. The analysis involved two main stages: evaluation of the measurement model and evaluation of the structural model. First, the measurement model was assessed to establish the reliability and validity of the constructs. Cronbach's alpha, composite reliability, and Average Variance Extracted (AVE) were examined to assess internal consistency and convergent validity. Discriminant validity was assessed using the HTMT ratio.

Second, the structural model was evaluated to examine the hypothesised relationships among motivation, metacognition, mathematics anxiety, and mathematics performance. Bootstrapping with 5,000 resamples was used to determine the significance of the path coefficients and indirect effects. The analysis showed that motivation positively predicted mathematics performance (β = 0.445, $p < 0.001$), while metacognition also had a significant positive effect on performance (β = 0.127, $p = 0.022$). In contrast, the indirect relationships through mathematics anxiety were not statistically significant, indicating that mathematics anxiety did not mediate the relationships between motivation or metacognition and mathematics performance in the present sample.

3.5 Ethical Considerations

The study followed the ethical requirements established by Management and Science University and the Maldivian Ministry of Education. Ethical approval and institutional permission were obtained before data collection began. Permission was also obtained from school authorities, and informed consent was secured from students and their parents or guardians before participation.

Participants were informed about the purpose and procedures of the study and were assured that their participation was voluntary. The study maintained the confidentiality, anonymity, and security of the collected data. Students were also informed that they could withdraw from the study at any stage without any consequences.

3.6 Methodological Rationale

The methodological approach was designed to provide a reliable and contextually appropriate examination of the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance. The use of established and validated instruments strengthened the measurement of the key constructs, while the use of students' actual mathematics test scores provided an objective indicator of academic performance.

Stratified random sampling was used to improve the representativeness of the sample and strengthen the generalisability of the findings within the Maldivian secondary school context. The pilot study further helped ensure that the questionnaire items were understandable and culturally appropriate for the target population. In addition, the use of PLS-SEM enabled the study to examine both direct and indirect relationships among the variables within a single analytical framework. The ethical procedures adopted throughout the study ensured that participants' rights, privacy, and wellbeing were protected. Collectively, these methodological decisions provided a systematic basis for examining cognitive and affective influences on mathematics performance among secondary school students in a SIDS context (Hair et al., 2019).

4. FINDINGS AND RESULTS

The data were analysed using SmartPLS 4 to examine the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance among secondary school students in Addu City, Maldives. Structural equation modelling (SEM) was conducted using 5,000 bootstrap resamples. The analysis focused on the reliability and validity of the measurement model, model fit, structural relationships, mediation effects, and the explanatory power of the model. The findings are presented below according to the study hypotheses.

4.1 Reliability and Discriminant Validity

The reliability and convergent validity of the constructs were assessed before examining the structural relationships. As shown in Table 1, all constructs demonstrated strong internal consistency. Cronbach's alpha values were 0.900 for Mathematics Anxiety, 0.909 for Metacognition, 0.908 for Motivation, and 0.935 for Performance. These values were well above the recommended minimum of 0.70.

Composite reliability values were also satisfactory, with both rho_a and rho_c exceeding the recommended threshold. The AVE values ranged from 0.643 to 0.721, which were above the minimum acceptable value of 0.50. These findings provide evidence of adequate convergent validity and indicate that the measurement items appropriately represented their respective constructs.

Table 1: Reliability and Convergent Validity

Construct	Cronbach's α	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE	Reliability/Validity
Mathematics Anxiety	0.900	0.903	0.923	0.666	Meets criteria
Metacognition	0.909	0.925	0.929	0.686	Meets criteria
Motivation	0.908	0.914	0.927	0.643	Meets criteria
Performance	0.935	0.938	0.948	0.721	Meets criteria

Note. Recommended thresholds: Cronbach's α ≥ 0.70, composite reliability ≥ 0.70, and AVE ≥ 0.50 indicate satisfactory reliability and convergent validity (Hair et al., 2019).

Discriminant validity was examined using the heterotrait–monotrait (HTMT) ratio. As presented in Table 2, all HTMT values were below the recommended threshold of 0.85. This indicates that the four constructs were sufficiently distinct from one another. The highest HTMT value was observed between metacognition and mathematics anxiety (0.497), followed by the relationship between motivation and performance (0.441). Overall, the results confirm that the measurement model demonstrated satisfactory discriminant validity.

Table 2: Discriminant Validity Based on HTMT Ratios

	Mathematics Anxiety	Metacognition	Motivation	Performance
Mathematics Anxiety	—	—	—	—
Metacognition	0.497	—	—	—
Motivation	0.177	0.242	—	—
Performance	0.083	0.081	0.441	—

4.2 Model Fit Indices

The model fit indices indicated an acceptable fit between the proposed model and the observed data. The SRMR was 0.056 for both the saturated and estimated models, which was below the commonly accepted threshold of 0.08. The d_ULS and d_G values were 1.103 and 0.362, respectively. The chi-square value was 520.851, while the NFI was 0.884.

Although the NFI was slightly below the commonly preferred value of 0.90, the overall pattern of fit indices, particularly the SRMR value, indicated an acceptable level of model fit. The results therefore provided sufficient support for proceeding with the assessment of the structural model.

Table 3: Model Fit Indices

Fit Index	Saturated Model	Estimated Model
SRMR	0.056	0.056
d_ULS	1.103	1.103
d_G	0.362	0.362
Chi-square	520.851	520.851
NFI	0.884	0.884

4.3 Path Coefficients and Direct Effects

The structural model was examined to determine the direct effects of motivation, metacognition, and mathematics anxiety on mathematics performance. As shown in Table 4, motivation had the strongest positive effect on mathematics performance ($\beta = 0.445$, $t = 6.891$, $p < 0.001$). This finding indicates that students with higher levels of motivation tended to demonstrate better mathematics performance.

Metacognition also had a significant positive effect on mathematics performance, although the effect was smaller than that of motivation ($\beta = 0.127$, $t = 2.298$, $p = 0.022$). This suggests that students who are more capable of planning, monitoring, and regulating their learning strategies are more likely to achieve better mathematics outcomes.

A significant positive relationship was also found between metacognition and mathematics anxiety ($\beta = 0.453$, $t = 8.560$, $p < 0.001$). This relatively strong relationship suggests that students with higher levels of metacognitive engagement may also report greater awareness of anxiety or emotional responses associated with mathematical tasks. However, the finding should not be interpreted as evidence that metacognition causes mathematics anxiety.

In contrast, mathematics anxiety did not have a statistically significant effect on mathematics performance ($\beta = 0.084$, $t = 1.409$, $p = 0.159$). Similarly, the relationship between motivation and mathematics anxiety was negative but non-significant ($\beta = -0.057$, $t = 0.950$, $p = 0.342$). Therefore, the findings did not provide sufficient evidence to support these two hypothesised relationships.

Table 4: Path Coefficients and Direct Effects

Structural Path	β	t	p	Decision
Mathematics Anxiety → Performance	0.084	1.409	0.159	Not Supported
Metacognition → Mathematics Anxiety	0.453	8.560	< 0.001	Supported
Metacognition → Performance	0.127	2.298	0.022	Supported
Motivation → Mathematics Anxiety	−0.057	0.950	0.342	Not Supported
Motivation → Performance	0.445	6.891	< 0.001	Supported

The model explained 22.0% of the variance in mathematics anxiety ($R^2 = 0.220$; adjusted $R^2 = 0.213$) and 19.5% of the variance in mathematics performance ($R^2 = 0.195$; adjusted $R^2 = 0.185$).

These findings indicate that motivation and metacognition, together with mathematics anxiety in the structural model, explained a meaningful but limited proportion of variation in students' mathematics outcomes. This is consistent with the multifaceted nature of academic performance, which is influenced by a range of cognitive, motivational, emotional, instructional, and contextual factors.

4.4 Mediation Effects

The study further examined whether mathematics anxiety mediated the relationships between the cognitive-motivational variables and mathematics performance. The mediation analysis was conducted using the bootstrapping procedure with 5,000 resamples.

The indirect effect of metacognition on performance through mathematics anxiety was positive but not statistically significant ($\beta = 0.038$, $t = 1.375$, $p = 0.169$). Similarly, the indirect effect of motivation on performance through mathematics anxiety was very small and non-significant ($\beta = -0.005$, $t = 0.662$, $p = 0.508$).

Table 5: Specific Indirect Effects

Specific Indirect Effect	β	t	p	Decision
Metacognition → Mathematics Anxiety → Performance	0.038	1.375	0.169	Not Significant
Motivation → Mathematics Anxiety → Performance	−0.005	0.662	0.508	Not Significant

These results indicate that mathematics anxiety did not significantly mediate either the relationship between metacognition and mathematics performance or the relationship between motivation and mathematics performance. Although metacognition was significantly associated with mathematics anxiety, this association did not translate into a significant indirect effect on mathematics performance.

4.5 Summary of Results

Overall, the findings indicate that motivation was the strongest predictor of mathematics performance among the variables examined. Metacognition also made a significant positive contribution to performance, although its effect was considerably smaller. Metacognition was additionally associated with mathematics anxiety, suggesting an important connection between students' cognitive regulation processes and their emotional experiences during mathematics learning.

However, mathematics anxiety did not significantly predict mathematics performance and did not mediate the effects of either motivation or metacognition on performance. The measurement model demonstrated strong reliability, convergent validity, and discriminant validity, while the structural model showed an acceptable overall fit.

Taken together, the findings suggest that motivation and metacognitive skills may have a more direct role in mathematics performance than mathematics anxiety within the present sample. The relatively modest R^2 values also indicate that mathematics achievement is influenced by several factors beyond those included in the current model. Therefore, the findings provide useful evidence for understanding mathematics learning among secondary school students in Addu City while also highlighting the need to consider the broader educational and contextual factors that shape academic performance.

Figure 2 presents the structural equation model, while Tables 1–5 provide the detailed results of the reliability, validity, model fit, structural path, and mediation analyses.

5. DISCUSSION, CONCLUSION, AND IMPLICATIONS

This section discusses the findings of the study on motivation, metacognition, mathematics anxiety, and mathematics performance among secondary school students in Addu City, Maldives. The discussion focuses on the meaning of the findings, their relationship with previous research, and their theoretical and practical implications. Particular attention is given to the Maldivian context as a Small Island Developing State (SIDS), where educational experiences may differ from those reported in larger and more extensively studied settings.

5.1 Interpretation of Key Findings

The findings showed that motivation was the strongest predictor of mathematics performance. The positive relationship suggests that students who are more motivated to learn mathematics are more likely to persist with challenging tasks, remain engaged in learning activities, and put greater effort into solving mathematical problems. This finding is consistent with Self-Regulated Learning (SRL) theory, which recognises motivation as an important component of students' learning behaviour and self-regulation (Schunk & DiBenedetto, 2020). In the present context, motivated students may be more willing to invest the time and effort required to overcome difficulties in mathematics.

Metacognition also had a significant positive relationship with mathematics performance, although its effect was smaller than that of motivation. This finding highlights the importance of students' ability to plan, monitor, and evaluate their own learning strategies. Students who are able to recognise what they understand, identify areas of difficulty, and adjust their strategies accordingly may be better prepared to approach mathematical problems effectively.

An important finding was the significant positive relationship between metacognition and mathematics anxiety. Rather than indicating that metacognition necessarily causes anxiety, this relationship may suggest that students who actively monitor their thinking are also more conscious of the difficulties and emotional responses they experience during mathematics learning. However, mathematics anxiety itself did not significantly predict mathematics performance. It also failed to mediate the relationships between motivation, metacognition, and performance. Therefore, in this sample, anxiety did not appear to be a central mechanism through which cognitive and motivational resources influenced mathematics achievement.

5.2 Comparison with Prior Research

The finding that motivation was the strongest predictor of mathematics performance is consistent with previous research emphasising the importance of motivation in academic achievement (Lazarides et al., 2022; Guo et al., 2021). Students who are interested in learning and willing to persist when faced with challenging tasks are generally more likely to engage actively with academic activities.

The positive effect of metacognition on mathematics performance also supports previous research highlighting the importance of self-regulation and metacognitive processes in problem-solving and learning (Veenman & Spaans, 2020). The ability to plan an approach, monitor progress, and evaluate the effectiveness of a strategy can be particularly valuable when students encounter complex mathematical problems.

However, the findings concerning mathematics anxiety differ from research that has commonly reported a negative association between mathematics anxiety and mathematics achievement. For example, previous meta-analytic evidence has identified a generally negative relationship between mathematics anxiety and performance (Namkung et al., 2019). In the present study, however, mathematics anxiety had neither a significant direct effect on performance nor a significant mediating effect.

One possible explanation is that the relationship between mathematics anxiety and performance may depend on the educational and cultural context. Students may experience anxiety without it necessarily interfering with their ability to perform mathematical tasks. Other resources, particularly motivation and metacognitive skills, may help some students remain engaged and effective despite experiencing anxiety. These findings therefore reinforce the importance of considering cultural and contextual factors when applying psychological and educational models across different settings. Research has also suggested that motivation can influence students' experiences of anxiety and academic engagement (Putwain et al., 2021).

5.3 Theoretical Contributions

The study contributes to the application of Self-Regulated Learning theory by demonstrating how motivational and metacognitive processes operate within a Maldivian SIDS context. First, the strong relationship between motivation and mathematics performance supports the central role of goal-directed motivation in students' learning behaviour. Motivation appears to provide an important foundation for sustained engagement and academic effort.

Second, the significant effect of metacognition on performance reinforces the role of cognitive regulation in successful learning. At the same time, the strong relationship between metacognition and mathematics anxiety suggests that cognitive monitoring may also be connected to students' awareness of their emotional experiences during mathematical activities.

Third, the non-significant effect of mathematics anxiety challenges the assumption that anxiety will necessarily have the same negative effect on academic performance across all contexts. Rather than treating anxiety as a universally determining factor, the findings suggest that its influence may depend on how it interacts with students' cognitive and motivational resources. This interpretation is consistent with broader perspectives that view affect, cognition, and motivation as interconnected components of learning rather than as completely independent processes (Pekrun et al., 2021).

5.4 Practical Implications for Maldivian Education

The findings have several implications for teachers, curriculum developers, and education policymakers in the Maldives. Since motivation emerged as the strongest predictor of mathematics performance, classroom practices should provide opportunities for students to develop interest, persistence, and active engagement in mathematics. Teachers may use meaningful learning activities, achievable goals, constructive feedback, and opportunities for students to experience progress and success.

The findings also support greater emphasis on metacognitive instruction. Students can be explicitly taught how to plan their approach to mathematical problems, monitor their understanding, identify errors, and evaluate which strategies are effective. Student-centred feedback, goal-setting activities, and structured opportunities for reflection may help strengthen these skills (Lazowski & Hulleman, 2016; Dignath & Büttner, 2018).

Although mathematics anxiety was not a significant predictor or mediator in this study, it should not be disregarded. Some students may still experience substantial anxiety that affects their classroom participation or wellbeing. However, the findings suggest that anxiety-reduction strategies may be most effective when combined with broader efforts to strengthen students' motivation and self-regulation rather than being treated as the sole focus of intervention.

These implications are particularly relevant to the Maldivian educational context, where available resources, classroom conditions, cultural expectations, and geographical characteristics may shape students' learning experiences. Educational interventions should therefore be adapted to local needs rather than relying exclusively on approaches developed in different educational and cultural settings.

5.5 Limitations and Future Research

Several limitations should be considered when interpreting the findings. First, most of the key constructs were measured using self-report instruments. Although established and reliable measures were used, self-reported responses may still be influenced by social desirability, students' perceptions, or their ability to accurately assess their own learning behaviours and emotional experiences. Mathematics performance was based on students' actual school test scores, which provided an objective complement to the self-reported measures.

Second, the cross-sectional design limits the extent to which causal relationships can be established. Although SEM can be used to examine theoretically specified relationships among variables, the findings should not be interpreted as definitive evidence that motivation or metacognition causes changes in mathematics performance. Longitudinal or experimental studies would provide stronger evidence regarding the direction and development of these relationships.

Third, the study was conducted in Addu City, which limits the extent to which the findings can be generalised to students in other atolls or educational settings in the Maldives. Future studies should therefore include students from a wider range of islands and schools. Comparative research across different Maldivian regions could provide a more comprehensive understanding of how local educational and social conditions influence mathematics learning.

Future research could also examine potential moderating variables such as gender, previous academic achievement, socioeconomic background, and school characteristics. Longitudinal research could further investigate how motivation, metacognition, and mathematics anxiety develop over time and how changes in these factors influence mathematics achievement. Experimental research examining context-specific instructional strategies may also help identify effective approaches for strengthening motivation and metacognitive regulation among Maldivian students.

5.6 Conclusion

This study examined the relationships among motivation, metacognition, mathematics anxiety, and mathematics performance among secondary school students in Addu City, Maldives. The findings showed that motivation was the strongest predictor of mathematics performance, while metacognition also made a significant positive contribution. Metacognition was significantly associated with mathematics anxiety, but mathematics anxiety did not significantly predict mathematics performance or mediate the relationships between motivation, metacognition, and performance.

The findings contribute to the growing application of Self-Regulated Learning perspectives in non-Western and SIDS educational contexts. They suggest that cognitive and motivational resources may play a more direct role in mathematics achievement than anxiety within the present context. From a practical perspective, the results support greater attention to developing students' motivation, self-regulation, and metacognitive skills alongside appropriate support for students who experience mathematics anxiety.

Overall, the study provides evidence that strengthening motivation and metacognitive regulation may offer productive avenues for improving mathematics learning among Maldivian secondary school students. At the same time, the findings highlight the importance of context-sensitive educational research and interventions that recognise the distinctive conditions of learning in Small Island Developing States.

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