Conceptual Model of the Relationship Between Metacognitive Learning Strategies and Meta-Emotion with Academic Engagement Mediated by Attributional Styles in Students With High and Low Levels of Anxiety

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Objective: The aim of this study was to examine a conceptual model of the relationship between metacognitive learning strategies and meta-emotion with academic engagement, mediated by attributional styles, in students with high and low levels of anxiety.

Methods and Materials: This study employed a descriptive–correlational design using structural equation modeling and, in terms of purpose classification, was an applied research study. The statistical population included all upper secondary school students in Torbat-e Heydarieh during the 2023–2024 academic year (N = 12,713). Using G*Power software, a sample size of 372 students was determined, who were selected through multistage cluster sampling with proportional allocation by district. The research instruments included the Metacognitive Learning Strategies Questionnaire by Karimi (2002), the Meta-Emotion Scale by Mitmansgruber (2009), the Attributional Style Questionnaire (ASQ; 1982), and the Test Anxiety Questionnaire (TA; 1996).

Findings: The results indicated that the model demonstrated adequate predictive power for the dependent variables at the 0.05 significance level. Subsequently, the model was analyzed using a factor analysis procedure in SmartPLS software. The findings showed that test anxiety did not have a significant moderating effect on the strength of the relationship between metacognitive learning strategies and academic engagement through the mediating role of attributional styles at the 0.05 significance level. In addition, test anxiety did not have a significant effect on the strength of the relationship between metacognitive learning strategies and meta-emotion with academic engagement through the mediating role of attributional styles at the 0.05 significance level.

Conclusion: The final results indicated that through the design, instruction, and practice of using metacognitive strategies, meta-emotion, and attributional styles, students' academic engagement increases; however, these factors do not have an effect on their test anxiety.

Keywords: test anxiety; metacognitive learning strategies; academic engagement; attributional styles; meta-emotion.

1. Introduction

Academic engagement has emerged as a central construct in contemporary educational psychology, reflecting the degree to which students are cognitively, behaviorally, and motivationally involved in learning activities. High levels of academic engagement are consistently associated with adaptive learning behaviors, deeper processing of educational content, persistence in the face of difficulty, and improved academic achievement, whereas low engagement is linked to disengagement, academic failure, and emotional distress (Linnenbrink-Garcia et al., 2010; Mega et al., 2014; Talebi et al., 2014). As educational systems face increasing challenges related to learner diversity, performance pressure, and emotional well-being, identifying the psychological mechanisms that foster or hinder students' engagement has become a critical research priority.

Among the cognitive factors influencing academic engagement, metacognitive learning strategies occupy a prominent position. Metacognition broadly refers to individuals' awareness, monitoring, and regulation of their own cognitive processes during learning tasks. Students who effectively employ metacognitive strategies such as planning, monitoring, and evaluation are better able to organize their learning, detect comprehension failures, and adapt strategies to task demands (Dent & Koenka, 2016; Discipulo & Bautista, 2022; Salimi, 2018). Empirical evidence indicates that metacognitive competence predicts not only academic achievement but also sustained engagement and self-regulated learning behaviors across educational stages (Da et al., 2024; Meyer & Parker, 2025; Najafipour Deyvkolaei et al., 2021). Instructional interventions targeting cognitive and metacognitive strategies have likewise demonstrated positive effects on students' academic engagement and motivational resilience, particularly in populations facing learning difficulties or contextual disadvantages (Amir Ardehjani, 2022; Kokabi Rahman et al., 2023; Soleimani et al., 2021).

In parallel with cognitive regulation, emotional processes play a decisive role in shaping students' learning experiences. Academic contexts are inherently emotional, eliciting feelings such as enjoyment, interest, anxiety, shame, and frustration. These emotions influence attention allocation, strategy use, persistence, and ultimately engagement (Linnenbrink-Garcia et al., 2010; Mega et al., 2014). Recent research has moved beyond the examination of first-order emotions to consider higher-order emotional processes, including meta-emotions. Meta-emotion refers to individuals' emotional reactions to their own emotions, encompassing how people perceive, evaluate, and regulate their emotional experiences (Miceli & Castelfranchi, 2019; Norman & Furnes, 2016). Positive meta-emotions, such as compassion toward oneself or interest in one's emotional states, can facilitate adaptive regulation, whereas negative meta-emotions, such as shame or anger about experiencing certain emotions, may exacerbate distress and avoidance behaviors.

Within educational settings, meta-emotion has been shown to relate to self-directed learning, emotional regulation, and academic outcomes. Students who exhibit positive meta-emotional beliefs are more likely to accept and manage academic emotions constructively, thereby sustaining engagement and motivation (Alamalhoda & Zeynali, 2021; Rahmanian, 2024). Conversely, maladaptive meta-emotional patterns have been linked to heightened anxiety, emotional dysregulation, and academic burnout (Hurrell et al., 2017; Mansell et al., 2020). The growing body of evidence underscores the importance of integrating meta-emotional processes into models of academic engagement, particularly in adolescence, when emotional awareness and regulation undergo substantial developmental changes.

Another key psychological mechanism implicated in students' engagement and emotional functioning is attributional style. Attributional styles reflect individuals' habitual explanations for success and failure across dimensions such as internality versus externality, stability versus instability, and globality versus specificity (Weiner, 2013). In academic contexts, students who attribute success to internal, controllable, and stable causes tend to demonstrate higher motivation, persistence, and engagement, whereas attributing failure to internal, stable, and global causes is associated with helplessness, disengagement, and anxiety (Tamannaifar et al., 2013; Zakeri et al., 2023). Attributional processes therefore serve as a cognitive–motivational lens through which students interpret academic experiences, shaping both emotional responses and subsequent learning behaviors.

Empirical studies have documented meaningful relationships between attributional styles and academic engagement, as well as with emotional variables such as test anxiety and academic emotions (Saber & Sharifi, 2013; Zakeri et al., 2023). Moreover, attributional styles have been proposed as mediating mechanisms linking cognitive beliefs and emotional regulation to engagement outcomes. For instance, students with stronger metacognitive awareness

may develop more adaptive attributional patterns by accurately monitoring performance and distinguishing between controllable and uncontrollable factors (Najafipour Deyvkolaei et al., 2021; Tamannaifar et al., 2013). Similarly, positive meta-emotion may foster constructive attributions by reducing self-blame and promoting reflective interpretation of emotional experiences (Mansell et al., 2020; Miceli & Castelfranchi, 2019). Despite these theoretical propositions, empirical models simultaneously examining metacognition, meta-emotion, attributional styles, and academic engagement remain limited.

Test anxiety represents another critical variable in the academic emotional landscape, particularly during secondary education, where evaluative pressure intensifies. Test anxiety is characterized by cognitive worry, emotional arousal, and behavioral avoidance in evaluative situations, and has been consistently associated with lower academic performance and engagement (Jahanshahi, 2015; Li et al., 2024). Research indicates that test anxiety is influenced by cognitive factors such as metacognitive beliefs and attributional styles, as well as by emotional regulation processes (Gharib Navaz et al., 2017; Karshki et al., 2017; Rasouli et al., 2012). High test anxiety may disrupt the effective use of learning strategies and undermine students' engagement by diverting attentional resources and reinforcing maladaptive interpretations of academic outcomes.

Recent studies suggest that the relationship between cognitive–emotional resources and academic engagement may vary depending on students' levels of anxiety. For example, metacognitive skills that are generally adaptive may become less effective under high anxiety, while emotional awareness may either buffer or amplify anxiety's effects depending on students' meta-emotional beliefs (Barrientos et al., 2022; Lu et al., 2024). Similarly, attributional styles may operate differently in low- versus high-anxiety students, influencing whether academic challenges are perceived as manageable or threatening (Hatami Zargaran, 2012; Jafari & Shalchi, 2021). These findings highlight the importance of examining anxiety not only as an outcome but also as a potential moderating factor in models of academic engagement.

Advances in educational psychology have increasingly emphasized integrative, multivariate models that account for the dynamic interplay between cognition, emotion, and motivation. Contemporary research employing structural equation modeling and, more recently, machine learning approaches has demonstrated that combinations of metacognitive, emotional, and attributional variables provide stronger predictive power for academic outcomes than single-factor models (Ma et al., 2025; Ma, 2023; Xiao et al., 2025). Systematic reviews further underscore the need for nuanced measurement and modeling of meta-cognitive and meta-emotional processes, particularly in K–12 populations (Toomla et al., 2025; Wenzel et al., 2023). Despite this progress, there remains a notable gap in the literature concerning how metacognitive learning strategies and meta-emotion jointly relate to academic engagement through attributional styles, and how these relationships may differ across levels of test anxiety.

The Iranian educational context, similar to many high-pressure academic systems, places considerable emphasis on examinations and academic performance, which can intensify students' anxiety and shape their engagement trajectories. Prior studies conducted within this context have documented associations among metacognition, academic emotions, attributional styles, and anxiety, yet often in isolation or using simple correlational designs (Mambayni, 2014; Rajabzadeh, 2020; Rezaei et al., 2014). There is a need for comprehensive conceptual models that integrate these constructs and test their direct, indirect, and conditional relationships within a unified analytical framework.

In response to these theoretical and empirical gaps, the present study adopts a structural equation modeling approach to examine a conceptual model linking metacognitive learning strategies and meta-emotion (positive and negative) to academic engagement, with attributional styles as a mediating mechanism and test anxiety as a moderating variable. By comparing students with varying levels of test anxiety, this study seeks to clarify whether anxiety alters the strength of these relationships, thereby contributing to a more differentiated understanding of engagement processes in adolescence. Such insights have important implications for educational interventions aimed at enhancing engagement by targeting not only cognitive strategies but also emotional awareness and attributional thinking.

The aim of this study was to examine a conceptual model of the relationships between metacognitive learning strategies and meta-emotion with academic engagement, mediated by attributional styles, in students with high and low levels of test anxiety.

2.   Methods and Materials

2.1.   Study Design and Participants

The present study employed a cross-sectional correlational design and was conducted within the framework of structural equation modeling. From the perspective of research purpose, the study was applied in nature. The statistical population consisted of all upper secondary school students (Grades 10, 11, and 12) enrolled in public schools in Torbat-e Heydarieh during the 2023–2024 academic year, totaling 12,713 students. Based on recommendations by Loehlin (2004), an appropriate sample size for structural equation modeling ranges between 200 and 400 participants, as samples smaller than 200 are considered inadequate and samples larger than 400 may increase sensitivity to fit indices while potentially yielding unstable models. Taking into account possible attrition, incomplete responses, or unusable questionnaires, the required sample size was determined to be 372 students using G*Power software. Participants were selected through multistage cluster sampling with proportional allocation. In this process, schools were first selected as clusters, followed by the selection of classes from different grade levels (10th, 11th, and 12th) and academic tracks, including experimental sciences, mathematics and physics, humanities, technical–vocational, and work-and-knowledge streams. Questionnaires were distributed to the selected students in person, and after screening for completeness and accuracy, all valid questionnaires were entered into the final statistical analyses.

2.2.   Measures

Academic engagement was assessed using the Academic Engagement Questionnaire developed by Fredericks et al. (2014), which was designed to measure engagement among students and learners. This instrument consists of 15 items and assesses three dimensions of engagement: motivational engagement (Items 1–6), cognitive engagement (Items 7–12), and behavioral engagement (Items 13–15). Responses are rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Subscale scores are calculated by summing the relevant items, with higher scores indicating greater engagement in the respective domain. Motivational engagement scores equal to or greater than 15, cognitive engagement scores equal to or greater than 12, and behavioral engagement scores equal to or greater than 10 indicate the presence of engagement in that subscale. Items 6, 8, and 9 are reverse-scored. The total score ranges from 15 to 75, with higher scores reflecting higher levels of academic engagement. Evidence for the construct validity of the Persian version of this questionnaire has been reported through exploratory and confirmatory factor analyses, confirming the three-factor structure, and acceptable goodness-of-fit indices have been documented. Reliability estimates reported Cronbach's alpha coefficients above .70 for all subscales, indicating satisfactory internal consistency (Talebi et al., 2014). In the present study, content validity was confirmed by psychology experts, and internal consistency was excellent, with a Cronbach's alpha of .93, composite reliability of .96, convergent validity of .63, and discriminant validity of .79, indicating strong psychometric properties.

Metacognitive learning strategies were measured using the Metacognitive Strategies Questionnaire developed by Karimi (2002). This self-report instrument assesses learners' awareness and regulation of their cognitive processes and includes components related to planning, monitoring and evaluation, and organization. The face validity of the questionnaire was confirmed by its developer, and previous studies have demonstrated strong construct validity and high internal consistency, with correlations between individual items and the total score reported to be very high (Bayat & Abutorabi Kashani, 2022). Reliability indices obtained using Cronbach's alpha and test–retest methods indicated coefficients of .81 for planning, .84 for monitoring and evaluation, .69 for organization, and .97 for the total scale. In the present study, the questionnaire's validity and reliability were again confirmed by psychology experts. Internal consistency was excellent, with a Cronbach's alpha of .98, composite reliability of .99, convergent validity of .70, and discriminant validity of .83, demonstrating that the instrument was suitable for use with the current sample.

Meta-emotion was assessed using the Meta-Emotion Questionnaire developed by Beck and Hofer (2009), which is designed to evaluate meta-emotional processes in adolescents and adults. This instrument contains 28 items rated on a six-point Likert scale ranging from completely true (6) to completely untrue (1). The scale measures six components, including anger, shame, violence control, and suppression as indicators of negative meta-emotion, as well as compassion and interest as indicators of positive meta-emotion. Higher scores indicate higher levels of the corresponding meta-emotional component. Previous validation studies using factor analysis have confirmed a two-factor structure representing positive and negative

meta-emotion, with all factor loadings exceeding .30 and acceptable goodness-of-fit indices reported (Rezaei et al., 2014). Concurrent validity has also been supported through correlations with emotional intelligence measures. In the present study, expert review confirmed content validity. Reliability analysis yielded Cronbach's alpha coefficients of .93 for positive meta-emotion and .76 for negative meta-emotion. Composite reliability coefficients were .94 and .84 for positive and negative meta-emotion, respectively, while convergent validity values were .65 and .57, and discriminant validity values were .81 and .76, indicating satisfactory reliability and validity.

Attributional styles were measured using the Attributional Style Questionnaire (ASQ) developed by Peterson, Seligman, Semmel, Bayer, Abramson, and Metalaksy in 1982. This self-report instrument assesses individuals' habitual explanations for positive and negative life events across dimensions of internality versus externality, stability versus instability, globality versus specificity, and controllability versus uncontrollability. The ASQ consists of 48 items rated on a seven-point Likert scale. Scores for positive and negative events are calculated separately, and a composite attributional style score is derived by subtracting the negative event score from the positive event score, with higher scores reflecting a more adaptive attributional style. The Persian version of the ASQ was translated and culturally adapted for use in Iran and has demonstrated acceptable construct validity through confirmatory factor analysis, as well as meaningful correlations with academic emotions (Sheikh Eslami, 1998; Shokri et al., 2012). Previous studies have reported Cronbach's alpha coefficients around .74 for the total scale (Parsafar & Yazdankhah, 2014). In the current study, expert evaluation confirmed content validity, and reliability indices were strong, with a Cronbach's alpha of .92, composite reliability of .93, convergent validity of .50, and discriminant validity of .71, supporting the adequacy of the measure.

Test anxiety was measured using the Test Anxiety Inventory (TAI) developed and validated by Abolghasemi et al. (1996). This questionnaire consists of 25 items assessing a single dimension of test anxiety, rated on a four-point Likert scale ranging from never (0) to often (3). Total scores range from 0 to 75, with higher scores indicating greater levels of test anxiety. The scale was originally developed using a large student sample, and its psychometric properties were established through factor analysis, concurrent validity with measures of general anxiety and self-esteem, and expert judgment regarding face validity. Reliability estimates reported test–retest coefficients ranging from .73 to .88 and Cronbach's alpha coefficients between .79 and .88 (Abolghasemi et al., 1996). In the present study, content validity was confirmed by psychology experts, and reliability analysis yielded a Cronbach's alpha of .97, composite reliability of .96, convergent validity of .51, and discriminant validity of .71, indicating excellent internal consistency and acceptable validity.

2.3.   Data Analysis

Data analysis was conducted using both SPSS and SmartPLS software. Initially, descriptive statistics were computed to examine the distributional properties of the variables, followed by reliability and validity analyses to confirm the psychometric adequacy of the measurement instruments. Pearson correlation coefficients were calculated to examine bivariate relationships among metacognitive learning strategies, meta-emotion, attributional styles, academic engagement, and test anxiety. Structural equation modeling was then employed to test the proposed conceptual model, including direct and indirect paths among the variables. Model fit was evaluated using standard goodness-of-fit indices, and the significance of path coefficients was assessed at the .05 level. In addition, multi-group and moderation analyses were conducted to examine whether test anxiety influenced the strength of the relationships between metacognitive learning strategies, meta-emotion, and academic engagement through the mediating role of attributional styles. Bootstrapping procedures were used to test the significance of indirect effects and to ensure the robustness of the estimated parameters.

3.   Findings and Results

The findings section is organized around three core analytical outputs. First, descriptive statistics are presented to provide an overview of the central tendency and dispersion of the study variables and to verify that observed values fall within theoretically and instrumentally plausible ranges.

Table 1

Descriptive statistics for the study variables (N = 372)

Variable	Possible Range	Observed Range	Mean (M)	Standard Deviation (SD)
Metacognitive learning strategies	1–5	1.62–4.83	3.47	0.61
Positive meta-emotion	1–6	1.48–5.76	3.89	0.72
Negative meta-emotion	1–6	1.31–5.42	2.84	0.69
Attributional styles	-18–+18	-9.74–14.63	4.28	5.11
Academic engagement	15–75	22–71	48.63	9.42
Test anxiety	0–75	6–68	34.91	11.37

In the Table 1, the descriptive results indicate that the mean score for metacognitive learning strategies was above the scale midpoint (M = 3.47, SD = 0.61), suggesting a moderate-to-high use of such strategies among students. Positive meta-emotion showed a relatively high mean (M = 3.89, SD = 0.72), whereas negative meta-emotion was lower (M = 2.84, SD = 0.69), indicating that positive meta-emotional experiences were more prevalent than negative ones. The mean attributional style score was positive (M = 4.28, SD = 5.11), reflecting a tendency toward more adaptive attributional patterns. Academic engagement scores were moderately high (M = 48.63, SD = 9.42) within the possible range of 15 to 75, while test anxiety levels were moderate (M = 34.91, SD = 11.37), showing substantial interindividual variability among students.

**Table 2**

Measurement and structural model quality indices

Model	Index	Metacognitive Learning Strategies	Positive Meta-Emotion	Negative Meta-Emotion	Academic Engagement	Test Anxiety	Attributional Styles
Measurement model	Metacognitive learning strategies	0.83					
	Positive meta-emotion	0.70	0.81				
	Negative meta-emotion	0.30	0.33	0.76			
	Academic engagement	-0.55	-0.52	-0.28	0.79		
	Test anxiety	0.21	0.03	-0.16	-0.21	0.71	
	Attributional styles	-0.14	0.22	-0.30	-0.25	-0.23	0.71
	AVE	0.70	0.65	0.57	0.63	0.51	0.50
	Cronbach's alpha	0.98	0.93	0.76	0.96	0.97	0.92
	Composite reliability	0.99	0.94	0.84	0.96	0.96	0.93
Structural model	Q^2	—	—	—	0.44	—	0.14
	f^2	0.80	0.14	0.01	—	0.01	0.11
	R^2	—	—	—	0.75	—	0.14

The measurement model demonstrated strong psychometric properties. All average variance extracted (AVE) values exceeded the recommended threshold of 0.50, supporting convergent validity. Cronbach's alpha coefficients ranged from 0.76 to 0.98, and composite reliability values ranged from 0.84 to 0.99, indicating excellent internal consistency across constructs. Discriminant validity was supported, as the square roots of AVE values (diagonal elements) were greater than the corresponding inter-construct correlations. In the structural model, the R^2 value for academic engagement was 0.75, indicating that approximately 75% of its variance was explained by the predictor variables, while attributional styles showed an R^2 of 0.14. The Q^2 values suggested adequate predictive relevance for both academic engagement (Q^2 = 0.44) and attributional styles (Q^2 = 0.14). Effect size indices (f^2) indicated a large effect of metacognitive learning strategies, small-to-moderate effects of positive meta-emotion, and negligible effects for negative meta-emotion and test anxiety.

Table 3

Direct, indirect, and total effects in the structural model (bootstrapping results)

Path	b	S.E.	β	p
Metacognitive learning strategies → Academic engagement	0.85	0.02	0.85	< .001
Positive meta-emotion → Academic engagement	0.72	0.03	0.72	< .001
Negative meta-emotion → Academic engagement	-0.28	0.05	-0.28	< .001
Test anxiety → Academic engagement	-0.20	0.22	-0.20	.347
Metacognitive learning strategies → Attributional styles	0.35	0.03	0.35	< .001
Positive meta-emotion → Attributional styles	0.49	0.04	0.49	< .001
Negative meta-emotion → Attributional styles	-0.13	0.18	-0.13	.481
Metacognitive learning strategies → Academic engagement (indirect via attributional styles)	0.39	0.03	0.39	< .001
Positive meta-emotion → Academic engagement (indirect via attributional styles)	0.43	0.04	0.43	< .001
Negative meta-emotion → Academic engagement (indirect via attributional styles)	-0.05	0.09	-0.05	.559
Metacognitive learning strategies → Academic engagement (total effect)	1.24	—	1.24	—
Positive meta-emotion → Academic engagement (total effect)	1.15	—	1.15	—
Negative meta-emotion → Academic engagement (total effect)	-0.33	—	-0.33	—

Figure 1

Standardized Coefficients Model—Overall Model
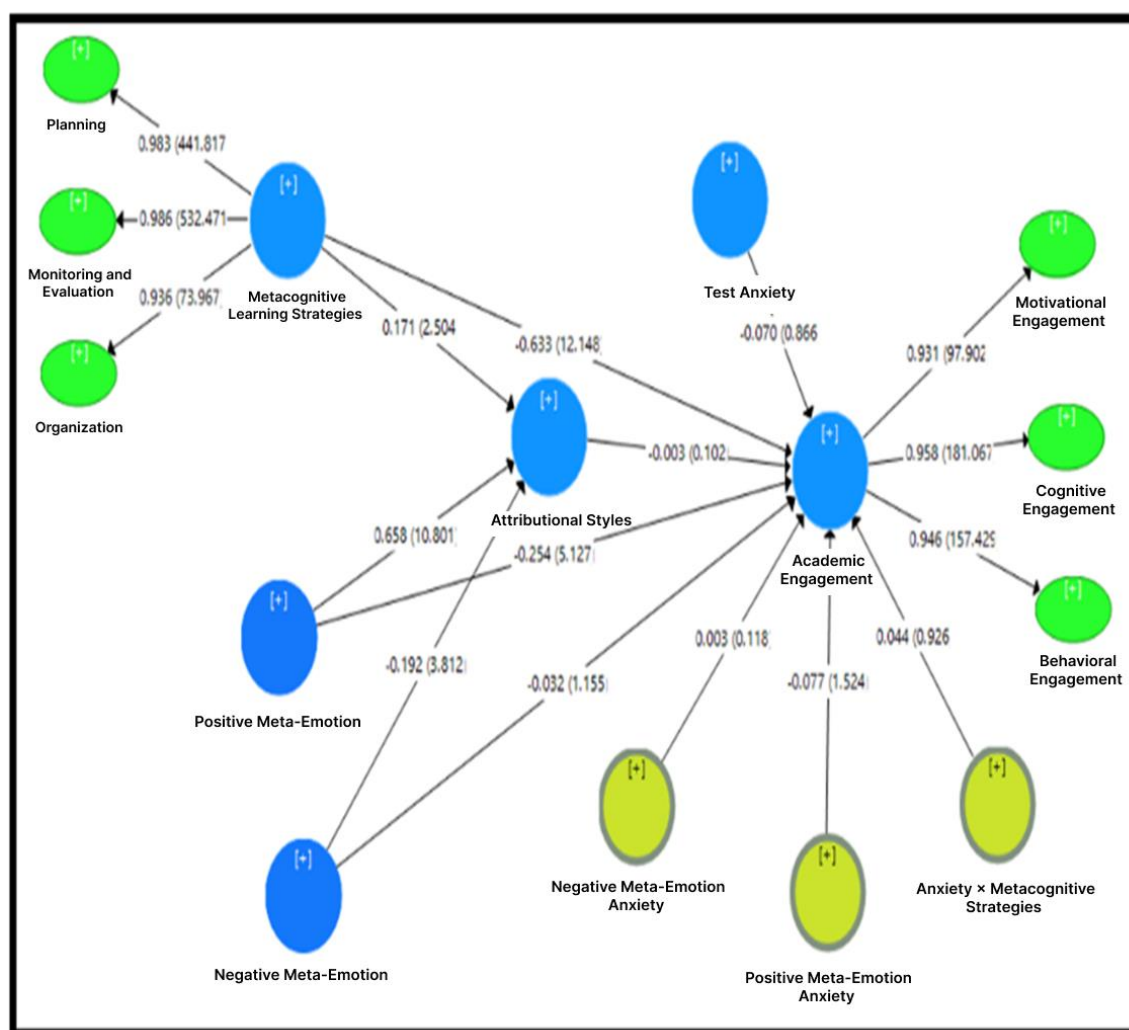
The structural path analysis revealed that metacognitive learning strategies had a strong and positive direct effect on academic engagement (β = 0.85, p < .001), while positive meta-emotion also exerted a substantial positive effect (β = 0.72, p < .001). Negative meta-emotion showed a significant inverse direct relationship with academic engagement (β = −0.28, p < .001). In contrast, the direct effect of test anxiety on academic engagement was not statistically significant (β = −0.20, p = .347). Regarding the mediator, both metacognitive learning strategies (β = 0.35, p < .001) and positive meta-emotion (β = 0.49, p < .001) significantly predicted attributional styles, whereas negative meta-emotion did not. Indirect effects through attributional styles were significant for metacognitive learning strategies (β = 0.39, p < .001) and positive meta-emotion (β = 0.43, p < .001), but not for negative meta-emotion. The total effects indicated that metacognitive learning strategies and positive meta-emotion had the strongest overall influence on academic engagement, while the overall effect of negative meta-emotion remained negative but smaller in magnitude.

4. Discussion

The present study examined a conceptual model linking metacognitive learning strategies and meta-emotion to academic engagement through the mediating role of attributional styles, while also testing the moderating role of test anxiety. Overall, the findings provide strong empirical support for the proposed model and offer an integrated explanation of how cognitive, emotional, and attributional mechanisms jointly shape students' academic engagement. The results demonstrated that metacognitive learning strategies exerted a strong and positive direct effect on academic engagement, alongside a significant indirect effect through attributional styles. This pattern indicates that students who actively plan, monitor, and regulate their learning not only engage more deeply in academic tasks but also tend to develop more adaptive attributional interpretations of academic experiences, which further enhance engagement. These findings are consistent with prior research emphasizing the central role of metacognition in sustaining engagement and self-regulated learning (Da et al., 2024; Meyer & Parker, 2025; Najafipour Deyvkolaei et al., 2021). They also align with intervention studies showing that explicit instruction in cognitive and metacognitive strategies leads to improvements in academic engagement across diverse student populations (Amir Ardehjani, 2022; Kokabi Rahman et al., 2023; Soleimani et al., 2021).

The strong direct association between metacognitive learning strategies and academic engagement observed in this study can be interpreted through self-regulated learning frameworks, which posit that metacognition enables learners to set goals, allocate effort efficiently, and persist in the face of challenges. When students are aware of their cognitive processes and can regulate them effectively, they are more likely to experience a sense of control over learning, which promotes sustained behavioral, cognitive, and motivational engagement (Dent & Koenka, 2016; Discipulo & Bautista, 2022). Moreover, the significant indirect pathway through attributional styles suggests that metacognitive learners are better equipped to interpret academic successes and failures in adaptive ways, attributing outcomes to controllable and specific factors rather than stable and global causes. This interpretation is consistent with attribution theory, which highlights the role of perceived controllability and stability in shaping motivation and engagement (Tamannaifar et al., 2013; Weiner, 2013).

In addition to metacognitive strategies, positive meta-emotion emerged as a significant predictor of academic engagement, both directly and indirectly through attributional styles. Students who reported higher levels of positive meta-emotion—such as interest in, acceptance of, and compassion toward their own emotional experiences—showed greater academic engagement. This finding underscores the importance of higher-order emotional processes in learning, extending previous work that has linked emotional awareness and regulation to academic outcomes (Linnenbrink-Garcia et al., 2010; Mega et al., 2014). Positive meta-emotion likely facilitates engagement by enabling students to tolerate and manage challenging academic emotions, such as frustration or anxiety, without becoming overwhelmed or disengaged. This interpretation aligns with theoretical perspectives suggesting that meta-emotional acceptance reduces avoidance and promotes adaptive coping (Miceli & Castelfranchi, 2019; Norman & Furnes, 2016).

The mediating role of attributional styles in the relationship between positive meta-emotion and academic engagement further highlights the cognitive–emotional interplay underlying engagement. Students with positive meta-emotional orientations may be less prone to self-blame and catastrophic interpretations of emotional experiences, leading them to attribute academic difficulties to situational or controllable factors rather than personal inadequacy. Such attributional patterns are known to support persistence, motivation, and engagement (Saber & Sharifi, 2013; Zakeri

et al., 2023). Prior research has similarly suggested that emotional regulation and meta-emotional beliefs influence attributional thinking, which in turn affects academic behaviors (Mansell et al., 2020; Rahmanian, 2024). The present findings extend this literature by empirically demonstrating this mediation within a comprehensive structural model.

In contrast to positive meta-emotion, negative meta-emotion showed a significant direct negative effect on academic engagement but did not significantly predict attributional styles or indirectly influence engagement through this mediator. This suggests that experiencing negative reactions toward one's own emotions—such as shame, anger, or suppression—directly undermines engagement, possibly by increasing emotional distress and avoidance behaviors. However, these negative meta-emotional responses may not systematically translate into stable attributional patterns, which could explain the absence of a significant indirect effect. Previous studies have linked maladaptive meta-emotional processes to academic burnout, anxiety, and disengagement (Hurrell et al., 2017; Mansell et al., 2020), and the present results corroborate these associations by showing a direct detrimental effect on engagement.

Test anxiety, while negatively associated with academic engagement at the correlational level, did not exert a significant direct effect on engagement in the structural model, nor did it moderate the relationships between metacognitive strategies, meta-emotion, attributional styles, and engagement. This finding suggests that, within the context of the present model, cognitive and meta-emotional resources may play a more central role in explaining engagement than anxiety per se. One possible interpretation is that students' use of metacognitive strategies and their meta-emotional orientations buffer the potential negative impact of test anxiety on engagement. This explanation is partially consistent with research indicating that effective self-regulation and emotional awareness can mitigate the disruptive effects of anxiety on learning processes (Barrientos et al., 2022; Gharib Navaz et al., 2017).

The absence of a moderating effect of test anxiety also contrasts with some previous studies that have reported differential effects of cognitive and emotional variables under varying levels of anxiety (Li et al., 2024; Lu et al., 2024). However, other research has similarly found that when higher-order regulatory processes are taken into account, the unique contribution of anxiety to engagement diminishes (Mambayni, 2014; Rajabzadeh, 2020). This

discrepancy may reflect contextual or developmental differences, as well as methodological variations in how anxiety and engagement are operationalized. In high-pressure educational environments, such as secondary education, students may experience moderate levels of anxiety as normative, with engagement being more strongly driven by their cognitive and emotional regulation capacities than by anxiety intensity alone (Jafari & Shalchi, 2021; Jahanshahi, 2015).

From a broader theoretical perspective, the findings support integrative models of learning that emphasize the dynamic interaction between metacognition, emotion, and motivation. Recent advances in educational psychology have increasingly highlighted the need to move beyond single-variable explanations and adopt multivariate approaches capable of capturing the complexity of students' learning experiences (Ma et al., 2025; Ma, 2023; Xiao et al., 2025). The present study contributes to this line of research by empirically validating a model in which metacognitive learning strategies and meta-emotion jointly influence academic engagement through attributional processes, while also clarifying the limited role of test anxiety as a moderator.

5.   Conclusion

The strong explanatory power of the model, as reflected in the substantial variance explained in academic engagement, underscores the practical relevance of targeting metacognitive and meta-emotional processes in educational interventions. Systematic reviews and meta-analytic evidence suggest that interventions focusing on self-regulation, emotional awareness, and attributional retraining can yield meaningful improvements in engagement and well-being (Toomla et al., 2025; Wenzel et al., 2023). The present findings provide empirical justification for integrating these components within comprehensive intervention frameworks, particularly in adolescent populations.

6.   Limitations & Suggestions

Despite its contributions, this study has several limitations that should be acknowledged. First, the cross-sectional design precludes causal inferences, and the observed relationships should be interpreted as associative rather than directional. Second, the reliance on self-report measures may introduce response biases, such as social desirability or shared method variance. Third, the sample was drawn from a specific educational and cultural context,

which may limit the generalizability of the findings to other regions or educational systems. Fourth, test anxiety was treated as a unidimensional construct, whereas multidimensional models of anxiety might yield more nuanced insights. Finally, although the model included key cognitive and emotional variables, other potentially relevant factors, such as teacher support or classroom climate, were not examined.

Future studies should employ longitudinal or experimental designs to examine the causal pathways among metacognitive strategies, meta-emotion, attributional styles, and academic engagement over time. Researchers are encouraged to test the proposed model across different educational levels and cultural contexts to assess its generalizability. Incorporating multi-method assessments, such as behavioral indicators of engagement or physiological measures of anxiety, could strengthen the validity of findings. Further research should also explore multidimensional conceptualizations of test anxiety and investigate whether specific components of anxiety interact differently with cognitive and meta-emotional processes. Finally, advanced analytical approaches, including person-centered or machine learning methods, may help identify distinct profiles of students based on their metacognitive, emotional, and attributional characteristics.

From a practical standpoint, educators and school psychologists should prioritize the development of students' metacognitive learning strategies through explicit instruction, guided practice, and reflective activities. Educational programs should also incorporate components aimed at fostering positive meta-emotion, such as emotional awareness training and acceptance-based approaches, to help students relate more adaptively to their academic emotions. Attributional retraining interventions can be used to encourage students to interpret academic outcomes in controllable and specific ways, thereby enhancing motivation and engagement. Schools may benefit from integrating these cognitive and emotional components into comprehensive engagement-promotion programs, particularly during high-stakes academic periods, to support students' sustained involvement in learning activities.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

S.N. conceptualized the study, developed the theoretical model, and supervised the overall research process. T.S.J.T. coordinated data collection, managed sampling procedures, and contributed to instrument administration and data preparation. F.S. conducted the statistical analyses, including structural equation modeling and interpretation of the findings, and assisted in reporting the results. J.J.F. contributed to the literature review, methodological refinement, and critical revision of the manuscript. All authors reviewed and approved the final manuscript and are accountable for all aspects of the work.

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