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Exploring the Interplay of Metacognitive Patterns, Emotion Regulation, Error Attribution and Learning Outcomes in Shanghai Primary Students

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ABSTRACT

Metacognitive development, emotion regulation, and error attribution are widely recognized as important psychological factors influencing students' learning; however, their interrelationships remain underexplored among primary school learners, particularly within the Chinese educational context. This study investigates the interplay of metacognitive patterns, emotion regulation, error attribution, and academic achievement among Shanghai primary students. Using a quantitative cross-sectional design, data were collected from 117 students in Grades 2–5 through validated questionnaires measuring emotion regulation, learning strategies, and error attribution, together with students' academic achievement records. Descriptive statistics, Spearman correlation, analysis of variance (ANOVA), and multiple linear regression analyses were conducted using SPSS. The findings revealed that excessive internal error attribution was significantly and negatively associated with academic achievement, suggesting that attributing academic failure to stable internal factors may undermine students' self-efficacy and learning performance. Emotion regulation demonstrated significant relationships with specific dimensions of learning strategies but did not directly predict academic achievement. Gender and grade differences were observed in the execution stage of learning strategies, indicating developmental variations in students' metacognitive behaviors. Although the predictive models explained a relatively small proportion of the variance in academic achievement, the findings contribute to a better understanding of the psychological mechanisms underlying primary students' learning. The study offers practical implications for fostering adaptive error attribution, strengthening metacognitive development, and designing educational interventions that support sustainable learning outcomes in primary education.

Keywords: Metacognition, Emotion Regulation, Error Attribution, Academic Achievement, Primary Education.

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Introduction

Academic errors, defined as honest, avoidable, and unintentional mistakes, including theoretical misunderstandings and incorrect answers that occur in students' academic tasks, are an inevitable core

feedback carrier in students' learning in basic education, and how students reflect or correct such errors greatly impacts the quality of their learning. In teaching practices, primary students commonly repeat the same errors after correction. This problem not only directly affects students' academic achievement but also impedes the development of their learning abilities. Metacognition, which is an individual's ability to monitor and regulate one's own cognitive activities (Flavell, 1979), serves as the core psychological foundation for error reflection. As a key component of metacognitive activities, error attribution in turn influences the implementation of metacognitive strategies and final learning outcomes.

Existing studies show that metacognitive ability is positively correlated with students' academic achievement, and error attribution training can effectively improve students' metacognitive level and learning efficiency (Hua, 2017). Rooted in Weiner's three-dimensional framework of achievement motivation, this theory provides the theoretical foundation for examining how students' attributions of academic errors shape their learning responses in this study. The theory also states that causal explanations for success and failure events determine an individual's subsequent learning behaviors by influencing emotional experiences and expectations. Meanwhile, developmental psychology studies highlight primary school as a critical period for developing metacognition and emotion regulation, with the level of emotional arousal directly affecting their memory and cognitive processing (Davis & Levine, 2013; Thompson, 1994).

However, there are still gaps in current research. First, most existing studies focus on error attribution behaviors of junior and senior high school students, while domestic empirical studies targeting primary students are relatively scarce, especially targeted analyses focusing on primary students in Shanghai. Second, most studies separately explore the impact of metacognition or emotion on learning, and no systematic empirical conclusions have been formed on the interactive effect of metacognitive patterns and emotional arousal, as well as the internal mechanism through which the two jointly affect learning outcomes via error attribution.

This study examines primary students in Shanghai to systematically explore the interactive characteristics of metacognitive patterns and emotional arousal, and elucidate the underlying pathways of error attribution in the process of the two influencing learning outcomes. The research aims to enrich relevant theories of metacognition and emotion regulation in primary school, but also inform practices for error management, metacognitive ability cultivation, and learning emotion intervention in primary schools.

Literature Review

Metacognition

Metacognition is defined as "cognition about cognition", which includes three core components: metacognitive knowledge (one's knowledge about oneself, tasks, strategies, goals, cognitive functions, validity of knowledge, and theory of mind), metacognitive experience (metacognitive feelings, metacognitive judgements, and online task-specific knowledge), and metacognitive skills (monitoring task requirements, planning task execution, regulating cognitive processing in response to difficulties, and evaluating task performance outcomes)(Efklides, 2006; Lin et al., 2021; Xie et al., 2021).

Studies show that metacognition is the most important predictor of academic performance (Xie et al., 2021), as it equips students with the ability to plan, monitor, and adjust their learning strategies based on task demands and ongoing progress (Efklides, 2006). Consequently, metacognition level can significantly and positively predict academic achievement (Cui et al., 2026). Students with high academic achievement usually possess more metacognitive knowledge, have stronger belief in their own problem-solving ability, and exhibit stronger planning, monitoring and self-reflection abilities in the problem-solving process (Xie et al., 2021). As the core component, metacognitive skills runs through the entire process of cognitive activities, and promotes individuals to solve problems successfully through dynamic

regulation of goal confirmation, strategy selection and result inspection (Efklides, 2006; Hua, 2017; Xie et al., 2021).

Emotion Regulation

Emotion regulation also plays a key role in the learning process, which involves the process by which individuals modify the type, intensity and duration of emotions (Davis & Levine, 2013). Studies have distinguished between antecedent-focused regulation strategies such as reappraisal and response-focused regulation strategies such as suppression (Gross, 1998). Reappraisal can effectively reduce negative emotional experiences and enhance children's memory for educational information, while suppression may increase attention to negative affect or physiological activation, which is not conducive to the allocation of learning resources (Davis & Levine, 2013; Gross, 1998). Individuals show flexible choices in emotion regulation. In low-intensity negative situations, people tend to choose reappraisal with higher cognitive cost, while in high-intensity situations, they tend to choose distraction to block emotional processing (Sheppes et al., 2011).

According to the Control-Value Theory, academic achievement emotions are induced by an individual's assessment of the sense of control and value of learning activities, and these assessments are closely related to metacognitive skills (Pekrun, 2006). Metacognitive experiences, such as the sense of difficulty and the sense of confidence, have dual attributes of cognition and affect, and serve as a bridge connecting cognitive monitoring and emotional feedback (Efklides, 2006). Emotion regulation and metacognitive activities jointly affect learning performance. Effective emotion regulation can prevent negative emotions such as anxiety from consuming cognitive resources, thus providing psychological space for high-level metacognitive skills (Keith & Frese, 2005).

Error Attribution

Academic errors are not mere learning obstacles, but key educational events carrying important learning value. When individuals adopt adaptive and reflective cognitive and behavioral strategies such as positive attribution, in-depth review and strategy adjustment to deal with errors, their academic achievement and learning efficacy can be significantly improved. However, the diverse emotional responses such as anxiety, shame and frustration and motivational states such as learned helplessness, avoidance motivation and self-handicapping induced by errors often exert significant hindering or adverse effects on the subsequent learning process (Tulis et al., 2016).

Weiner's Attribution Theory of Achievement Motivation points out that an individual's causal attribution for success or failure in achievement situations can be analyzed according to three core dimensions: locus of control (internal/external), stability (stable/unstable), and controllability (controllable/uncontrollable). The theory also explicitly emphasizes that the dimensional characteristics of attribution, rather than specific attribution content such as ability, effort and luck, are the key variables that shape an individual's subsequent psychology and behaviors (Weiner, 1976). Therefore, exploring the internal correlation between individual error attribution patterns, emotion regulation ability and academic achievement is helpful to reveal how to guide individuals to form positive error attribution patterns, optimize learning strategies through effective emotion regulation and metacognitive skills, and ultimately promote the improvement of their academic achievement and learning efficacy (Hua, 2017; Keith & Frese, 2005; Lin et al., 2021).

Literature Summary

Metacognition, emotion regulation, and error attribution are all core topics in the study of the influencing mechanism of academic achievement in the field of psychology. Existing studies have carried out numerous explorations on the connotation, structure and functional mechanism of the three variables, and also initially explored the internal correlation among them. Metacognitive ability, especially the

level of metacognitive skills, has been confirmed to have a significant positive predictive effect on academic achievement. An individual's emotion regulation ability can exert a significant regulatory effect on their learning motivation and learning behaviors, thereby affecting the improvement of academic achievement. Positive error attribution strategies can effectively improve learning efficacy, while negative emotions and passive motivation induced by errors can form learning obstacles. In addition, studies related to error management training have confirmed that the synergistic effect of emotion regulation and metacognition can guide positive error attribution, optimize learning strategies, and thus improve academic achievement (Hua, 2017; Keith & Frese, 2005; Lin et al., 2021). However, existing studies still have many limitations, which are embodied in the following three aspects. First, most existing studies focus on groups such as middle school students and college students, and lack research on primary students.

Second, most existing studies separately examine the independent effects of metacognition, emotion regulation or error attribution on academic achievement, and few studies incorporate error attribution patterns, emotion regulation ability and learning strategies into the same research framework to systematically explore the internal interaction, mediating or moderating effects among them. Third, most existing studies focus on general academic performance, or separate cognitive model construction and emotion regulation analysis, rather than focusing on error attribution, a high-frequency and specific situation in the daily learning of primary students. Error attribution is a high-frequency cognitive and emotional experience process in the daily learning of primary students. Exploring the internal influencing mechanism of error attribution patterns, emotion regulation ability and learning strategies on academic achievement in this specific situation has important theoretical and practical value. This study takes primary students as the research subjects, incorporates error attribution patterns, emotion regulation ability, learning strategies and academic achievement into the same analytical framework, and systematically discusses the internal correlation and functional paths among multiple variables. It can not only fill the gaps in existing learning psychology research, but also fit the actual learning problems of primary students in error coping. It also provides targeted theoretical support and practical paths for guiding primary students to form positive error attribution patterns and improve their emotion regulation ability and application level of learning strategies in educational practice.

Method

Research Subjects

The subjects of this study are Grade 2 to Grade 5 students of a primary school in Shanghai. The study adopted a stratified sampling method, with one class selected from each grade as the sample, and a total of 121 samples were finally obtained. The final sample comprised 117 students after excluding invalid data, which includes missing responses, straight- lining, or inconsistent responses. The participants were evenly distributed across grades, with male samples accounting for 46.6% and female samples accounting for 53.4%. The gender ratio was balanced, and the sample had good representativeness. Other basic information about the subjects is shown in (Table 1).

Table 1. Demographic Variables

Name	Choices	Frequency	Percentage (%)
Gender	Female	63	53.39
	Male	55	46.61
Grade	Second	31	26.27
	Third	21	17.80
	Fourth	28	23.73
	Fifth	38	32.20
Total		117	100.0

Research Instruments and Scale Selection

This study used scales to measure the error attribution patterns, learning strategies and emotion regulation ability of the research samples, and reflected their metacognitive development level through error attribution patterns and learning strategies. Informed consent was obtained from all participants before the measurement. Emotion Regulation: In terms of emotion regulation, this study adopted the Chinese revised version of the Emotion Regulation Questionnaire developed by Gross and John et al., which includes two dimensions, cognitive reappraisal and expressive suppression, to judge students' emotion regulation patterns. The Cronbach's α coefficient of this scale in this study is 0.751.

Learning Strategy: In this study, the Chinese revised version of the Learning Strategies

Questionnaire developed by the Centre for the Study of Learning and Performance at Concordia University in Montreal, Canada, was used to examine students' learning strategies, and to assess their metacognitive level. This questionnaire consists of 5 sections and assesses students' learning strategies across key dimensions including planning, execution, reflection, success cognition, and task cognition. This can effectively reflect students' metacognitive level. The Cronbach's α coefficient of this scale in this study is 0.747.

Error Attribution: In this study, an error attribution questionnaire adapted for primary students, revised based on the Attribution of College Students' Exam Failure Questionnaire, was used to evaluate the subjects' error attribution strategies and patterns. The questionnaire includes two dimensions: internal attribution and external attribution. It used a 5-point Likert scoring system, with 1 representing "completely inconsistent" and 5 representing "completely consistent". The score of relevant questions within the dimension can be used to judge the error attribution pattern. The Cronbach's α coefficient of this scale in this study is 0.848.

Research Methods

This study adopted a stratified sampling method to select one class from Grade 2 to Grade 5 of a primary school in Shanghai as samples. The survey was conducted after the final examination. Students completed the paper questionnaire under unified guidance in the classroom. The questionnaire covered four modules: basic demographic information of the subjects, error attribution patterns, learning strategies, and emotion regulation ability. Meanwhile, the subjects' final examination scores were collected as the criterion variable of academic performance for subsequent analysis.

After data collection, manual verification and logical inspection were conducted to eliminate incomplete or invalid data to ensure data quality. Subsequently, Statistical Product and Service Solutions software (SPSS) was used for data analysis, and the analysis methods included descriptive statistics, analysis of variance, correlation analysis, and multiple linear regression. During the research, it was ensured that all subjects participated voluntarily, and data confidentiality and ethical norms were strictly followed, so as to guarantee the reliability and validity of the research conclusions.

Research Results

Correlation Analysis of Each Variable

Spearman correlation analysis was used to explore the correlation between academic achievement of primary students in Shanghai and emotion regulation, learning strategies, and error attribution patterns, and to analyze the impact of demographic variables on each research variable.

The results of correlation analysis showed that only internal attribution and the reflection stage of learning strategies were significantly and negatively correlated with academic achievement (see Table 2). It indicates that low-achieving students tend to blame themselves for academic failures, while excessive or maladaptive reflection may trigger learning anxiety and self-doubt, ultimately hindering

academic achievement. It is important to note that these findings, as cross-sectional correlational data, only demonstrate associations and do not imply causation.

Table 2. Correlation Analysis of Academic Achievement and Variables

Variables	r	P
Cognitive Reappraisal	-0.107	0.253
Expressive Suppression	-0.034	0.717
Planning Stage	-0.009	0.921
Execution Stage	-0.001	0.990
Reflection Stage	-0.195	0.036*
Success Cognition	-0.037	0.692
Task Cognition	-0.077	0.410
Internal Attribution	-0.270	0.003**
External Attribution	-0.125	0.182
* p<0.05 ** p<0.01		

The results of correlation analysis of demographic variables showed that grade was significantly and positively correlated with cognitive reappraisal and the execution stage of learning strategies (see Table 3). No other significant correlations were observed between grade level and the remaining variables. It indicates that primary school students, with the increase of grade, their level of cognitive reappraisal and the execution stage tended to increase.

Table 3. Correlation Analysis of Grade and Variables

Variables	r	P
Cognitive Reappraisal	0.201	0.031*
Expressive Suppression	0.054	0.564
Planning Stage	0.141	0.131
Execution Stage	0.306	0.001**
Reflection Stage	-0.014	0.885
Success Cognition	-0.106	0.257
Task Cognition	-0.091	0.332
Internal Attribution	-0.142	0.127
External Attribution	-0.143	0.125
* p<0.05 ** p<0.01		

ANOVA on Learning Strategies by Demographic Variables

This study conducted ANOVA to explore the impact of gender and grade (age) on the learning strategies of primary students. The results showed that gender had a significant difference in the "execution stage" dimension of learning strategies. Specifically, girls scored significantly higher than boys in the execution stage. This indicated that in the sample of this study, girls outperformed boys in execution-related performances such as classroom concentration, task decomposition and continuous progress monitoring (see Table 4).

Table 4. ANOVA on Learning Strategies by Gender

	Gender (Mean ±Standard Deviation)		F	p
	Female(N=61)	Male (N=56)		
Planning Stage	3.06±0.42	2.94±0.53	1.952	0.165
Execution Stage	3.08±0.50	2.84±0.65	4.976	0.028*

	Gender (Mean ±Standard Deviation)		F	p
	Female(N=61)	Male (N=56)		
Reflection Stage	2.46±0.50	2.47±0.39	0.002	0.963
Success Cognition	1.88±0.52	1.82±0.49	0.410	0.523
Task Cognition	2.52±0.42	2.46±0.44	0.687	0.409
* p<0.05 ** p<0.01				

The results also showed that grade level had a significant effect on the execution stage of learning strategies. Further comparison of the mean scores across grade groups revealed that third-grade students scored higher on the execution stage than students in any other grade, with a dramatic increase from second-grade to third-grade. It is speculated that this phenomenon is related to the first increase in the difficulty of subjects in Grade 3, and students invested more monitoring costs in the learning execution stage to adapt to the change in difficulty. In contrast, no significant grade differences were found for the planning stage, reflection stage, success cognition, or task cognition. Although the reflection stage showed a marginal trend, this difference did not reach statistical significance (see Table 5).

Table 5. ANOVA on Learning Strategies by Grade

	Grade (Mean ±Standard Deviation)				F	p
	Second	Third	Fourth	Fifth		
Planning Stage	2.93±0.49	3.12±0.38	3.00±0.44	2.99±0.55	0.641	0.59
Execution Stage	2.75±0.64	3.33±0.41	2.92±0.54	2.96±0.57	4.643	0.004**
Reflection Stage	2.37±0.44	2.30±0.40	2.56±0.32	2.56±0.54	2.382	0.073
Success Cognition	1.94±0.44	1.85±0.51	1.87±0.48	1.77±0.57	0.711	0.547
Task Cognition	2.56±0.47	2.43±0.35	2.51±0.42	2.46±0.44	0.473	0.702
* p<0.05 ** p<0.01						

Analysis of Predictors of Learning Strategies

Regression Analysis of Emotion Regulation on Learning Strategies

This study used regression models with cognitive reappraisal and expressive suppression as independent variables and five learning strategy dimensions as dependent variables. The results showed that expressive suppression significantly and negatively predicted the planning stage (β=-0.198, p=0.031), while it significantly and positively predicted the reflection stage (β=0.224, p=0.016). But its effects on the execution stage, success cognition, and task cognition were not statistically significant. By contrast, cognitive reappraisal showed no predictive effects across the five dimensions. However, these results should be interpreted with caution due to the limited explanatory power of the models, suggesting that other unmeasured factors may play a larger role in shaping students' learning strategies (see Table 6).

Table 6. Regression Analysis of Emotion Regulation on Learning Strategies

Dependent Variables	Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
		B	SE	Beta			VIF	Tolerance
Planning Stage	Constant	2.872	0.216	-	13.268	0	-	-
	Cognitive Reappraisal	0.074	0.039	0.17	1.877	0.063	1.002	0.998

Dependent Variables	Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
		B	SE	Beta			VIF	Tolerance
Execution Stage	Expressive Suppression	-0.062	0.029	-0.198	-2.185	0.031 *	1.002	0.998
	R2 = 0.065, adjusted R2 = 0.049, F(2,114) = 3.994, p = 0.021, DW = 2.003, N = 117							
	Constant	2.994	0.268	-	11.177	0	-	-
	Cognitive Reappraisal	0.038	0.049	0.072	0.776	0.440	1.002	0.998
	Expressive Suppression	-0.058	0.035	-0.152	-1.648	0.102	1.002	0.998
	R2 = 0.027, adjusted R2 = 0.01, F(2,114) = 1.612, p = 0.204, DW = 1.878, N = 117							
Reflection Stage	Constant	2.332	0.206	-	11.338	0	-	-
	Cognitive Reappraisal	-0.022	0.037	-0.055	-0.6	0.549	1.002	0.998
	Expressive Suppression	0.067	0.027	0.224	2.45	0.016 *	1.002	0.998
	R2 = 0.052, adjusted R2 = 0.035, F(2,114) = 3.128, p = 0.048, DW = 1.886, N = 117							
Success Cognition	Constant	2.082	0.233	-	8.917	0	-	-
	Cognitive Reappraisal	-0.016	0.043	-0.036	-0.387	0.700	1.002	0.998
	Expressive Suppression	-0.042	0.031	-0.127	-1.372	0.173	1.002	0.998
	R2 = 0.018, adjusted R2 = 0.001, F(2,114) = 1.038, p = 0.358, DW = 1.83, N = 117							
Task Cognition	Constant	2.678	0.195	-	13.723	0	-	-
	Cognitive Reappraisal	-0.059	0.036	-0.152	-1.65	0.102	1.002	0.998
	Expressive Suppression	0.026	0.026	0.093	1.008	0.315	1.002	0.998
	R2 = 0.031, adjusted R2 = 0.014, F(2,114) = 1.807, p = 0.169, DW = 1.896, N = 117							

* p<0.05 ** p<0.01

Regression Analysis of Error Attribution on Learning Strategies

This study used regression models with internal attribution and external attribution as independent variables and five learning strategy dimensions as dependent variables. The results showed that internal attribution significantly and negatively predicted the planning and execution stage ($p<0.05$), while it significantly and positively predicted the reflection stage ($p<0.01$). By contrast, external attribution had no significant predictive effect on the five learning strategy dimensions. Specifically, the regression models for the planning, execution, and reflection stages were all statistically significant, whereas those for success cognition and task cognition were not significant. However, these results should be interpreted with caution due to the limited explanatory power of the models, suggesting that other unmeasured factors may play a larger role in shaping students' learning strategies (see Table 7).

Table 7. Regression Analysis of Error Attribution on Learning Strategies

Dependent Variables	Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
		B	SE	Beta			VIF	Tolerance
Planning	Constant	3.533	0.145	-	24.429	0	-	-

Dependent Variables	Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
		B	SE	Beta			VIF	Tolerance
Stage	Internal Attribution	-0.212	0.081	-0.282	-2.607	0.010 *	1.505	0.664
	External Attribution	-0.071	0.08	-0.097	-0.892	0.374	1.505	0.664
	R2 = 0.121, adjusted R2 = 0.105, F(2,113) = 7.742, p = 0.0, DW = 2.012, N = 116							
	Constant	3.413	0.177	-	19.235	0	-	-
Execution Stage	Internal Attribution	-0.318	0.1	-0.351	-3.194	0.002 * *	1.505	0.664
	External Attribution	0.088	0.098	0.098	0.894	0.373	1.505	0.664
	R2 = 0.093, adjusted R2 = 0.077, F(2,113) = 5.788, p = 0.004, DW = 1.963, N = 116							
	Constant	2.007	0.137	-	14.622	0	-	-
Reflection Stage	Internal Attribution	0.227	0.077	0.32	2.941	0.004 * *	1.505	0.664
	External Attribution	0.014	0.076	0.021	0.191	0.849	1.505	0.664
	R2 = 0.111, adjusted R2 = 0.095, F(2,113) = 7.028, p = 0.001, DW = 1.727, N = 116							
	Constant	1.976	0.162	-	12.2	0	-	-
Success Cognition	Internal Attribution	-0.085	0.091	-0.107	-0.931	0.354	1.505	0.664
	External Attribution	0.022	0.09	0.028	0.246	0.806	1.505	0.664
	R2 = 0.009, adjusted R2 = -0.009, F(2,113) = 0.498, p = 0.609, DW = 1.869, N = 116							
	Constant	2.449	0.135	-	18.092	0	-	-
Task Cognition	Internal Attribution	0.036	0.076	0.054	0.47	0.640	1.505	0.664
	External Attribution	-0.018	0.075	-0.028	-0.244	0.808	1.505	0.664
	R2 = 0.002, adjusted R2 = -0.016, F(2,113) = 0.111, p = 0.895, DW = 2.013, N = 116							

* p<0.05 ** p<0.01

Regression Analysis of Academic Achievement and Each Variable

Regression Analysis of Emotion Regulation on Academic Achievement

This study used a regression model with cognitive reappraisal and expressive suppression as independent variables and academic achievement as the dependent variable. The results showed that the overall predictive effect of emotion regulation on academic achievement was not significant. Cognitive reappraisal showed a negative predictive trend toward academic achievement, but this effect was not statistically significant. However, these results should be interpreted with caution due to the limited explanatory power of the model, suggesting that other unmeasured factors may play a larger role in impacting students' academic achievement (see Table 8).

Table 8. Regression Analysis of Emotion Regulation on Academic Achievement

Variables	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
	B	SE	Beta			VIF	Tolerance
Constant	90.838	5.209	-	17.439	0.000	-	-
Cognitive reappraisal	-1.549	0.948	-0.151	-1.633	0.105	1.002	0.998
Expressive suppression	0.017	0.688	0.002	0.025	0.980	1.002	0.998
R^2=0.023, Adjusted R^2=0.006, F(2, 114)=1.335, p=0.267, DW=2.05, N=117							
* p <0.05 ** p <0.01							

Regression Analysis of Learning Strategies on Academic Achievement

This study used a regression model with five learning strategy dimensions as independent variables and academic achievement as the dependent variable. The results showed that the overall predictive effect of the model was not significant, and the five learning strategy variables could only explain 4.9% of the variance of academic achievement (see Table 9). The results of correlation analysis showed that the reflection stage strategy had a significant negative impact on academic achievement (see Table 2). It is speculated that the reason for this result is that among primary students, excessive and maladaptive learning reflection is likely to trigger excessive anxiety about errors, which in turn interferes with academic achievement.

Table 9. Regression Analysis of Learning Strategies on Academic Achievement

	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
	B	SE	Beta			VIF	Tolerance
Constant	99.361	9.372	-	10.602	0.000	-	-
Planning Stage	-0.720	2.814	-0.031	-0.256	0.798	1.669	0.599
Execution Stage	1.141	2.323	0.059	0.491	0.624	1.673	0.598
Reflection Stage	-3.904	2.552	-0.157	-1.530	0.129	1.222	0.819
Success Cognition	-1.453	2.273	-0.068	-0.639	0.524	1.312	0.762
Task Cognition	-1.567	3.170	-0.054	-0.494	0.622	1.386	0.721
R^2=0.049, Adjusted R^2=0.006, F(5, 111)=1.139, p=0.344, DW=1.917, N=117							
* p <0.05 ** p <0.01							

Regression Analysis of Error Attribution on Academic Achievement

This study used a regression model with internal attribution and external attribution as independent variables and academic achievement as the dependent variable. The results showed that the error attribution model had a statistically significant impact on academic achievement, though it explained only 5.7% of the variance in academic achievement. Specifically, internal attribution significantly and negatively predicted academic achievement, meaning the more students tended to attribute errors to internal factors, the lower their academic achievement. In contrast, external attribution had no significant impact on academic achievement, suggesting that although attributing failure to external factors (e.g., luck or environment) is prevalent, it does not significantly affect actual academic achievement (see Table 10).

Table 10. Regression Analysis of Error Attribution on Academic Achievement

	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnostics	
	B	SE	Beta			VIF	Tolerance
Constant	90.273	3.532	-	25.557	0.000	-	-
Internal Attribution	-4.885	1.983	-0.276	-2.464	0.015*	1.505	0.664
External Attribution	1.412	1.953	0.081	0.723	0.471	1.505	0.664
R^2=0.057, Adjusted R^2=0.04, F(2, 113)=3.408, p=0.037, DW=1.836, N=116							
* p <0.05 ** p <0.01							

Discussion

This study systematically explored the correlations among emotion regulation, error attribution patterns, learning strategies, and academic achievement, as well as the influencing characteristics of demographic variables, using correlation analysis, analysis of variance (ANOVA), and regression analysis. The research results verified some theoretical hypotheses and revealed unique developmental patterns of primary students, providing empirical reference for understanding the functional mechanism of psychological factors in primary school learning.

A core finding was the significant and negative predictive effect of internal attribution on academic achievement. This result seems to be contrary to Weiner's Attribution Theory that controllable internal attribution promotes individual academic performance, but it can be reasonably explained in combination with the psychological development characteristics of primary students. The self-cognitive system of primary students is not yet fully developed, and their interpretation of internal factors is mostly limited to uncontrollable dimensions such as innate ability. If students excessively attribute errors to insufficient ability, they may develop a sense of learned helplessness, which in turn may induce a decline in self-efficacy and intrinsic learning motivation.

This explanatory mechanism is further validated by the significant positive prediction of internal attribution on the reflection stage and the significant negative correlation between the reflection stage and academic achievement, which collectively suggest the adverse influence of internal attribution on primary students' academic achievement. It is important to note that this study used only one final exam score to measure academic achievement, so the present findings cannot fully establish the predictive effect of internal attribution on academic achievement. Furthermore, the low explanatory power of the regression models indicates that internal attribution explains only a small portion of variance in academic achievement.

Therefore, further longitudinal studies are needed to verify these relationships. However, the findings reflect that primary students are more inclined to make internal attributions when facing lower academic achievement. This also indicates that primary students are in a relatively healthy attribution state on the whole. According to the core conclusion of Weiner's Attribution Theory, this kind of attribution characteristic also means that students have higher potential for improvement in achievement performance in the subsequent learning process.

Second, the predictive effect of emotion regulation on learning strategies showed obvious dimensional specificity. Expressive suppression significantly and negatively predicted the planning stage, while it significantly and positively predicted the reflection stage. By contrast, cognitive reappraisal showed no significant predictive effects on any learning strategy dimensions. This result reflects the differentiated impacts of emotion regulation strategies on learning processes. Specifically, expressive suppression may constrain proactive learning planning but prompt post-task reflective behaviors in primary students. Although expressive suppression is often regarded as a maladaptive

strategy, moderate use may help students reduce emotional interference and focus on error reflection. However, emotion regulation had no significant predictive effect on academic achievement in this study, revealing that the role of emotion regulation in primary school is more evident in behavioral regulation during the learning process rather than direct academic performance gains.

This study also found that the impact of demographic variables on learning strategies mainly focused on the execution stage. In terms of gender differences, girls scored significantly higher than boys in the execution stage, which is related to the differences in psychological development characteristics between male and female students in primary school. In terms of grade differences, third-grade students scored significantly higher than students in other grades in the execution stage, showing a dramatic increase from second-grade to third-grade. This change may be highly consistent with the escalating academic demands in primary school. As a transitional stage from the lower grades to the middle grades of primary school, Grade 3 witnesses the first significant increase in the difficulty of subject knowledge. Students need to invest more cognitive and behavioral energy to monitor the learning process and complete learning tasks, thus promoting the rapid development of execution ability. Additionally, grade was significantly positively correlated with cognitive reappraisal, consistent with the developmental law of emotional and metacognitive abilities in primary students.

Finally, the overall predictive power of learning strategies on academic achievement was weak, and only the reflection stage showed a significant negative correlation with academic achievement in the correlation analysis. This result suggests that the application of learning strategies by primary students remains superficial. They have a vague understanding of strategies (such as planning, monitoring, and reflection) and have not yet transformed them into an efficient learning ability, so it is difficult to directly promote improvements in short-term academic achievement. The negative impact of the reflection stage may stem from the fact that some students excessively dwell on the errors themselves in the reflection process, rather than summarizing the causes of errors and extracting solutions. This not only can reduce learning efficiency but also easily generates negative emotions due to excessive entanglement with failures, which in turn interferes with learning performance.

Conclusion

Regression Analysis of Error Attribution on Academic Achievement

This study systematically examines the interplay of emotion regulation, learning strategies, error attribution, and academic achievement among Shanghai primary students, aiming to address research gaps in the existing literature. The key findings of the study are summarized as follows. First, primary students have not yet developed a mature self-cognitive system. Their interpretation of internal factors is mostly confined to uncontrollable dimensions such as innate ability.

Excessive internal attribution of errors significantly and negatively predicts academic achievement, likely because it induces learned helplessness and reduces self- efficacy. Although an internal attribution tendency reflects students' sense of responsibility for academic outcomes, maladaptive internal attribution hinders learning. These results highlight the need to guide students toward controllable attributions (e.g., effort and strategy) rather than stable internal traits.

Second, the influence of emotion regulation among primary students is more evident in students' behavioral control than in direct academic achievement. Specifically, expressive suppression negatively predicts the planning stage but positively predicts the reflection stage of learning strategies, whereas cognitive reappraisal shows no significant predictive effects on any learning strategy dimension. Last but not least, the impact of demographic variables on learning strategies is primarily concentrated in the execution stage. Both gender and age (grade) show statistical significance in the execution stage, with female participants having a significantly higher score than males, and the third-grade scoring the highest among all.

Research Limitation and Prospects

Although this study systematically explored the correlation of emotion regulation, learning strategies, error attribution, and academic achievement among Shanghai primary students, it still has certain limitations. First, a total of 121 questionnaires were collected, and only 117 valid samples were finally included. The relatively small sample size may compromise the stability of some research findings. Second, academic achievement was measured using only a single final examination score, which may not fully represent students' long-term learning outcomes. Third, the overall explanatory power of the research model is limited. The variance explanation rates of emotion regulation, learning strategies, and error attribution on academic achievement are all low, reflecting that the influencing factors of academic achievement are highly complex. In addition to the psychological factors focused on in this study, family education and school teaching may also play important roles. Fourth, this study adopted a cross- sectional research design, which can only reveal the correlation between variables, but cannot clarify the causal relationship and functional paths between variables.

In view of the above limitations, future research can be improved in the following ways. First, a longitudinal research design could be used to track developmental changes of primary students, dynamically analyzing the interaction mechanism among emotion regulation, learning strategies, error attribution, and academic achievement. Second, multiple indicators of academic achievement (e.g., multiple exams, formative assessment) should be adopted to increase reliability. Third, error attribution intervention programs can be designed and tested to examine whether training in adaptive attribution improves learning strategies and academic performance.

In conclusion, the metacognitive perspective offers a unique insight into primary school students' attribution and emotions. This perspective can yield further and more insightful findings that not only broaden our understanding of cognitive development in learning-age children, but also provide possible solutions to long-standing learning problems among primary school students.

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