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Dynamic changes in achievement emotions under policy intervention: a longitudinal data analysis of the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract. This study investigated the dynamic changes in five Achievement Emotions—enjoyment, pride, anger, anxiety, and shame—among compulsory education students in the Guangdong-Hong Kong-Macao Greater Bay Area before and after the implementation of the "Double Reduction" policy in China. Based on longitudinal data collected from multiple waves between 2017 and 2025, repeated measures ANOVA was employed to analyze emotional trajectories. The results showed that in the initial stage of policy implementation, students' enjoyment significantly increased and anger significantly decreased. However, in the later stage, anxiety continued to rise, while shame and anger showed signs of resurgence, indicating that emotional improvement was not linear or sustained. The trajectories of the five emotions exhibited diverse patterns, including V-shaped, Λ-shaped, U-shaped, L-shaped, and continuously increasing trends. This study reveals the complex effects of policy intervention on students' achievement emotions and highlights the need for educational practices to address students' latent stress and emotional regulation needs beyond simply reducing academic burden.

Keywords: Guangdong-Hong Kong-Macao Greater Bay Area, double reduction policy, achievement emotions, longitudinal study, emotional change

1. Introduction

In recent years, students' achievement emotions have increasingly become a research hotspot in the field of educational psychology. Achievement emotions refer to the emotions experienced by students in learning activities, including various affective manifestations such as enjoyment, pride, anxiety, anger and shame [1]. These emotions not only affect students' learning motivation and strategies, but also are closely related to their academic achievement [2, 3]. With the in-depth research on emotions, academic circles have gradually realized that achievement emotions are not immutable, but present complex characteristics of both stability and variability in the temporal dimension [4, 5]. Some studies have revealed the systematic changes in achievement emotions during the transition between academic stages, especially at the critical turning point

from primary school to junior high school, phenomena such as the decline in students' enjoyment, fluctuation in boredom and rise in anxiety are common [6, 7]. However, emotional changes are not only affected by individual development and learning environment, but also may be influenced or shaped by macro-level educational policies.

In 2021, the Ministry of Education of China issued the *Opinions on Further Reducing the Homework Burden and Off-Campus Training Burden of Students in the Compulsory Education Stage* (hereinafter referred to as the "Double Reduction" Policy), which focused on issues such as "safeguarding students' right to rest", "effectively alleviating the anxiety of parents and students, and promoting students' all-round development and healthy growth". After the implementation of the policy, the structure of students' learning and daily life has changed significantly, and achievement emotions have fluctuated accordingly. Sun's research initially found that the "Double Reduction" Policy has alleviated the anxiety of lower-grade students to a certain extent and improved their psychological enjoyment [8]; however, upper-grade students are faced with fluctuations in academic performance and adaptation difficulties. This indicates that the policy's impacts on different groups and different emotional dimensions may be heterogeneous. Nevertheless, most existing studies focus on the immediate responses in the initial stage of policy implementation, lacking follow-up investigations on its long-term emotional effects, especially the systematic depiction of emotional change trajectories.

Accordingly, this study aims at investigating the changing trends in students' achievement emotions before and after the implementation of the "Double Reduction" policy, utilizing longitudinal data collected from 2017 to 2025. Focusing on these five achievement emotions—enjoyment, pride, anger, anxiety, and shame, this study examined both their short-term fluctuations and long-term trajectories. By integrating longitudinal data with key policy time points, the research adopted an analytical framework that simultaneously considered temporal effects and contextual effects to address the following questions:

(1) Have the achievement emotions of students in the Guangdong-Hong Kong-Macao Greater Bay Area undergone significant changes following the policy intervention?

(2) Are the change trajectories of different emotions asynchronous, and if so, what are their respective patterns?

(3) Do students' emotional changes in the Guangdong-Hong Kong-Macao Greater Bay Area reflect a complex pattern characterized by both positive improvements and emerging challenges?

2. Achievement emotions and their stabilities

2.1. The concept and classification of achievement emotions

Achievement emotions refer to the emotions directly related to individuals' academic behaviors and achievement outcomes. For example, the joy generated in learning, the boredom experienced in classroom teaching, and the frustration or anger when encountering difficult problems all fall within the scope of achievement emotions. Previous studies on achievement emotions mostly focused on academic outcomes, and later it was clearly defined that achievement emotions should take both academic behaviors and academic outcomes into account. There are various classification methods for achievement emotions in academic circles. First, according to the concept of achievement emotions, achievement emotions can be divided into two categories: (1) Activity emotions, which describe the emotions occurring during learning activities; (2) Outcome emotions, which describe individuals' emotions when these activities produce certain results [9]. Outcome emotions also include prospective or anticipatory emotions (e.g., the desire for success, anxiety about failure) and retrospective emotions (e.g., pride or self-blame after receiving feedback on academic achievement). Second, according to the psychological characteristics of achievement emotions, they can be

divided into another two categories: (1) State achievement emotions, referring to transient emotions occurring in specific situations and at specific time points, such as test anxiety experienced by an individual before a certain exam. (2) Trait achievement emotions, referring to habitual emotions formed by individuals when state emotions related to academic activities or outcomes occur repeatedly. Moreover, trait achievement emotions are also related to specific disciplinary situations, for example, trait mathematical emotions refer to the habitual mathematical affect experienced and formed by students in mathematics learning. Third, in terms of emotional valence, achievement emotions are usually divided into four categories: positive emotions (e.g., enjoyment, pride), neutral emotions (e.g., relaxation), negative emotions (e.g., anxiety, anger, boredom) and mixed emotions (e.g., hope mixed with anxiety). This classification system has laid a conceptual foundation for subsequent longitudinal research on emotions.

2.2. The stability and variability of achievement emotions

There are different views in academic circles on whether achievement emotions have temporal stabilities. Some researchers emphasize the persistence of emotions and believe that certain emotional states are not easy to change. Baker et al. found in their research on emotions in computer-assisted learning environments that boredom is a fairly persistent and unchangeable emotional state [4]. Sinclair et al. further pointed out that the probability of boredom transitioning to other emotions is low, making it one of the most worrying emotional problems, and the transition between emotions usually does not occur directly between two extremes [10]. Hou and Chen's research also showed that positive emotions and neutral emotions have a certain degree of temporal stability in online learning environments [11].

However, another group of researchers pay more attention to the variability of emotions. Tze et al. examined the changes in four emotions (anxiety, boredom, guilt and relaxation) over four months, and the results showed that boredom and guilt presented two changing patterns of "mitigating type" and "aggravating type" with certain regularity [3]; anxiety, on the other hand, showed great volatility and complexity, and although relaxation is a decompressive emotion, it can maintain learners' subsequent learning motivation. Hawrot conducted a four-year follow-up study on learning enjoyment and found that students' enjoyment showed a continuous declining trend from the fifth grade to the ninth grade [12]. This finding is consistent with the research results of different academic stages in other countries [2, 13, 14], providing empirical evidence for understanding the predictability and intervention possibility of emotional changes.

2.3. The diversity of emotional combinations and change trajectories

In recent years, researchers have gradually shifted from single-emotion analysis to comprehensive investigation of emotional combinations and change trajectories. Tze et al. identified nine emotional transition paths in higher education and computer-assisted learning environments, among which three are stable types and six are transitional types, involving changes from positive to negative, positive to mixed, negative to positive, negative to mixed, mixed to positive and mixed to negative [3]. The study further found that different emotional change trajectories have important impacts on academic achievement: students with stable positive emotions have significantly better academic performance than other types, and some transition trajectories involving negative emotions may also be related to relatively good academic performance. The researchers speculated that moderate negative emotions may arouse students' alertness and behavioral adjustment, a view that echoes Weiner's attribution theory—some negative emotions such as guilt and anger can become motivational emotions that stimulate positive achievement [15].

Rentzios et al. adopted a person-centered cluster analysis method to conduct a joint investigation on the Achievement Emotions, emotional regulation, academic motivation and approaches to learning of 509 Greek

university students, and identified three typical learning patterns: "anxious yet well-organized learners", "deep, happy and intrinsically motivated learners" and "alienated, bored and emotion-suppressed learners" [16]. The three types of learners showed systematic differences in affect, motivation and learning strategies, and these differences were significantly related to academic performance. Among them, "deep, happy and intrinsically motivated learners" had the highest academic performance, while "alienated, bored and emotion-suppressed learners" had the lowest. This study reveals that academic performance cannot be the only criterion for judging students' achievement emotions, and there is an asynchronous and complex relationship among affect, motivation and learning strategies.

In addition, the dynamic evolution of emotions in the short term has also begun to attract attention. Zheng et al. found that students' curiosity and confusion gradually decreased in the three stages of forethought, performance and self-reflection in self-regulated learning, while boredom increased significantly in the self-reflection stage [17]. The study also identified three emotional combinations: "curiosity-positive type", "confusion-negative type" and "moderate-to-low intensity type". Among them, students with the curiosity-positive type maintained a relatively stable emotional state in all stages, while students with the confusion-negative type and moderate-to-low intensity type presented specific transitional patterns.

2.4. Influencing factors of achievement emotional changes

The changes in achievement emotions are affected by multiple factors including personal factors, teaching environment and socio-cultural background. From the perspective of personal factors, Tze et al. believe that students' learning abilities will affect their emotional change trajectories: the stronger the learning ability, the more learning methods and skills students master, and the easier it is for them to be in a state of low boredom and moderate anxiety [5]. In addition, students' self-concept and self-efficacy have also been proven to have a significant impact on achievement emotions [18, 19].

From the perspective of teaching environment, the selection of educational technology and teaching platforms will regulate students' emotional experience. Studies by Yang et al., Taub et al., and Ahn & Harle found that digitally gamified learning environments can alleviate students' anxiety and improve their academic performance [20-22]. A systematic review by Tan et al. further confirmed that online learning environments are an important factor affecting the changes in students' learning emotions [23]. Tze also pointed out that the greater the autonomy provided by curriculum content, the higher the students' enjoyment [5].

From the perspective of macro-level social context, Su's research found that the "Double Reduction" Policy has positive effects on improving students' psychological enjoyment, promoting social interaction and time management, especially alleviating the anxiety of lower-grade students [8]; however, upper-grade students and those preparing for important examinations have experienced fluctuations in academic performance and adaptation difficulties, reflecting the heterogeneity of the policy's impacts on the emotions and academic performance of different groups. In addition, DeCuir-Gunby & Williams-Johnson emphasized that cultural differences are also an important factor affecting students' emotions. Ethnic and cultural diversity has increasingly become a key force shaping the affective climate in school education, and cultural dimensions have become an important perspective that cannot be ignored in understanding students' Achievement Emotions [24].

To sum up, existing studies in academic circles have accumulated certain achievements in the classification, variability and influencing factors of Achievement Emotions. Nevertheless, there are still the following research gaps: First, most studies focus on emotional changes in the natural development process, and few pay attention to the impact and reshaping of macro-level policy intervention on Achievement Emotions; Second, although some studies involve emotional change trajectories, long-term follow-up data are

relatively scarce, making it difficult to reveal the sustained evolutionary trends of emotions; Third, research on the emotional effects under the background of the "Double Reduction" Policy is still in its infancy, lacking multi-time point quantitative evaluation. Accordingly, this study uses longitudinal follow-up data from 2017 to 2025 to examine the changing trends of five achievement emotions (enjoyment, pride, anger, anxiety, and shame) of students before and after the implementation of the "Double Reduction" Policy, attempting to reveal the dynamic evolutionary laws of achievement emotions under policy intervention, and provide empirical evidence for policy optimization and emotional intervention.

3. Research methods

3.1. Participants

Using a random sampling approach, this study selected one school from each of four cities in the Guangdong-Hong Kong-Macao Greater Bay Area—Shenzhen (including the Shenzhen-Hong Kong Cooperation Zone), Guangzhou, Dongguan, and Foshan—to participate in the survey. Meanwhile, the *Questionnaire on Achievement Emotions of Primary and Secondary School Students in the Greater Bay Area* issued in this study was distributed through the online link of Wenjuanxing, an online questionnaire platform. A total of 1323 students participated in the online questionnaire survey. The specific descriptive information of the research participants is shown in Table 1:

Table 1. Descriptive statistics of the participants

Year	Statistical Variable	Level	Frequency	Percentage
2017	Gender	Male	113	8.5%
		Female	105	7.9%
	Grade	Primary	0	/
		Secondary	218	16.5%
	School Location	Shenzhen-Hong Kong Cooperation Zone	218	2.1%
	School Type	Public School	218	16.5%
		Private School	0	/
2022	Gender	Male	150	11.3%
		Female	204	15.4%
	Grade	Primary	354	26.8%
		Secondary	0	/
	School Location	Shenzhen	28	2.1%

Table 1. Continued

2022	School Location	Dongguan	136	10.3%
		Guangzhou	122	9.2%
		Foshan	68	5.1%
	School Type	Public School	286	21.6%
		Private School	68	5.1%
2024	Gender	Male	139	10.5%
		Female	137	10.4%
	Grade	Primary	276	20.9%
		Secondary	0	/
	School Location	Shenzhen-Hong Kong Cooperation Zone	276	20.9%
	School Type	Public School	276	20.9%
		Private School	0	/
2025	Gender	Male	256	19.3%
		Female	219	16.6%
	Grade	Primary	226	17.1%
		Secondary	249	18.8%
	School Location	Shenzhen-Hong Kong Cooperation Zone	134	10.1%
		Yangjiang	341	25.8%
	School Type	Public School	475	35.9%
		Private School	0	/

3.2. Measures

This study adopted the subscale of the Achievement Emotion Questionnaire (AEQ) developed by Pekrun et al. to assess students' achievement emotions [9]. The original AEQ-M includes 5 dimensions with a total of 37 items. This study used all 37 items in the AEQ-M to evaluate students' achievement emotions in learning, including enjoyment (e.g., "I answer math exam questions very carefully because I expect to get good grades"), pride (e.g., "I think I can be proud of my mathematical knowledge"), anger (e.g., "I am so angry that I want to throw my math homework out the window"), etc. Participants were asked to rate each item on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Previous studies have shown that the AEQ has good psychometric properties [25].

3.3. Data analysis methods

SPSS 16.0 was used for reliability analysis to test the validity of the questionnaire, and Amos 17.0 was used for confirmatory factor analysis. Reliability tests were conducted on each dimension of the questionnaire and the total scale, with internal consistency reliability as the reliability index and Cronbach's α coefficient as the test method. Secondly, since this study conducted multiple measurements on the same group of participants at four time points, one-way repeated measures analysis of variance was used to test whether there were significant changes in the five Achievement Emotions in the temporal dimension. On the basis of statistical significance (p-value), this study further calculated partial eta-squared (η^2) as an effect size index to evaluate the degree of the temporal factor's impact on emotional changes.

4. Results

4.1. Short-term, sustained and baseline comparative analyses

This study attempted to explore the short-term effects, sustained effects and overall baseline comparison of policy implementation through comparative analysis of three key time periods before and after the implementation of the "Double Reduction" Policy.

Table 2. Short-term, sustained and baseline comparisons of the five achievement emotions

Comparison Type	Emotional Dimension	Pre-test Mean	Post-test Mean	Mean Difference	p-value	Result Interpretation
Short-term Effects 2022 vs 2024	Enjoyment	2.5214	3.2874	-0.766	$p < 0.001$	Enjoyment increased significantly
	Anger	3.7333	2.0842	1.649	$p < 0.001$	Anger decreased significantly
Sustained Effects 2024 vs 2025	Enjoyment	3.2874	3.3411	-0.054	$p = 0.434$	Enjoyment increased slightly
	Anger	2.0842	2.1797	-0.096	$p = 0.171$	Anger rebounded slightly
	Pride	3.1812	3.4074	-0.226	$p = 0.001$	Pride increased significantly
	Anxiety	2.6208	2.9196	-0.299	$p < 0.001$	Anxiety rebounded and increased significantly
	Shame	2.1639	2.4237	-0.260	$p < 0.001$	Shame rebounded and increased significantly
Baseline Comparison 2017 vs 2025 Comparison Type	Enjoyment	2.7880	3.3411	-0.553	$p < 0.001$	Enjoyment increased significantly
	Anger	2.9088	2.1797	0.729	$p < 0.001$	Anger decreased significantly
	Pride	3.2118	3.4074	-0.196	$p = 0.01$	Pride increased significantly
	Anxiety	2.3861	2.9196	-0.534	$p < 0.001$	Anxiety rebounded and increased significantly
	Shame	2.9977	2.4237	0.574	$p < 0.001$	Shame decreased significantly

The results are shown in Table 2. A comparison of the data from 2022 and 2024 found that the "Double Reduction" Policy achieved remarkable results in the initial stage of implementation: enjoyment increased significantly (MD = -0.77, $p < .001$) and anger decreased significantly (MD = 1.65, $p < .001$), indicating that

the policy played an immediate positive role in alleviating negative emotions and improving positive experiences. However, from the perspective of sustained effects (2024 vs 2025), pride continued to increase significantly (MD = -0.23, $p = .001$) and enjoyment remained stable with a slight increase ($p > .05$); yet the improved negative emotions rebounded—anger rose slightly, and shame rebounded significantly (MD = -0.26, $p < .001$). Most notably, anxiety showed a sustained and significant upward trend (MD = -0.30, $p < .001$), becoming a new challenge in the later stage of policy implementation. A further comparison of the data from 2017 to 2025 found that enjoyment (MD = -0.55, $p < .001$) and pride (MD = -0.20, $p = .01$) increased significantly, and anger (MD = 0.73, $p < .001$) and shame (MD = 0.57, $p < .001$) decreased significantly. It can be seen that after the implementation of the policy, the overall emotional ecosystem of students in the Greater Bay Area has turned for the better. However, the sustained increase in anxiety (MD = -0.53, $p < .001$) indicates that students' academic anxiety has not been effectively alleviated, and emotional intervention needs to be more targeted.

4.2. Repeated measures analysis of variance

This study further conducted a repeated measures analysis of variance on the scores of the five Achievement Emotions of students in the Greater Bay Area at four time points. The results are shown in Table 3. All five Achievement Emotions showed significant temporal effects ($p < .01$), but there were obvious differences in the variation amplitude and patterns of the emotions. Among them, enjoyment ($F = 68.51$, $p < .001$, $\eta^2 = 0.14$) and anger ($F = 244.39$, $p < .001$, $\eta^2 = 0.36$) showed extremely large effect sizes, and the temporal factor could explain 25% and 44% of the emotional variation respectively, indicating that these two types of emotions are the most sensitive to policy intervention. Enjoyment presented a V-shaped rebound trajectory after reaching a trough in 2022, while anger showed a Λ-shaped decline pattern after peaking in 2022. Shame ($\eta^2 = 0.10$) and anxiety ($\eta^2 = 0.05$) showed moderate to large effect sizes; the former presented an L-shaped decline followed by a slight rebound, and the latter continued to rise, becoming the only negative emotion that is difficult to control in the long term. Although pride ($\eta^2 = 0.01$) reached statistical significance ($F = 6.40$, $p = .002$), its effect size was small with limited variation amplitude. Overall, the policy has achieved significant results in improving emotions, but the asynchronous characteristics of emotional changes are prominent: the recovery of positive emotions is slow, some negative emotions improve rapidly, while anxiety continues to worsen. This suggests that subsequent interventions need to adopt targeted measures for different categories and make targeted efforts.

Table 3. Change trajectories of the five achievement emotions

	2017		2022		2024		2025	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Enjoyment	2.79	0.37	2.52	0.95	3.29	0.99	3.34	0.99
Anger	2.90	0.40	3.73	0.99	2.08	0.93	2.18	1.03
Pride	3.21	0.44	/	/	3.18	0.99	3.41	1.05
Anxiety	2.39	0.51	/	/	2.62	1.12	2.92	1.04
Shame	3.00	0.36	/	/	2.16	0.93	2.42	1.03

Note: SD = Standard Deviation

Table 3. Continued

	F-value	η^2	Effect Size	Change Trend
Enjoyment	68.51	0.14	2025>2024>2017>2022	V-shaped (decline first, then rise)
Anger	244.39	0.36	2022>2017>2025>2024	Λ-shaped (rise first, then decline)
Pride	6.40	0.01	2025>2017>2024	U-shaped
Anxiety	24.18	0.05	2025>2024>2017	Continuous increase
Shame	54.82	0.10	2017>2025>2024	L-shaped (decline first, then stabilize)

5. Discussion and implications

5.1. Addressing rising anxiety via emotional regulation and supportive pedagogy

Given that the results of this study indicate that the continuous rise in anxiety has become the most prominent emotional problem, schools should take it as the key intervention target of mental health education. It is suggested to integrate emotional regulation training such as mindfulness practice, cognitive restructuring and emotional expression skills into daily teaching to help students identify and cope with anxiety triggers. At the same time, teachers should pay attention to the emotional state of upper-grade students and exam-preparing groups, and provide personalized psychological support to avoid the accumulation and generalization of anxiety. In addition, we can draw on gamified learning [26] and autonomous curriculum design [27] to enhance the interest and sense of control in learning, and alleviate anxiety from the source.

5.2. Toward a developmental evaluation framework to counteract latent stress post-"Double Reduction"

The "Double Reduction" Policy has achieved remarkable results in reducing external burdens, but the continuous rise in anxiety suggests that students' stressors may have shifted from "explicit burdens" to "latent stress"—such as parental expectations, academic competition for further education, and anxiety about self-worth. It is suggested that while continuing to promote the "Double Reduction" Policy, we should accelerate the supporting reform of the evaluation system, break the shackles of the score-centric single evaluation orientation, and establish a diversified and developmental student evaluation mechanism. At the same time, strengthen home-school collaboration, guide parents to rationally adjust their academic expectations for their children, and avoid the emotional backlash effect of "reducing burdens at school but increasing them at home".

5.3. Further explore the mechanisms and intervention paths of emotional changes

This study reveals the dynamic evolutionary laws of Achievement Emotions under policy intervention, but the psychological mechanisms behind emotional changes still need in-depth exploration. Future research can combine the Control-Value Theory [9] to examine how students' sense of control and value appraisal of learning tasks change in the policy environment, and thus affect their emotional experience. At the same time, we can draw on Rentzios et al.'s person-centered research paradigm [16] to identify the subgroup

characteristics of different emotional change trajectories, providing a theoretical basis for precise intervention. In addition, the late rebound of shame is worthy of continuous follow-up to explore its correlation mechanism with academic failure, social comparison, self-attribution and other factors.

6. Conclusion

Based on 8-year follow-up data of the Guangdong-Hong Kong-Macao Greater Bay Area, this study systematically reveals the dynamic evolution trajectories of students' achievement emotions before and after the implementation of the "Double Reduction" Policy. The study found that the policy significantly improved students' enjoyment and anger in the short term, and the overall emotional ecosystem showed a positive trend; however, the continuous rise in anxiety and the late rebound of shame and anger indicate that emotional improvement is not linear and sustained, and the policy effects have the characteristics of temporal heterogeneity and asynchrony across emotional dimensions. It can be seen that policy evaluation cannot stop at short-term effects, but should establish a long-term follow-up mechanism; emotional intervention cannot adopt a one-size-fits-all approach, but should implement targeted measures for different categories and make targeted efforts. Only by truly realizing "stress reduction" while reducing academic burdens can we promote the all-round and healthy development of students' achievement emotions.

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