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# Exploring the relationship between teacher and parent support and students' noncognitive outcomes via Latent Profile Analysis

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Support from both teachers and parents is essential for shaping students' noncognitive outcomes. Despite the acknowledged importance of both support sources, research on their combined impact remains sparse. Therefore, this study examined the patterns of combined teacher and parent support and their relationship with students' noncognitive outcomes such as self-confidence, interest in learning, anxiety, attitude, and student activeness. We applied Latent Profile Analysis to analyze data from 274 secondary school students in China, identifying four distinct profiles of teacher-parent support: low teacher support-low parent support, medium teacher support-low parent support, high teacher support-low parent support, and high teacher support-high parent support. Analysis of variance was employed to analyze the differences in noncognitive support across these profiles, identifying significant differences in self-confidence, interest in learning, and anxiety across profiles; however, surprisingly, teacher and parent support were not significantly correlated with attitude or student activeness. This study highlights the critical role of teacher-parent support; contributes new insights for educators, parents, and schools; and underscores the necessity of personalized support tailored to individual needs.

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## Introduction

Noncognitive outcomes such as emotional skills are important for student development. Many studies have shown that noncognitive factors have a significant impact on students' academic performance (Rice et al., 2013; Simpkins et al., 2006). For instance, students with positive emotions toward mathematics are more likely to choose math courses and are more persistent in completing challenging mathematical tasks, thereby excelling at mathematics (Simpkins et al., 2006; Tulis & Fulmer, 2013). Therefore, it is crucial to aid students in developing positive noncognitive outcomes for their overall development.

According to Social Cognitive Theory, proposed by Bandura (1997), students' learning processes are significantly influenced by their environments. Teachers and parents, as pivotal figures in this learning environment, can significantly affect students' learning outcomes through their support. Teacher support refers to the degree to which students perceive their teachers as providing positive reinforcement and maintaining close interpersonal relationships in the school environment (Ma et al., 2021). Parent support can be defined as the degree of support that students perceive from their parents (Mata et al., 2018; Wijaya et al., 2022). Zimet et al. (1988) suggest that both teacher and parent support play important roles in influencing students' performance development. For example, when students encounter difficulties, positive feedback from teachers can help them rebuild their confidence (Zee and Koomen, 2016). Schmid and Garrels (2021) find that the level of parental involvement can influence students' academic performance.

Although some studies have shown significantly positive relationships between teacher support, parent support, and students' academic performance (Deci & Ryan, 2000; Mata et al., 2018), few studies have examined their combined impact on students' noncognitive outcomes. Understanding the impact of teacher and parent support on noncognitive factors can provide a scientific basis for teaching policy and practice. It helps educators adjust teaching methods and strategies for teacher–parent collaboration, thereby better supporting students' overall development.

Accordingly, this study explored subgroup profiles using Latent Profile Analysis (LPA) based on students' perceptions of teacher and parent support to identify differences in noncognitive outcomes (such as interest in learning, anxiety, attitude, student activeness, and mathematics learning achievement) across these profiles. The research primarily intended to clarify the varying levels of teacher and parent support and their respective effects on students' noncognitive outcomes. And the present investigation will highlight the critical role of teacher–parent support and contribute new insights to improving students' noncognitive outcomes.

## Literature review

**Teacher support.** Teacher support is an important facilitator of student learning because teachers play a significant role in organizing classroom activities (Patric et al., 2007). Teacher support can generally be categorized into academic and emotional support (Liu et al., 2017). Teacher academic support relates to students' perceptions that the teacher cares about what and how much they have learned, whereas teacher emotional support reflects students' perceptions that the teacher cares about them as unique individuals (Johnson et al., 1985). These two dimensions describe how teachers interact with students in both the classroom and social contexts.

Although some researchers believe that teachers' attention to their students' emotions does not have a significant impact on their learning (Calafato, 2024), the preponderance of research

demonstrates that students who receive teacher support exhibit positive attitudes, high self-confidence, and a favorable disposition in the school environment (Deci & Ryan, 2000). Teacher support, including caring for, respecting, and encouraging students, is positively correlated with interest in learning and self-perceptions among students (Jennings & Greenberg, 2009). When teachers provide more emotional support, students generally demonstrate higher class engagement and interest in learning (Patrick et al. 2007). In particular, when it comes to solving difficult learning tasks, teachers can provide positive feedback to help students build confidence and keep persevering when facing academic challenges (Zee & Koomen, 2016). Timely and positive feedback from teachers can make students feel respected, thereby generating interest in learning, increasing self-confidence, and enhancing engagement in learning.

**Parent support.** Researchers often focus on the various forms of parent support, such as academic support, emotional support, time support, and financial support (Mata et al., 2018; Wijaya et al., 2022). Empirical studies have frequently found that parent support has a positive influence on student performance (Mata et al., 2018). Various studies, albeit with small sample sizes, have found that parent support influences mathematics performance (Wijaya et al., 2022). Studies have also established that the level of parent involvement affects the learning success of secondary school students (ages 16–18) (Schmid & Garrels, 2021). However, in China, many parents are preoccupied with work and entrust their children's learning outcomes to schoolteachers and private tutors outside the school (He et al., 2021). Secondary school students in China tend to live with their parents. When students engage in learning beyond the school environment, parents play a pivotal role in providing conducive facilitating conditions that allow students to create an optimal space for reviewing mathematical lessons.

## Theoretical framework

Social Cognitive Theory provides a robust theoretical framework for comprehending the impact of teacher and parent support on students' noncognitive outcomes. This theory posits that individual behavior, individual cognition, and the environment mutually interact and that each has a two-way interaction and causal relationship (Bandura, 1997). Teachers and parents play pivotal roles in the educational context. Thus, support from teachers and parents has a significant impact on students' academic outcomes (Wijaya et al., 2022; Zee and Koomen, 2016).

Some studies further emphasize that the combined influence of multiple support sources may have a significant effect on students. In the present study, teacher–parent interactive support was divided into three categories: the enhancement mode, which means that one type of support can enhance the impact of the other (Hongyv, 2012); the compensation mode, which means that one type of support is deficient or counterproductive, and the other support compensates for its negative impact (Qin et al., 2013); and the independent mode, which refers to sources of support and their independent effects on individuals (Hongyv, 2012). Teacher and parent support interactively influence students' academic outcomes (Peng et al., 2022). Based on this analysis, this study aimed to examine the patterns of combined teacher and parent support and their relationship with students' noncognitive outcomes. Thus, we propose the following hypotheses:

H1: Different patterns of teacher–parent support are associated with significant differences in students' self-confidence.

- H2: Different patterns of teacher–parent support are associated with significant differences in students’ interest in learning.
- H3: Different patterns of teacher–parent support are associated with significant differences in students’ anxiety.
- H4: Different patterns of teacher–parent support are associated with significant differences in students’ attitudes.
- H5: Different patterns of teacher–parent support are associated with significant differences in student activeness.

Methodology

**Participants and data collection.** Data were obtained from regions in China with relatively high levels of economic and educational development. The researchers selected two full-time public secondary schools and surveyed their first-year students. A questionnaire was administered to 274 secondary school students. After the data were screened and cleaned, the final valid sample comprised 264 students: 143 junior high school students (54.2%) and 121 senior high school students (45.8%). The study included 131 male (49.6%) and 133 female students (50.4%).

The participants were selected using convenience sampling. We contacted Chinese secondary school teachers through personal connections and invited their students to complete the questionnaire. To ensure the reliability of their responses, all students completed paper-based questionnaires. Before collecting the data, we obtained the students’ consent and assured them that their privacy would be protected, ensuring that all data collected were used only for research purposes.

Measures

Our questionnaire, designed to assess students’ personal information, along with their perceived support from teachers and parents, and noncognitive outcomes in mathematics learning, is based on well-established items from the literature; thus, their relevance and validity are already supported (see Table S1). All items were measured using a 5-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (5). 1) *Teacher support*. The teacher support section consisted of four items that address two dimensions: emotional and academic support (Abdullah et al., 2022; Sun & Shi, 2022). 2) *Parent support*. The section on parent support included eight items categorized along four dimensions: emotional, academic, temporal, and financial support (Abdullah

et al., 2022; Wijaya et al., 2023). 3) *Students’ noncognitive factors*. The final part of the questionnaire measured students’ non-cognitive outcomes such as self-confidence, interest in learning, anxiety, attitude, mathematics learning achievement, and student activeness (Alturki & Aldraiweesh, 2022; Kosiba et al., 2022; Leijen et al., 2016; Yu et al., 2022).

Data analysis

All data in this study were processed using SPSS 25.0 and Mplus 7.4. Descriptive statistics were calculated for the variables, including means, standard deviations, and correlations. Before the calculation, confirmatory factor analysis (CFA) was adopted to test whether the data fit the original subscales of the non-cognitive factors in the questionnaire (Thompson, 2004). The goodness-of-fit indices of the CFA model were acceptable ( $\chi^2/df = 2.78$ , comparative fit index [CFI] = 0.959, Tucker-Lewis index [TLI] = 0.920, root mean square error of approximation [RMSEA] = 0.082, standardized root mean square residual [SRMR] = 0.043), indicating that the data were well structured. For noncognitive outcomes, we calculated the students’ final scores in a subdimension by averaging their scores for all items within that subdimension (Table 1).

Then, LPA was employed to group students into different classes according to their perceived teacher and parent support. LPA is a probability-based statistical method used to analyze continuous variables and identify potential classifications in samples (Muthén, 2001 ; Wijaya et al., 2024). In this study, students in the same group received similar teacher and parent support. Several fit indices were calculated to help determine into how many groups students should be divided, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size adjusted Bayesian information criterion (SSA-BIC), entropy, Vuong–Lo–Mendell–Rubin likelihood ratio test (VLMR–LRT), and Lo–Mendell–Rubin adjusted likelihood ratio test (LMRA–LRT) (Nylund et al., 2007). Generally, lower AIC, BIC, and SSA-BIC values indicate a better model fit. Higher entropy, typically closer to 1, suggests less uncertainty about the profile to which an individual belongs, indicating more distinct profiles and a better model fit (Muthén, 2001). VLMR and LMRA–LRT were used to compare the fit of a *k*-profile solution against a (*k* – 1)-profile solution in LPA. A significant *p*-value for these tests suggests that the more complex model with *k* profiles

Table 1 definition and measures of variable.	
Variable	Definition
<i>teacher support</i>	
TS1	Teacher encourages students to try math problems.
TS2	Teacher motivates students so that they never give up.
TS3	Teacher pays attention to each child’s math ability.
TS4	Teacher is ready to re-explain difficult math problems.
<i>parents support</i>	
PS1	Parents keep children’s mood to learn math.
PS2	Parents say that children could do math problems.
PS3	Parents find their children private math teachers.
PS4	Parents help their children doing difficult math problems.
PS5	Parents accompany their children to do math homework.
PS6	Parents accompany their children to review math material.
PS7	Parents give money to buy math practice problem books.
PS8	Parents buy their children a tablet to study math through micro lectures.
<i>non-cognitive outcomes</i>	
Self-confidence	Students believe they can learn math well and do math problems correctly.
Interest in learning	Students enthusiastic to lean mathematics.
anxiety	Students afraid to take math lessons and deal with math materials.
attitude	Students think that learning mathematics is important.
Student activeness	Students try to answer math questions from teacher and discuss with others.

Table 2 Descriptive statistics of variables.		
Variable	Mean	SD
<i>teacher support</i>		
TS1	4.35	0.73
TS2	4.17	0.90
TS3	4.18	0.84
TS4	4.04	0.93
<i>parents support</i>		
PS1	4.06	1.02
PS2	4.20	0.83
PS3	3.43	1.25
PS4	3.03	1.41
PS5	2.55	1.27
PS6	2.86	1.38
PS7	4.02	1.02
PS8	3.14	1.29
<i>non-cognitive outcomes</i>		
Self-confidence	3.67	0.98
Interest in learning	3.47	1.04
anxiety	1.95	0.97
attitude	3.99	0.80
Mathematics Learning achievement	3.21	1.00
Student activeness	3.79	0.87

fits the data better than the simpler model with  $k - 1$  profiles (Lo et al., 2001). Finally, we explored the effect of teacher and parent support on students' noncognitive outcomes based on the LPA results. We employed analysis of variance (ANOVA) to analyze the differences in noncognitive outcomes among the groups.

Results

This study aimed to explore the patterns arising from the combination of teacher and parent support and examine how these patterns are related to various student noncognitive outcomes such as self-confidence, interest in learning, anxiety, attitude, and student activeness. The Results section is divided into two primary subsections: Descriptive Statistics and Latent Profile Analysis. The first subsection provides a detailed overview of the basic statistical summary of the data collected in this study, including information such as mean scores and standard deviations, and a foundational understanding of the dataset. It also provides context for the more complex analyses that follow. The second subsection delves into the LPA results. LPA is a sophisticated statistical technique used to identify unobservable (latent) subgroups within a study population based on observed variables. This analysis reveals distinct patterns or profiles in combined teacher and parent support and their relationship with students' noncognitive outcomes. The results of this analysis are discussed in detail, including the number of profiles identified, their characteristics, and how they relate to the different noncognitive outcomes measured in the study.

**Descriptive statistics.** Table 2 shows the means and standard deviations of all the variables in this study. Students perceived high levels of teacher support but relatively low levels of parent support. Among these sources of support, parents provided the lowest level of time support to their children, with an average score of less than 3 points. Regarding noncognitive outcomes, students scored above the average level of 3 points except for anxiety.

Table 3 presents the correlation coefficient matrix of the variables. Students' noncognitive outcomes showed a significant correlation with all teacher support variables, but not with all parent support variables. Noncognitive outcomes such as self-

Table 3 Correlation analysis.																	
TS1	1.00																
TS2	0.63	1.00															
TS3	0.69	0.57	1.00														
TS4	0.58	0.49	0.77	1.00													
PS1	0.37	0.23	0.38	0.27	1.00												
PS2	0.32	0.23	0.30	0.33	0.28	1.00											
PS3	0.22	0.26	0.30	0.15	0.09	0.23	1.00										
PS4	0.10	0.07	0.15	0.09	0.19	0.34	0.31	1.00									
PS5	0.06	0.17	0.21	0.16	0.14	0.31	0.28	0.29	1.00								
PS6	0.06	0.05	0.16	0.14	0.31	0.28	0.24	0.07	0.79	1.00							
PS7	0.32	0.30	0.30	0.29	0.19	0.14	0.31	0.26	0.22	0.25	1.00						
PS8	0.10	0.11	0.10	0.10	0.19	0.14	0.16	0.21	0.07	0.31	0.31	1.00					
Self confidence	0.22	0.29	0.46	0.38	0.41	0.45	0.10	0.29	0.05	0.22	0.05	0.05	1.00				
Interest in learning	0.34	0.32	0.43	0.38	0.18	0.41	0.03	0.15	0.08	0.15	0.14	0.08	0.59	1.00			
anxiety	-0.24	-0.16	-0.21	-0.14	-0.19	-0.27	0.12	-0.20	-0.05	-0.15	-0.05	-0.08	-0.36	1.00			
attitude	0.27	0.20	0.17	0.18	0.20	0.12	0.00	0.01	-0.06	0.00	0.04	0.00	0.42	0.20	1.00		
Mathematics Learning achievement	0.17	0.25	0.43	0.34	0.28	0.31	-0.01	0.22	0.21	0.15	-0.01	0.16	0.74	0.56	-0.31	1.00	
Student activeness	0.20	0.31	0.41	0.32	0.20	0.28	0.16	0.04	0.12	0.03	0.21	0.08	0.49	0.45	-0.32	0.54	1.00

The bold numbers indicate that the correlation coefficient is statistically significant at a significance level of 0.05.

Table 4 Fit statistics for latent profile analysis.								
Profile	size (n)	Free parameters	AIC	BIC	SSA-BIC	Entropy	VLMR-LRT (p)	LMRA-LRT (p)
1-profile	264	24	9310.03	9395.85	9319.76	---	---	---
2-profile	159/105	37	8813.42	8945.73	8828.42	0.864	0.1110	0.1142
3-profile	126/36/92	50	8496.75	8675.54	8517.02	0.919	0.0013	0.0014
4-profile	106/54/49/55	63	8266.79	8492.08	8292.33	<b>0.977</b>	0.4563	0.4596
5-profile	45/62/55/53/49	76	8129.37	8401.14	8160.19	0.958	0.5528	0.5553

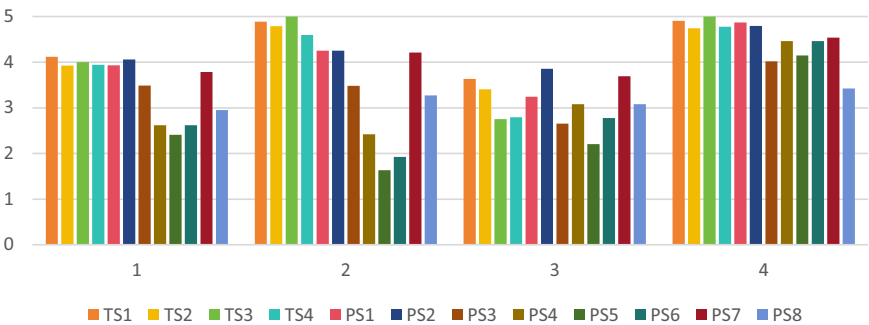


Fig. 1 The mean of teacher and parent support across four latent profiles.

Table 5 The result of ANOVA analysis.											
	MT-LP(1)		HT-LP(2)		LT-LP(3)		HT-HP(4)		$\eta^2$	P-value	Post-hoc
	M	SD	M	SD	M	SD	M	SD			
Self confidence	3.53	0.78	3.94	0.84	2.90	1.13	4.37	0.69	0.0325	<b>0.0033</b>	1 < 2*, 1 > 3***, 1 < 4***, 2 > 3***, 2 < 4*, 3 < 4***
Interest in learning	3.31	0.87	3.87	0.83	2.80	1.23	3.99	0.95	0.0161	<b>0.0392</b>	1 < 2**, 1 > 3*, 1 < 4***, 2 > 3***, 2 < 4, 3 < 4***
anxiety	2.04	0.77	1.89	1.10	2.28	1.11	1.55	0.93	0.0158	<b>0.0413</b>	1 > 2, 1 < 3, 1 > 4*, 2 < 3, 2 > 4, 3 > 4***
attitude	3.84	0.68	4.30	0.57	3.83	0.82	4.12	1.05	0.0076	0.1580	—
Student activeness	3.81	0.61	4.06	0.76	3.07	0.95	4.14	0.98	0.0002	0.8430	—

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

confidence, interest in learning, attitude, mathematics learning achievement, and student activeness were positively correlated with both teacher and parent support. However, anxiety negatively correlated with these types of support. This result indicates that support from teachers and parents may boost students' self-confidence, interest, attitude, and so on, and alleviate their academic anxiety.

**Latent profile analysis.** To further explore the impact of teacher and parent support on students' noncognitive outcomes in mathematics learning, LPA was adopted to group students into different categories based on their subjective perceptions of teacher and parent support. Several fit indices yielded inconsistent conclusions. After considering the results of the fit indices and interpretability of the grouping, this study categorized the students into four groups. The entropy for the four-profile model was 0.977, close to 1, indicating that the model accurately assigned individuals to their respective groups. Table 4 shows the fit indices of the latent profile models.

Figure 1 shows the means of teacher and parent support for the four groups. The first group showed moderate teacher support but low parent support and was named the "medium teacher support–low parent support group" (MT-LP group,  $n = 106$ ). The second group had high teacher support but low parent support and was called the "high teacher support–low parent support group" (HT-LP group,  $n = 54$ ). The third group was labelled the "low teacher support–low parent support group" (LT-LP group,  $n = 49$ ), as the students in this group perceived

low levels of support from both teachers and parents. The fourth group perceived high levels of support from both teachers and parents. Thus, this group was named the "high teacher support–high parent support group" (HT-HP group,  $n = 55$ ).

A series of ANOVA tests were then conducted to determine whether the four student profiles differed significantly in their noncognitive outcomes (Table 5). The four groups showed significant differences in mathematics learning self-confidence, with students in the HT-HP group exhibiting the highest level of confidence and those in the LT-LP group exhibiting the lowest level of confidence. The results for interest in learning aligned with the findings for self-confidence. However, the results for anxiety were the opposite, with students in the HT-HP group exhibiting the lowest level of anxiety and those in the LT-LP group exhibiting the highest level of anxiety. These results suggest that teacher and parent support benefit students' noncognitive outcomes. Additionally, we found significant differences between the HT groups and other groups. Surprisingly, the four profiles did not demonstrate significant difference in attitude ( $p$ -value > 0.05) and student activeness ( $p$ -value > 0.05).

**Discussion**

This study primarily intended to explore the profiles of subgroups of Chinese students based on support from parents and mathematics teachers and to investigate differences in self-confidence, interest in learning, anxiety, attitude toward mathematics, and student activeness across these profiles. To identify the student profiles, we employed LPA with a secondary clustering technique



to reduce the number of groups from five to four. This method aids in consolidating the subgroups to avoid ambiguity in student classification. Ultimately, we chose four groups, as they were more manageable than the five groups suggested by the AIC and BIC.

We identified four distinct latent profiles defined by the support provided to students by parents and mathematics teachers. Parent support was categorized into two groups based on our findings, low and high, whereas mathematics teacher support was divided into three categories: low, medium, and high. The four profiles were MT-LP, HT-LP, HT-HP, and LT-LP. We further investigated the characteristics of the students' noncognitive outcomes in the four groups.

**Differences in self-confidence across profiles.** Using ANOVA, we found differences among the subgroups in terms of conserving self-confidence. Unsurprisingly, the students in the HT-HP group had the highest self-confidence scores and those in the LT-LP group the lowest. The results indicate that both teacher and parent support have a significant effect on students' learning confidence.

As shown in Table 5, when all three groups shared the same condition of low parent support, those with high teacher support (Group 2) exhibited higher self-confidence than those with medium and low teacher support. The group with moderate teacher support (Group 1) displayed higher self-confidence than the group with low teacher support (Group 3). This result is consistent with other findings that students who perceive higher teacher support are more confident in their ability to solve mathematics problems (Kitsantas et al., 2021; Selda, 2012), and the same is true for those who perceive more parent support (Sha et al., 2016). Social Cognitive Theory holds that support from others, including moral support and material help, can increase a person's sense of self-efficacy (Bandura, 1997). Support from others encourages positive self-perceptions, such as the ability to achieve one's goals and acknowledge one's strengths (Feeney & Collins, 2014). In the context of mathematics education, this implies that students who receive positive support such as encouragement, constructive feedback, and praise from others may show significantly enhanced self-confidence, which in turn directly influences their confidence in engaging with and succeeding at mathematical tasks (Liu, 2017; Sha et al., 2016).

**Differences in interest in learning across profiles.** The subgroups differed significantly in students' interest in learning. Students in the HT-HP group had the highest interest scores, whereas those in the LT-LP group had the lowest. The development of interest depends on external support including challenges, encouragement, and feedback (Deci & Ryan, 1985; Hidi & Renninger, 2006), and teachers play a crucial supporting role in influencing students' academic interest by fostering emotional connections, providing motivation and effective pedagogy, acting as role models, and offering personalized learning experiences (Dietrich et al., 2015; Elisa & Rebecca, 2021). Insufficient teacher support can decrease students' academic enthusiasm.

Some studies have indicated the significance of parent support in the development of students' academic interests (Sha et al., 2016). This study demonstrated no significant difference in interest in learning between the HT-LP and HT-HP groups. This suggests that when student groups receive high levels of teacher support, parent support does not have a significant effect on students' interest in mathematics learning. The dynamics among teacher support, parent support, and students' interest in mathematics learning can be complex and multifaceted. Instances may arise in which high levels of support from teachers seemingly outweigh parent support in influencing students' interest in mathematics learning.

Social Cognitive Theory suggests that people learn by observing others. Students spend much of their school time with their teachers; therefore, they frequently observe and interact with them. When a teacher is supportive and makes math interesting, students notice this and become more excited about math. Teachers' immediate feedback and help in class can often make a significant difference in how students feel about math, sometimes having a stronger impact than that of the support they receive from parents, because it is more immediate and focused on the subject. Thus, teachers can adopt multiple teaching strategies, such as gamification of learning and real-world applications of mathematical concepts, to enhance students' interest in learning.

**Differences in anxiety across profiles.** The results showed significant differences in mathematics learning anxiety among different groups. However, differences were primarily observed between the HT-HP and MT-LP groups and between the HT-HP and LT-LP groups. This indicates that both teacher and parent support play a combined role in students' anxiety levels.

Many studies have shown that environmental factors play a significant role in how students experience anxiety (Rubinsten et al., 2018). Given their important role in the lives of secondary school students, the behavior of parents and teachers naturally influences students' feelings of anxiety. Teachers can assist students in dealing with learning challenges and reducing their anxiety by fostering emotional connections, offering positive feedback, and providing guidance (Chai & Gong, 2015; Rice et al., 2013). Parents and teachers play different roles in students' lives. Parents have a better understanding of students' home environments, while teachers concentrate on academic learning at school. Family and school represent the two most critical aspects of students' social networks. Support from these two sources can address students' various needs and offer comprehensive assistance and guidance, thereby reducing anxiety.

These findings indicate that the extent of teacher support for students does not reduce anxiety during mathematics learning if parent support is low. Students perceived parent support to be crucial in alleviating their anxiety while studying mathematics. This underscores the significance of various forms of parent support, including academic, financial, time, and emotional support, in mitigating student anxiety, and aligns with studies suggesting that parent support, particularly emotional and financial support, fosters student engagement in learning and diminishes anxiety (Li et al., 2021).

**Differences in attitude toward mathematics across profiles.** The results showed no significant difference in students' attitudes among the different subgroups, which means that neither teacher support nor parent support was significantly correlated with students' attitudes toward mathematics. This result is surprising because studies have shown the importance of both teacher and parent support in developing positive attitudes toward mathematics (Luo et al., 2023; Rice et al., 2013). Numerous factors can influence students' attitudes toward mathematics. In this study's sample, the students tended to spend more time learning at school. Consequently, they may perceive peer support as a more significant influencer of their attitudes toward mathematics. Mata (2018) provides evidence that peer support has a stronger impact on students' attitudes toward mathematics across grades 5–12. Similarly, a large-scale study conducted by Mazana (2018) finds that peer support significantly influences students' attitudes toward mathematics at the elementary, secondary, and college levels.

Moreover, internal psychological factors may significantly influence students' attitudes. According to Social Cognitive Theory, attitudes can be influenced by both internal psychological

factors and external factors. Students' perception of the importance of learning mathematics is a rather complex internal psychological factor that can be influenced by various confounding factors. The intrinsic value system is a relatively fixed element that is difficult to change without the support of teachers or parents. Therefore, the above results show that changing students' attitudes toward mathematics is not easy and requires greater effort.

**Differences in student activeness across profiles.** Another interesting finding concerns the lack of significant differences in student activeness among the different groups, which means that teacher or parent support had no significant correlation with student activeness. This finding is surprising because studies generally suggest that support from others encourages students to actively engage in their studies (Chai & Gong, 2015). This may suggest that individual differences among students have played an important role. We found that students had different needs and learning styles. The individual characteristics of students, such as their personality, interests, learning styles, and goals, may have a significant impact on their perception and response to received support. Some students may depend more on the support from their family and teachers to drive their learning, while others may rely more on self-motivation and are less influenced by external support. Furthermore, intrinsic motivation plays a pivotal role in student engagement in instructional activities. Therefore, although our research has found that the impact of parent and teacher support on students' learning activeness is not significant, this does not imply that such support is unimportant. Rather, it suggests that we need to gain a deeper understanding of the complexity of support and the influence of individual differences among students. Through further research and discussion, we can provide a scientific basis for formulating more effective educational policies and teaching methods, in order to better stimulate students' learning motivation and creativity.

**Implications of this study.** Our study began by identifying distinctions between groups with high teacher support and high parent support concerning self-confidence, interest in learning, and anxiety. Our findings align with studies indicating a positive impact of teacher and parent support on both cognitive and noncognitive factors. These findings offer novel insights for educators and parents, highlighting the crucial roles of teacher and parent support in shaping students' noncognitive outcomes, encompassing social, emotional, and behavioral facets beyond mere academic achievement.

Furthermore, our findings revealed that teacher-parent support did not significantly influence students' attitudes toward mathematics or their activeness levels within mathematics classrooms. This raises important considerations for teachers, parents, and schools. We believe that each child is unique. Customizing support to individual student needs and characteristics plays a pivotal role in positively influencing their noncognitive outcomes.

Based on our findings, we propose recommendations for mathematics teachers, parents, and educational policymakers. For teachers, the selection of learning approaches can significantly influence the classroom atmosphere and students' noncognitive development. Diverse teaching methods can accommodate various learning styles, abilities, and interests, offering students the opportunity to excel beyond academics. Teachers employing a range of teaching strategies can effectively nurture students' emotional, social, and behavioral advancement, ultimately contributing to their holistic growth. For parents, engagement that acknowledges and adjusts to a student's uniqueness can

profoundly affect their noncognitive development. Through understanding students' interests, emotional requirements, and learning preferences, parents can offer personalized support that fosters students' noncognitive growth. Parents must establish a positive family environment and actively cooperate with teachers to promote the development of students' noncognitive outcomes. Policymakers should attach importance to the impact of teacher-parent support on student learning outcomes and noncognitive abilities and consider promoting home-school collaboration in policy development so that students can build good support networks between school and home to facilitate their learning and development. Moreover, they need to provide training and resources to help teachers and parents better understand and respond to students' emotional and social needs as well as provide effective support and guidance.

## Conclusion

This study primarily aimed to fill a gap identified in the literature by examining the combined impact of teacher and parent support on students' noncognitive outcomes. The findings revealed four distinct profiles: LT-LP, MT-LP, HT-LP, and HT-HP. Subsequently, we discovered that teacher-parent support significantly influenced self-confidence, interest in learning, and anxiety. Students receiving high levels of both teacher and parent support exhibited better self-confidence and interest in learning and lower anxiety levels than the other three groups. However, teacher and parent support did not significantly influence student activeness or attitudes toward mathematics.

The findings of this study offer new insights for students, teachers, and schools regarding the impact of teacher and parent support on students' noncognitive outcomes, particularly in mathematics education. These findings align with studies highlighting the positive effects of teacher-parent support on noncognitive outcomes. This underscores the importance of schools, teachers, parents, and researchers focusing on enhancing teacher-parent support, emphasizing its significance in fostering students' holistic development.

## Limitations

Although our study provides valuable knowledge and implications for readers, it has several limitations. First, self-reported parent-teacher support scales may not comprehensively cover all the support received by students. Using interviews and observations in future research could provide additional information on the support received by students. Second, the final process in LPA using secondary clustering techniques may be partially subjective, as no formal statistical tests can be used to determine the optimal clusters. Finally, the sample consisted of a small number of Chinese students. Therefore, caution should be exercised when applying the findings of this study to other countries. Subsequent research should consider collecting samples from different countries and comparing the subgroups across countries.

## Data availability

The collected data and the description and analysis thereof are included in the text.

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## Author contributions

Conceptualization and investigation: Y.H., T.T.W., H.A.; data collection: H.C., M.G.; data analysis and visualization: Y.H., T.T.W.; writing: Y.H., T.T.W.; review and editing: Y.H., T.T.W., H.A., H.C., M.G. All authors have read and agreed to the published version of the manuscript.

## Competing interests

The author declares no competing interests.

## Ethical approval

This study was conducted according to the guidelines of the Declaration of Helsinki. The author sought and obtained ethical approval from the School of



Mathematical Sciences Beijing Normal University's Research Ethical Board, and the study complied with ethical standards (March 29, 2023). No number was attached to the approval.

### Informed consent

All participants were informed of the purpose of the study. The study used voluntarily and openly shared online posts that had no personally identifiable information. The interviews were administered to the respondents during school working hours without interfering with the school-set timetable. Participants who opted not to continue with the study were allowed to withdraw, even after the interview stage.

### Additional information

**Supplementary information** The online version contains supplementary material available at <https://doi.org/10.1057/s41599-025-04422-w>.

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