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ARTICLE

Exploring the congruence between perceived parent–teacher achievement goals and student academic outcomes: A study using polynomial regression with response surface analysis

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Abstract

Background: The achievement goals set by parents and teachers play a crucial role in shaping students' personal goal orientation and academic performance. Previous studies have revealed discrepancies between achievement goals set by parents and teachers. However, limited research has examined how the congruence of perceived parents' and teachers' achievement goals is associated with students' academic performance.

Aims: The current study sought to investigate the impact of congruence and discrepancy between students' perceptions of teachers' and parents' achievement goals, including mastery goals and performance goals, on students' academic performance in mathematics and language.

Sample and Methods: Data were collected from a sample of 4944 Chinese students from Grades 3 to 8 using self-reported questionnaires. Polynomial regression with response surface analyses were employed to analyse the data.

Results: The results indicated that students' performance in both mathematics and language improved when congruence levels were high in perceived teachers' and parents' mastery goals. Conversely, the congruence level between perceptions of teachers' and parents' performance goals was only related to students' mathematics performance.

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Conclusions: The findings underscore the significance of congruence between perceived teachers' and parents' achievement goals in influencing students' academic performance.

KEYWORDS
academic performance, achievement goals, response surface analysis, teacher–parent congruence

INTRODUCTION

Students' academic motivation and confidence are closely related to teachers' and parents' academic expectations (Friedel et al., 2007; Gonzalez-DeHass et al., 2005; Parsons et al., 1982). Achievement goal theory proposes that parents and teachers possess the ability to shape and influence a wide array of academic outcomes in students, including self-efficacy beliefs and performance (Friedel et al., 2010). Moreover, prior research has observed that effective parent–school interactions enhance students' academic performance (Erbe, 1991; Fortier et al., 1995; Hill & Tyson, 2009; Li et al., 2019). Both home-based discipline from parents and school-based pedagogical guidance from teachers shape children's behaviour and development. As a result, understanding the impact of parents and teachers on students' academic performance necessitates an examination of the combined effects of home-based discipline from parents and school-based pedagogical guidance from teachers (Bronfenbrenner, 1979).

According to achievement goal theory (Anderman & Maehr, 1994; Kaplan & Maehr, 2002), there are two types of achievement goals: mastery goals and performance goals. Mastery goals involve developing competence, acquiring knowledge and embracing the learning process. Individuals with mastery goals display intrinsic motivation, employ deep learning strategies, persevere in the face of challenges and consider failure as an opportunity for personal growth. On the other hand, performance goals revolve around obtaining favourable judgements of competence and outperforming others. Individuals with performance goals are motivated by external factors such as grades and social recognition, and they may utilize surface learning strategies to meet external standards of success. They tend to avoid challenging tasks and view failure as a threat to their self-esteem.

In line with ecological systems theory (Bronfenbrenner, 1979), parents and teachers play crucial roles in moulding students' sociocultural environments. Students' behaviours are notably influenced by the attitudes and support from teachers and parents. Previous research has demonstrated that parents' and teachers' achievement goals can influence students' individual self-efficacy and personal achievement goals (Jiang et al., 2013), with the students' goal orientation serving as a mediating factor (Friedel et al., 2007, 2010).

Simultaneously, the goal orientations of parents and teachers have shown distinct predictive impacts on students' academic achievement (Régner et al., 2009). For instance, Gonida et al. (2009) suggested that both school and parental factors can collectively predict students' mastery goals, while only parents' performance approach goals can predict students' performance approach goals.

Parental and teacher goal orientations may not always align with each other, potentially leading to discrepancies that may impact students' individual growth and academic development (Nadon et al., 2023). Existing research has not fully explored how these divergences in parental and teacher achievement goals influence students' academic performance. Recognizing this gap, the current study aims to supplement the existing body of knowledge by examining the effects of parents' and teachers' goal orientations and their interplay on students' learning. In particular, the polynomial regression with response surface analysis was employed in this study to delve into how congruence and discrepancies between perceived parental and teacher goal orientations influence students' individual academic performance.

LITERATURE REVIEW

The impact of teachers' achievement goals on students' academic performance

Teachers play a crucial role in shaping students' learning habits through communication and motivational strategies. Research has shown that teachers' expectations and achievement goals for students are closely linked to students' self-efficacy, learning strategies and academic performance (Friedel et al., 2007; Jiang et al., 2013).

However, teachers' academic expectations can sometimes lead to stereotypical biases among students. For example, teachers may expect academically superior students to possess superior mathematical abilities; however, variations may exist in their expectations based on students' individual gender, race or nationality (Fiske & Neuberg, 1989; Li, 1999). Research has shown that teachers often assume that male middle-level students possess better mathematical and logical thinking abilities than their female counterparts (Fennema et al., 1990). These differing expectations can shape students' learning attitudes and subsequently influence their individual academic abilities and performance.

The goals set by teachers can significantly impact students' performance, particularly when considering the differentiation between mastery goals and performance goals. Teachers who prioritize mastery goals focus on fostering students' intrinsic motivation, cultivating deep understanding and nurturing the acquisition of fundamental knowledge and critical thinking abilities. They create a supportive learning environment in which students are encouraged to actively participate in the learning process, take risks and persevere through challenges (Ames, 1992; Dweck & Leggett, 1988). In contrast, teachers who prioritize performance goals often place more importance on external measures of success, such as grades or rankings, and they may cultivate a competitive atmosphere in which students are driven to outperform their peers or achieve high marks (Ritzema et al., 2016; Song, 2018).

The influence of these goals on students' performance is noteworthy. When teachers prioritize mastery goals, students tend to develop a growth mindset, valuing effort and embracing learning as a journey. This approach encourage students to adopt effective learning strategies, seek deeper understanding and take ownership of their education (Rissanen et al., 2021). Consequently, students with teachers who emphasize mastery goals often demonstrate higher levels of self-efficacy, engagement and overall academic achievement (Uçar & Sungur, 2017). However, teachers who prioritize performance goals may unintentionally foster a fixed mindset among students. Instead of focusing on the process of learning, these students become more preoccupied with attaining external rewards and recognition rather than intrinsic motivation or a genuine understanding of the subject matter (Song, 2018). While performance goals can provide short-term motivation, they may hinder long-term learning and growth. Students may develop a fear of failure, shy away from challenging tasks or resort to surface-level learning strategies aimed at achieving high grades without deep comprehension (Dweck et al., 2014).

Previous research has suggested that teachers who prioritize mastery goals tend to encourage personal effort and progress in students, while those who emphasize performance goals tend to enhance students' competitive abilities (Butler, 2007). However, several studies have indicated that performance approach goals, which prioritize outperforming others rather than demonstrating high competence, are more reliable predictors of academic performance compared to mastery approach goals (Bipp & van Dam, 2014; Durik et al., 2009; Elliot, 2005; Hulleman et al., 2010; Kaplan & Maehr, 2007; Van Yperen et al., 2015). Nonetheless, the impact of context and specific tasks on the relationship between goal orientation and performance remains an area that requires further research. For example, research has shown that mastery approach goals have been associated with superior performance in verbal tasks compared to performance approach goals (Van Yperen et al., 2015).

The impact of parents' achievement goals on students' academic performance

Parents' influence on students' achievement goals manifests through both mastery goals and performance goals. Similar to teachers' goals, parents' goals need to be recognized by the students to effectively influence them. Prior research has demonstrated that parents with higher expectations are often perceived by their children as more competent, especially in areas such as mathematics. This perception typically corresponds with higher self-assessed mathematical ability and overall academic performance (Eccles & Jacobs, 1986). Furthermore, students with parents who emphasize mastery goals tend to outperform those whose parents prioritize performance goals less (Gutman, 2006). It is noteworthy that the goal orientation of teachers and parents, as perceived by students, frequently exert influence directly or via mediating variables. This concept was supported by Friedel et al. (2007), who discovered that students' perceptions of classroom goal structure and parents' achievement goals impacted their academic success through the lens of personal goal structures. These personal goal structures include beliefs, attitudes and expectations regarding achievement and success. When students perceive a mastery-oriented classroom, they develop personal goal structures that prioritize learning and understanding. Conversely, a performance-oriented classroom may lead to personal goal structures focused on external rewards and outperforming peers. The perceptions of parental goals and motivating styles were confirmed to predict Korean students' various goal orientations directly as well as via diverse types of self-regulated motivations (Kim et al., 2010). Additionally, a recent study revealed that parents' educational expectations are an important factor influencing students' academic achievement, which functioned directly or through parental educational involvement among left-behind students (Li et al., 2024).

Despite these findings, research specifically addressing Chinese populations remains scarce. In China, parents across generations share a long-held expectation for their children, gradually forming a saying 'wang zi cheng long, wang nv cheng feng', which means that parents hope their son or daughter to become dragon or phoenix someday, and the so-called dragon or phoenix represent those successful people with high achievement (Chen et al., 2022). With these ultimate expectations, Chinese parents also have stage expectations for children at different stages of growth. At school age, children are expected to have good academic performance and achieve their academic goals. To a large degree, those stage-expectations are determined by parents' own achievement goals. However, it currently remains understudied and calls for further empirical research to provide a comprehensive understanding of the association of Chinese parents' achievement goals and their children' academic performance. Thus, this study investigates the manner in which students' perceptions of their parents' and teachers' achievement goals influence their academic performance in China.

The interaction between teachers' and parents' achievement goals and its impact on students' academic performance

As the two primary influencers in a students' educational journey, parents and teachers have a complex and multifaceted impact on academic achievement. Numerous studies have investigated how the expectations of parents and teachers influence students' academic attitudes and achievement (Eccles & Jacobs, 1986). For instance, perceived parents' and teachers' emphases on mastery and performance goals significantly predicted children's personal goals in mathematics (Friedel et al., 2007). Overall, the development of students' personal achievement goals appears to be a result of their comprehensive absorption and internalization of the perceived goals and motivations from both parents and teachers (Nadon et al., 2023).

Recent studies have provided more nuanced insights into the distinct roles of parents and teachers in shaping students' academic outcomes. For example, it was found that students who perceived higher parents' expectations had better final grades in the Portuguese language, while those who had greater math achievement reported higher perceptions of teachers' expectations rather than parents' expectations (Nunes et al., 2023). Another study found that students' perceptions of classroom goals set by

teachers were stronger predictors of their own goals and performance in mathematics, compared to the perceived parental goals and motivating styles (Kim et al., 2010). These findings highlight the need to consider the specific academic domain when examining the impact of parental and teacher expectations on students' academic performance.

It is noteworthy that the academic expectations of parents and teachers may differ sometimes, even contradicting each other (Ivanova et al., 2020), and that these expectations simultaneously influence students' individual academic performance. Thus, it is clear that the interactions between parents and teachers concerning students' academic intervention are intricate. Interactions are centred on students, and varying expectations and social behaviours of parents and teachers have direct impact on students. Prior research has shown that cognitive and emotional interactions between parents and teachers not only directly influence students' mental health and interest in learning but also indirectly affect their academic success and mental health through behavioural and emotional engagement (Wang & Sheikh-Khalil, 2014).

Some studies reveal that, in Western developed countries, high levels of interaction between parents and teachers improve students' academic performance (Fu et al., 2022; Li et al., 2019). However, the findings from developing countries vary. Chinese government has implemented the 'double reduction' policy for more than 2 years, which intends to reducing the burden of primary and secondary school students (Chen et al., 2022). This policy, to a certain degree, facilitates the close cooperation between family and school to educate students. As two major actioners, parents and teachers take important and independent responsibility in students' education at home and school respectively. Moreover, their interaction in this cooperation also has critical effects on students' education. The interaction effect between parents and teachers hinges on the degree of communication between them. While these interactions may not increase parents' dependence on schools, they can enhance parents' understanding of their children's education (Ho et al., 2013). In contrast, distrust or conflict between parents and teachers can undermine the positive impact of such interactions on students' individual performance. A recent study involving a sample of nearly 6000 parents and 600 teachers in a rural area of China suggested that due to supply-side and demand-side factors, the prevalence and effectiveness of parent–teacher interactions vary significantly (Li et al., 2019). Considering the developmental reality and needs in Chinese context, this study aims to explore what and how the parent–teacher interactions influence students' academic performance, which may enrich the literature from developing countries and provide in-depth suggestions for policymakers and practitioners in China.

Application of polynomial regression with response surface analysis in predicting students' achievement using the achievement goals set by teachers and parents

To investigate the joint influence of perceived parents' and teachers' achievement goals on students' academic performance, we employed polynomial regression with response surface analysis (RSA) to examine the congruence and discrepancy between explanatory variables (Shanock et al., 2010). This technique has been used to explore the relationship between the combinations of two predictors and the response variables, as well as clarifying the effects of congruence or discrepancy in these combinations (Box & Draper, 1987; Schönbrodt, 2016). Polynomial regression is used to model the relationship between the explanatory variables and the response variable, while RSA visualizes and helps interpret the results of the polynomial regression. Specifically, RSA generates graphs displaying the relationship between the two explanatory variables, their interactions, and response variables within a three-dimensional coordinate axis space (Khuri & Mukhopadhyay, 2010). RSA was initially developed and mainly applied in experimental designs to fit (non)linear response surface models and determine the optimum operating conditions in the fields of physics and industry (Khuri & Mukhopadhyay, 2010). Scholars have gradually expanded its usage by combining it with polynomial regression and applying it to various research questions in diverse domains, such as organizational and behavioural sciences (Shanock et al., 2010). This combined technique offers superior explanatory potential compared to multipoint scoring or traditional

regression methods (Ahmad & Janahiraman, 2014; Barranti et al., 2017). It can address more detailed queries, such as whether the results obtained by pairing two explanatory variables are superior to those garnered without matching predictors and determine the level of variable matching that yields the optimal response value (Myers et al., 2016). To use polynomial regression with RSA, several prerequisites must be met. First, the predictors must share the same conceptual domain; otherwise, any difference in standing on the two variables would be interpreted in a meaningless manner. Second, the predictors must be measured or transformed on the same scale. Finally, the usual requirements of regression analysis must also be satisfied (Shanock et al., 2010).

Recently, polynomial regression with response surface analysis has been employed in the field of educational and developmental psychology, for example, examination of the influence of parent–child and teacher–student (in)congruence on individual development (Lee et al., 2022; Luo et al., 2020; Milatz et al., 2015). This technique has also served as a robust statistical tool for examining the interplay between parental and teacher influences on student outcomes (Saffer et al., 2021). This analytic approach has been pivotal in identifying the positive effects of congruence (Lee et al., 2022). When parents' and teachers' educational strategies and values are aligned, students exhibit notable improvements in both academic achievement and socio-emotional development (Garbacz et al., 2021). For students, the expectations and requirements of parents and teachers play a pivotal role in enhancing their academic performance. However, when faced with divergent views and goals from their teachers and parents, students may feel uncertain about which direction to prioritize, potentially leading to disruptions in their academic performance. This raises several important questions: How does this impact students' performance in subjects including mathematics and language? Do the differing goals of parents and teachers have varying effects on students' performance? Traditional multiple regression methods struggle to provide a comprehensive explanation for these complex dilemmas. Therefore, to delve into the influence of parents' and teachers' perceived achievement goals on students' academic performance, specific conclusions can be drawn using polynomial regression with response surface analysis.

Research questions

Considering the aforementioned theoretical inspiration and research gaps, this study aimed to explore the effects of the perceptions of mastery and performance goals set by parents and teachers on students' achievements in mathematics and language. Specifically, this study proposes the following research questions:

1. What is the impact of (in)congruence between students' perceptions of teachers' and parents' mastery goals on students' mathematics achievement?
2. What is the impact of (in)congruence between students' perceptions of teachers' and parents' performance goals on students' mathematics achievement?
3. What is the impact of (in)congruence between students' perceptions of teachers' and parents' mastery goals on students' language achievement?
4. What is the impact of (in)congruence between students' perceptions of teachers' and parents' performance goals on students' language achievement?

METHOD

Sample

The data utilized in this study stem from a research project encompassing families across five provinces, municipalities and autonomous regions in China, each with distinct gross domestic product (GDP) levels. These provinces included Beijing, Shanxi, Shaanxi and Guangxi.

TABLE 1 Descriptive data for the samples.

Grade		3	4	5	6	7	8
Gender	Male	528	540	520	589	197	204
	Female	442	451	506	442	237	251
Total		970	991	1026	1031	434	455

The study involved 5751 participating students from Grade 3 to Grade 8 at both the primary and junior middle school levels. Informed consent has been obtained from students, teachers, parents and school leaders. We initially removed participants who had missing values on all variables and then excluded the participants who had missing responses for more than 10% of the items of achievement goal (about 10% of the sample) (Newman, 2014). The final dataset included 4944 students, comprising 2578 boys (52.54%) and 2329 girls (47.46%). (There were about 37 participants whose gender was not provided.) Of the remaining group, 4018 students (81.2%) were from primary school and 889 students (18%) were from middle school (Table 1).

Measures

Perceived parents' achievement goals

The scale evaluating students' perceptions of their parents' goals was adapted from the Patterns of Adaptive Learning Scale (PALS), designed to assess students' adaptability to their environment from their own perspective, gauging their perceptions of their parents' achievement goals (Midgley et al., 2000). The parent mastery goal scale identifies whether parents are perceived to promote their children's competence development; for example, 'My parents want my work to be challenging for me.' The parent performance goals scale probes whether parents encourage demonstrating competence, such as 'My parents would like me to show others that I am good at class work.' All items were rated on a 6-point Likert scale from '1' (never) to '6' (always), specifically designed to avoid a neutral option. The reliability coefficient for this parent goal scale was 0.60.

Perceived teachers' achievement goals

The scale for gauging students' perceptions of their teachers' goals also originated from the PALS (Midgley et al., 2000). The teacher mastery goal scale determines whether teachers are perceived to encourage students to develop competence in their instructional activities; for instance, 'My teacher wants us to understand our work, not just memorize it.' In the PALS, teachers' performance goals encompass both performance approach and performance-avoid goals. The teacher performance approach goal scale measures whether teachers encourage students to exhibit competence in instructional activities, mirroring parental performance goals. The teacher's performance avoidance goal scale determines whether teachers prefer their students to avoid demonstrating incompetence. This study concentrates particularly on the impact of teacher performance approach goals on students' academic performance. All items were also evaluated on a 6-point scale. The reliability coefficient for the teacher goal scale was 0.67.

Students' academic performance

This study employed a self-designed test to assess students' academic performance in language and mathematics, and the tests of different grades were developed according to the scope of the contents in the curriculum standards for compulsory education of each grade. The language test elements

included narrative reading, expository reading, argumentative reading and writing. The math test elements included number and algebra, space and geometry, statistics and probability. Given the variance in item difficulty across different grades, this study used a one-dimensional Item Response Theory (IRT) model for cross-grade equivalence, enabling the conversion of scores from different grades to the same standard scale. The students' final mathematics examination scores ranged from −4.04 to 2.39 ($M = -0.87$, $SD = 1.10$), while their language scores ranged from −1.68 to 1.55 ($M = 0.07$, $SD = 0.52$).

Data analysis

We use polynomial regression with response surface analysis to analyse the impact of mastery and performance goals of teachers and parents on students' academic performance, following the analytic steps outlined by previous research (Luo et al., 2020; Schönbrodt, 2016; Van Petegem et al., 2020). Before applying polynomial regression, we first examined the distribution and association of the two sets of predictor variables with the outcome variables. This step was crucial to ascertain the applicability of polynomial regression with response surface analysis to our research by examine the third prerequisite mentioned above. Then, we constructed a polynomial regression model to further investigate the effects of perceived goal congruence or incongruence on academic achievement. Generally, there are two formal steps: conduct polynomial regression to obtain coefficients and use them to generate three-dimensional response surface graphs.

To perform polynomial regression analysis, all predictors were centralized around their mean scores to remain consistent in evaluation scale and ensure that the interpretation of results is consisted with theories of how (in)congruence correlated to outcomes (Luo et al., 2020; Van Petegem et al., 2020). Then, polynomial regression analysis was performed for students' academic achievements, by regressing each of them on the effects of perceived parental and teacher mastery/performance goals. In the polynomial regression model, Z is the outcome variable (i.e., students' academic achievements), X and Y represent the two predictors respectively (i.e., perceived parent and teacher achievement goal). The parameters to be evaluated include the intercept (b_0), the linear (b_1 and b_2) effect of the perceived parental and teacher mastery/performance goals, the quadratic (b_3 and b_4) effect of the perceived parental and teacher mastery/performance goals, the interaction (b_5) effect between perceived parental and teacher mastery/performance goals and an error term (e), composing the following result equation:

$$Z = b_0 + b_1X + b_2Y + b_3X^2 + b_4Y^2 + b_5XY + e \quad (1)$$

Due to the inclusion of quadratic and interaction terms, the interpretation of polynomial regression can be complex. The response surface analysis was employed to visualize the results to better interpret the results. Response surface analysis provides a visual representation of the results of polynomial regression based on congruence and discrepancies between the two predictor variables. RSA provides four coefficients (a_1–a_4) that explain the questions about how (in)congruence matters with the following parameters: $a_1 = b_1 + b_2$, $a_2 = b_3 + b_4 + b_5$, $a_3 = b_1 - b_2$, and $a_4 = b_3 - b_4 + b_5$.

The coefficients a_1 and a_2 test the effects among a line of congruence. These effects use a linear slope a_1 and quadratic slope a_2 to assess how students' academic achievements are associated with perceived achievement goal when perceived parental and teacher mastery/performance goals have similar scores. The significant effects show that congruence of perceived parental and teacher mastery/performance goals is associated with students' academic achievements.

The linear slope a_3 and quadratic slope a_4 test the effects of incongruence between perceived parental and teacher mastery/performance goals on students' academic achievements along a line of incongruence. The a_3 value indicates the likelihood of higher achievement when the perceived parental mastery/performance goals are higher than the teacher mastery/performance goals. The a_4 value shows whether students' achievements are especially likely at high or low levels of dissimilarity.

Considering that the full polynomial regression model may produce overfitting, Schönbrodt (2016) provided five simpler fitting models. These sub models are nested under the full polynomial regression model, with adjusted parameters to obtain fewer degrees of freedom. As two of fit models are mainly used for predictors, rather than a similar scale as in this study, the present study will adopt the other three models to compare with the full polynomial regression model.

The first type of model suppose that there is no main effect of predictor variables on the outcomes but allows for (in)congruence effects. Therefore, the level of perceived parental or teacher goal does not affect achievement, but it does matter how the similarity/discrepancy of parental and teacher mastery/performance goals are in students' achievement. The sub model shifted squared difference model (SSDQ) only models an effect of similarity/discrepancy, but (dis)similarity does not need to be at numerical equality.

The second type of fit model considers both (in)congruence effects and the effect of the level of the predictor variables on the outcome variables. It further considers how the level of (in)congruence between perceived parental and teacher mastery/performance goals affects students' performance. There are two sub models. The first sub model, basic rising ridge model (RR) assumes that there is a main effect of (in)congruence effects and that level of similarity between perceived parental and teacher mastery/performance goals affects students' achievement. Another sub model, the shifted rising ridge model (SRR) bears in mind that the optimal match is not when perceived parental and teacher mastery/performance goals have the same score.

The selection of these sub models is primarily based on the modified Akaike information criterion (AICc), with models having lower AICc values considered to provide a better fit to the data (Schönbrodt, 2016). We choose AICc as the model selection index because it has a good theoretical basis and can avoid the problem of model overfitting caused by many parameters (Burnham & Anderson, 2002; Humberg et al., 2019). When a model has a significantly higher AICc value, this suggests that the model's fitting effect is notably worse than that of the other models. Furthermore, the power analysis is complicated by the fact that parameters of higher order terms are involved in the analysis. The present study decomposes the multiple parameter estimates into a single indicator of effect size, namely the increase in explained variance R^2_{adj}. This may be related to the fact that the congruence effect accounts for the increase in the explained variance beyond the two main effects. For example, in a study involving 200 subjects, it can detect a R^2_{adj} of 5% with a statistical power of 90% ($\alpha = 5\%$) (Schönbrodt et al., 2018). In general, if the explained variance (R^2_{adj}) is significant, the outcomes can be interpreted (Franken et al., 2017). After the above steps, a three-dimensional response surface graph can be drawn using the parameters for a more intuitive representation of the results. The statistical software R Version 4.0.5 (R Core Team, 2021) was used for all procedures of data analyses.

RESULTS

Descriptive statistics

Table 2 presents the differences in the levels of predictors across all subjects. For mastery goals, 37.4% of the students perceived the level of parental mastery goals to be similar to that of the teachers' mastery goals. Furthermore, the number of students perceiving a higher mastery goal from teachers and those perceiving a higher mastery goal from parents were similar, with proportions of 31.5% (1313 students) and 31.1% (1294 students), respectively. Regarding performance goals, 31.5% of the students perceived that the parents' performance goals were similar to that of the teachers' performance goal. Meanwhile, 33.5% (1507 students) felt higher performance goals from teachers and 35.0% (1573 students) thought that parents' performance goals should be higher.

Table 3 provides descriptive statistics for teachers' and parents' mastery goals, performance goals and students' academic levels. For preliminary evaluation of the discrepancies between teacher's and parent's mastery and performance goal levels, paired *t*-tests were conducted. According to the

TABLE 2 Frequency of differences in predictors.

	Frequency	%	Valid %	Cumulative %
TMG < PMG	1294	26.2	31.1	31.10
TMG ≈ PMG	1558	31.5	37.4	68.5
TMG > PMG	1313	26.6	31.5	100
Total	4165	84.2	100	
Missing	779	15.8		
Total	4944	100		
TPG < PPG	1573	31.8	35.0	35
TPG ≈ PPG	1419	28.7	31.5	66.5
TPG > PPG	1507	30.5	33.5	100
Total	4499	91	100	
Missing	445	9		
Total	4944	100		

Abbreviations: PMG, parent mastery goal; PPG, parent performance goal; TMG, teacher mastery goal; TPG, teacher performance goal.

TABLE 3 Descriptive statistics of predictors.

			Mean difference		
Variable	**Mean**	***SD***	***df***	***t***	***p***
TMG	0.018	1.003	4164	−15.453***	.000
PMG	0.319	1.000			
TPG	−0.123	0.999	4498	−9.646***	.000
PPG	0.067	0.998			
Math	−0.871	1.100			
Language	0.705	0.515			

Abbreviations: PMG, parent mastery goal; PPG, parent performance goal; TMG, teacher mastery goal; TPG, teacher performance goal.
*$p < .05$.
**$p < .01$.
***$p < .001$.

data in Table 3, both the differences of mastery goals ($t = -15.453$, $p < .001$) and performance goals ($t = -9.646$, $p < .001$) between teacher and parent were statistically significant. Base on the data, we can conclude that exploring how difference between students' perceptions of teachers' and parents' goals makes practical sense.

Table 4 presents the correlations among the main measured variables. The correlational analyses indicated significant correlations between students' perceptions of teachers' and parents' goals, with correlation coefficients ranging from 0.053 to 0.411. For students' achievement, significant positive correlations were found between teachers' goals and students' achievement. Parents' performance goals were significantly negatively correlated with both students' mathematics and language achievement. However, no significant correlation was found between parents' mastery goals and language achievement.

Mastery goals and academic performance

Table 5 displays the models testing the effects of teachers' and parents' mastery goals on students' mathematics and language achievement. For mathematics performance, the full models demonstrated the

TABLE 4 The correlation between teachers' and parents' goal and students' performance.

	1	2	3	4	5	6
1. Teacher mastery goal						
2. Parents mastery goal	.213**					
3. Teacher performance goal	.222**	.167**				
4. Parents performance goal	.053**	.411**	.122**			
5. Math	.121**	.024	.057**	−.030*		
6. Language	.202**	.015	.060**	−.065**	.296**	

*$p < .05$.
**$p < .01$.

TABLE 5 Model selection of mastery goals on academic performance.

Model	AICc	ΔAICc	AICcWt	CFI	p_{model}	R^2_{adj}
Math						
Full	12628.888	0.714	0.375	1.000	.000	.020
SRR	12631.841	3.668	0.086	0.939	.000	.018
RR	12638.954	10.781	0.002	0.841	.000	.017
Additive	12648.563	20.390	0.000	0.725	.000	.014
SSQD	12662.323	34.149	0.000	0.559	.000	.011
Language						
Full	6069.418	0.000	0.872	1.000	.000	.051
SRR	6095.878	26.460	0.000	0.868	.000	.044
Additive	6108.335	38.917	0.000	0.806	.000	.041
RR	6152.290	82.871	0.000	0.603	.000	.031
SSQD	6169.865	100.447	0.000	0.522	.000	.027

Note: Notes are identical in the following tables.

Abbreviations: Additive, model with two linear main effects; AICc, corrected Akaike information criterion; CFI, comparative fit index; p_{model}, p value for explained variance of the model; R^2_{adj}, adjusted R^2; RR, rising ridge model; SRR, shifted rising ridge model; SSQD, shifted squared difference model.

smallest AICc value among all models, with significant adjusted R^2_{adj}. This indicated that the full model was the best fit for the relationship between mastery goals and mathematics performance.

Table 6 presents the full model results for the polynomial regression model of mastery goals and academic performance. Response surface parameters were estimated through linear combinations of polynomial regression coefficients: $a_1 = 0.16$ ($SE = 0.025$, $p < .001$), $a_2 = -0.04$ ($SE = 0.021$, $p = .089$), $a_3 = 0.073$ ($SE = 0.030$, $p = .013$) and $a_4 = -0.14$ ($SE = 0.030$, $p < .001$).

Figure 1 shows the outcomes for the effect of perceived parental and teacher mastery on students' math performance. The x-axis represents the level of perceived teacher mastery goal, the y-axis represents the level of perceived parental mastery goal and the z-axis represents the students' math scores. A significant a_1 with a nonsignificant a_2 suggests the effect along the line of congruence in mastery goals between teachers and parents. There is a linear prediction from the similarity of perceived parental mastery goals on students' math performance. Along the line of incongruence, the significant and negative a_4 value implies that the degree of discrepancies between teachers' and parents' mastery goals do impact students' mathematics performance. A positive a_3 value suggests that the direction of incongruence also impact the students' mathematics performance. This effect is stronger when a teacher's mastery goal exceeds the parents' mastery goal.

For language achievement performance, the full model was used for polynomial regression. According to the full model regression results (see Table 6), $a_1 = 0.11$ ($SE = 0.012$, $p < .001$), $a_2 = -0.04$ ($SE = 0.009$, $p < .001$), $a_3 = 0.09$ ($SE = 0.013$, $p < .001$) and $a_4 = -0.056$ ($SE = 0.015$, $p < .001$).

TABLE 6 Polynomial regression result of mastery goals on academic performance.

	Estimate	*SE*	*z*	*p*	CI. low	CI. upp
Math						
b0-intercept	−0.772	0.019	6.040	.000	0.078	0.153
b1-teacher	0.116	0.020	2.152	.031	0.004	0.081
b2-parent	0.043	0.014	−1.912	.056	−0.053	0.001
b3-teacher^2	−0.026	0.018	2.712	.007	0.014	0.085
b4-teacher × parent	0.050	0.012	−4.766	.000	−0.083	0.035
b5-parent^2	−0.059	0.024	−31.720	.000	−0.820	−0.724
a1 = b1 + b2	0.158	0.025	6.231	.000	0.109	0.208
a2 = b3 + b4 + b5	−0.035	0.021	−1.699	.089	−0.077	0.005
a3 = b1-b2	0.073	0.030	2.485	.013	0.016	0.131
a4 = b3-b4 + b5	−0.135	0.030	−4.447	.000	−0.194	−0.075
a5 = b3-b5	0.032	0.018	1.760	.078	−0.004	0.068
Language						
b0-intercept	0.138	0.011	12.338	.000	0.116	0.159
b1-teacher	0.100	0.009	11.41	.000	0.083	0.118
b2-parent	0.013	0.009	1.494	.135	−0.004	0.031
b3-teacher^2	−0.016	0.007	−2.286	.022	−0.029	−0.002
b4-teacher × parent	0.006	0.008	0.702	.483	−0.011	0.023
b5-parent^2	−0.0334	0.006	−5.816	.000	0.116	0.159
a1 = b1 + b2	0.114	0.012	9.725	.000	0.091	0.137
a2 = b3 + b4 + b5	−0.044	0.009	−4.749	.000	−0.062	−0.026
a3 = b1-b2	0.087	0.013	6.515	.000	0.061	0.113
a4 = b3-b4 + b5	−0.056	0.015	−3.757	.000	−0.085	−0.027

The significance of a_1 and a_2 suggests the effect is along the line of congruence. There is a linear and quadratic prediction from the similarity of perceived parental mastery goals on students' math performance. Students' language performance is higher, while perceived parental and teacher mastery goals have the same score and the degree is higher. A positive a_3 and a negative a_4 values suggest that discrepancies between teachers' and parents' mastery goals can impact language performance in similar ways as they do in mathematics performance. Figure 2 illustrates these effects.

Performance goals and academic performance

Table 7 showcases models that assess the influence of teachers' and parents' performance goals on students' academic achievement. Also, the full models demonstrated the smallest AICc value among all models, with significant adjusted R^2_{adj}.

Polynomial regression analysis revealed how parents' and teachers' performance goals were related to students' mathematics performance. The regression results were as follows (see Table 8): $a_1 = 0.07$ ($SE = 0.025$, $p = .008$), $a_2 = -0.03$ ($SE = 0.021$, $p = .149$), $a_3 = 0.08$ ($SE = 0.027$, $p = .005$) and $a_4 = -0.09$ ($SE = 0.030$, $p = .002$).

A significant a_1 with a nonsignificant a_2 suggests the effect along the line of congruence in performance goals between teachers and parents. There is a linear prediction from the similarity of perceived parental performance goals on students' math performance. Along the line of discrepancy, the significant and negative a_4 value implies that the degree of discrepancies between teacher's and parent's performance goals do impact students' mathematics performance. A positive a_3 value

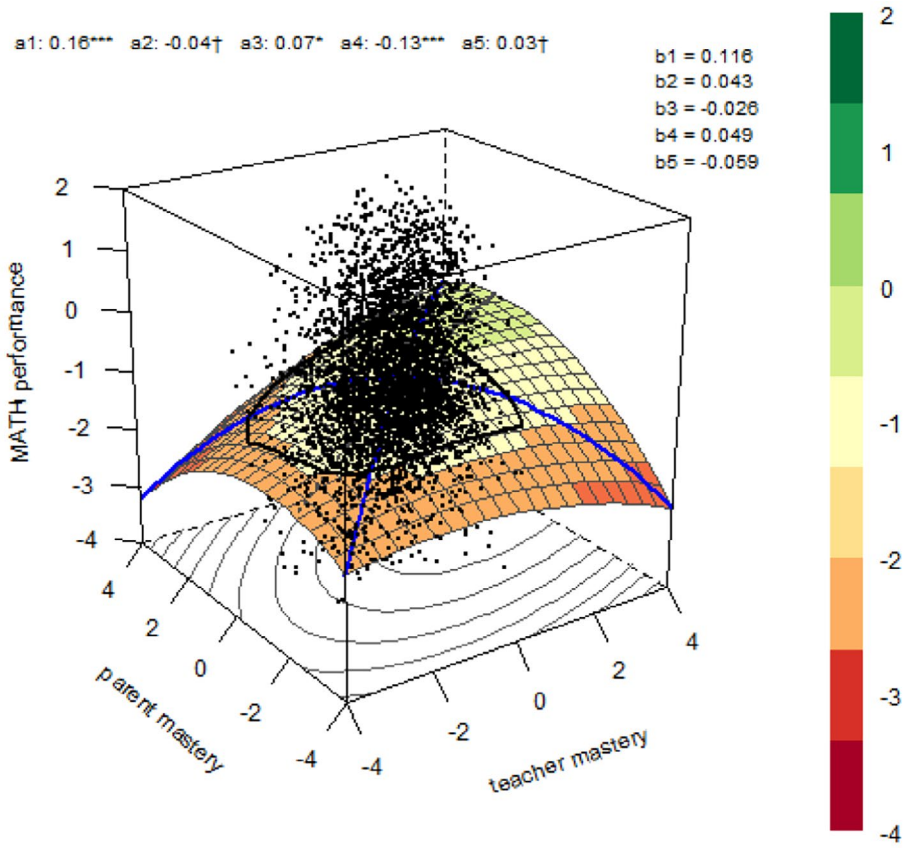

FIGURE 1 Response surface of the mastery goals on students' math performance.

suggests that the direction of incongruence also impacts the students' mathematics performance. This effect is stronger when a teacher's performance goal exceeds the parents' performance goal (see Figure 3).

For language performance, the results of the polynomial regression analysis were as follows: $a_1 = 0.02$ ($SE = 0.011$, $p = .151$), $a_2 = -0.03$ ($SE = 0.008$, $p = .004$), $a_3 = 0.06$ ($SE = 0.012$, $p < .001$) and $a_4 = -0.03$ ($SE = 0.013$, $p = .030$).

Except a_1 ($p = .1$), all parameters passed the significance test (see Table 8). The nonsignificant a_1 value with a significant a_2 suggests that There is a quadratic effect prediction from the similarity of perceived parental performance goals on students' language performance. Same as previous results, the significant a_3 and a_4 values showed that the direction of incongruence between perceived parental performance goals impacts the students' language performance. This effect is stronger when the level of teacher's performance goal is higher than the parents' (see Figure 4).

DISCUSSION

Limited research has examined the prediction of (in)congruence of perceived achievement goals set by teachers and parents on child academic outcomes. This research utilized polynomial regression with response surface analysis to explore how the (in)congruence in perceptions of parent and teacher achievement goals influence students' academic performance. Overall, this study discerned the influence of goal congruence on students' academic achievement, which appears to vary across subjects.

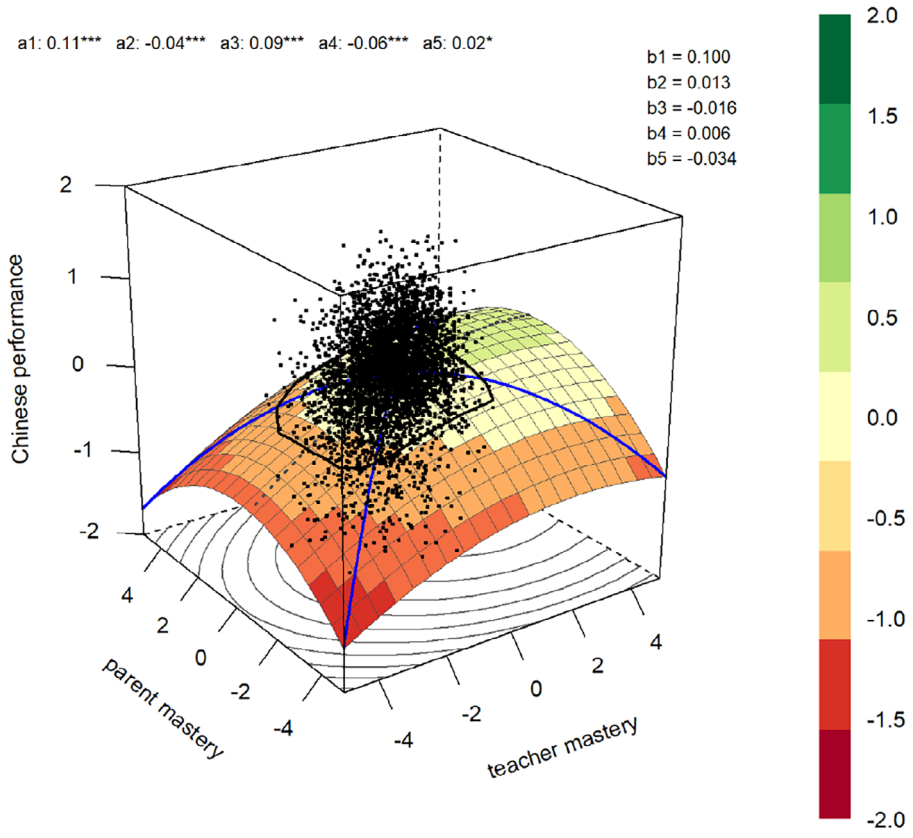

FIGURE 2 Response surface of the mastery goals on students' language performance.

TABLE 7 Model selection of performance goals on academic performance.

Model	AICc	ΔAICc	AICcWt	CFI	p_{model}	R^2_{adj}
Math						
Full	13628.848	1.909	0.263	1.000	.000	.008
SRR	13633.313	6.374	0.028	0.830	.000	.007
SSQD	13633.505	6.566	0.026	0.799	.000	.007
Additive	13641.698	14.759	0.000	0.584	.000	.005
RR	13642.475	15.536	0.000	0.564	.000	.005
Language						
Full	6696.148	1.879	0.280	1.000	.000	.013
SSQD	6705.739	11.470	0.002	0.790	.000	.010
SRR	6707.666	13.397	0.001	0.775	.000	.010
Additive	6709.819	15.550	0.000	0.722	.000	.010
RR	6737.229	42.960	0.000	0.266	.000	.004

Congruence of mastery goals and students' academic performance

Polynomial regression with response surface analysis results revealed that the congruence between mastery goals set by parents and teachers positively influenced students' mathematics performance. As the

TABLE 8 Polynomial regression result of performance goals on academic performance.

	Estimate	*SE*	*z*	*p*	CI. low	CI. upp
Math						
b0-intercept	0.072	0.018	3.909	0.000	0.036	0.108
b1-teacher	−0.005	0.019	−0.257	0.797	−0.041	0.032
b2-parent	−0.009	0.014	−0.637	0.524	−0.037	0.019
b3-teacher^2	0.032	0.017	1.814	0.070	−0.003	0.066
b4-teacher × parent	−0.053	0.013	−4.171	0.000	−0.078	−0.028
b5-parent^2	−0.780	0.024	−32.553	0.000	−0.827	−0.733
a1 = b1 + b2	0.067	0.025	2.671	0.008	0.018	0.117
a2 = b3 + b4 + b5	−0.030	0.021	−1.444	0.149	−0.071	0.011
a3 = b1-b2	0.077	0.027	2.825	0.005	0.024	0.130
a4 = b3-b4 + b5	−0.094	0.030	−3.147	0.002	−0.152	−0.035
Language						
b0-intercept	0.038	0.008	4.554	0.000	0.022	0.054
b1-teacher	−0.022	0.008	−2.587	0.010	−0.038	−0.005
b2-parent	−0.002	0.006	−0.369	0.712	−0.015	0.010
b3-teacher^2	0.002	0.008	0.259	0.795	−0.014	0.018
b4-teacher × parent	−0.025	0.006	−4.273	0.000	−0.036	−0.013
b5-parent^2	0.120	0.011	10.661	0.000	0.098	0.142
a1 = b1 + b2	0.016	0.011	1.436	0.151	−0.006	0.038
2 = b3 + b4 + b5	−0.025	0.010	−2.615	0.009	−0.044	−0.006
a3 = b1-b2	0.059	0.012	4.870	0.000	0.035	0.083
a4 = b3-b4 + b5	−0.029	0.013	−2.173	0.030	−0.056	−0.003

congruence increased between mastery objectives set by parents and teachers, so did students' mathematics performance, which was in line with previous studies (Friedel et al., 2010; Gherasim et al., 2013). These findings suggest that students' perceptions of their parents' and teachers' mastery goals significantly impact their academic achievement in mathematics.

For language subjects, a positive correlation was observed between the congruence of mastery goals and student performance at low to medium stages of congruence. This finding is in line with previous research, which indicates that mastery goals can facilitate Chinese students' learning and enhance their reading performance (Elliot et al., 2018). However, it is important to note that at exceptionally high levels of congruence, students' language performance showed a tendency to decline. This indicates that there is an optimal level of goal congruence between parents and teachers, beyond which student outcomes in language studies might be negatively impacted. One reason for this observation could be the presence of mediating factors. While mastery goals are typically associated with a strong mastery structure, deep cognitive strategies, motivation, positive attitudes and high aspirations, they can negatively correlate with surface learning strategies and motives (Ng, 2018). Considering language acquisition, surface learning strategies are instrumental in facilitating the memorization and retention of detailed linguistic knowledge (Liem et al., 2008; Wynn-Williams et al., 2016), and these strategies have been shown to enhance language performance (Dahlin & Watkins, 2000; Trigwell et al., 2013).

Congruence of performance goals and students' academic performance

Students' mathematical achievement demonstrated a significant relationship with the perceived performance goals set by parents and teachers. The congruence of performance goals between parents

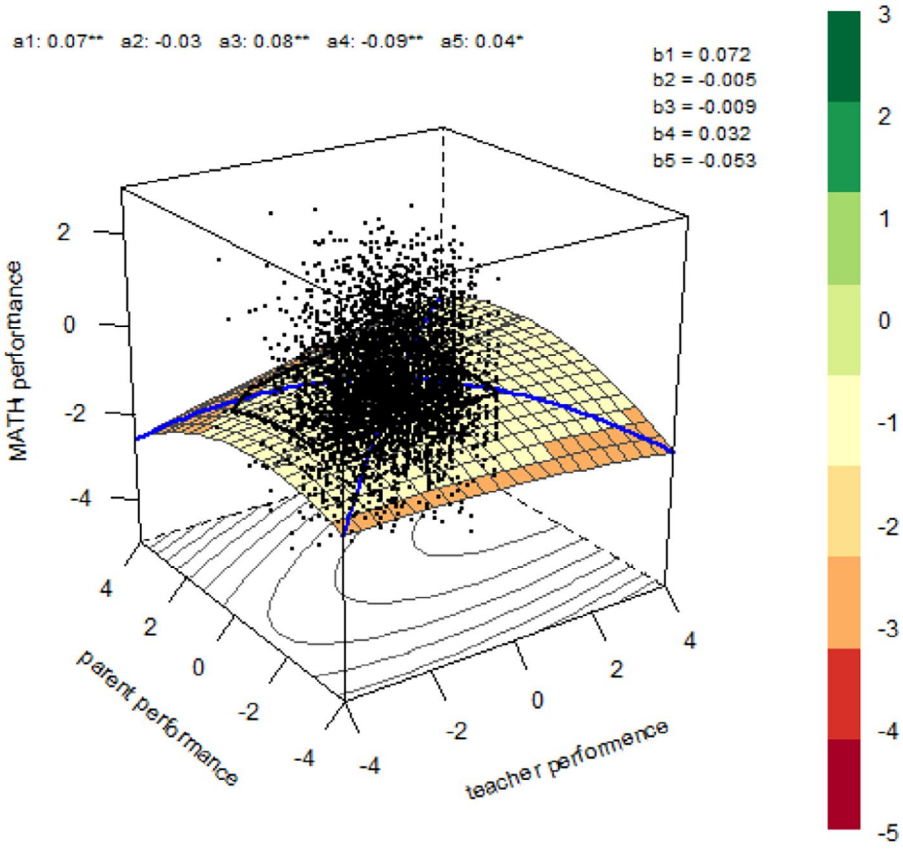

FIGURE 3 Response surface of the performance goals on students' math performance.

and teachers was positively correlated with students' performance in mathematics, which is in line with previous studies (Church et al., 2001; Jiang et al., 2013).

Results showed that the congruence of performance goals between teachers and parents did not correlate with improved language performance among students. This is in line with some studies showing that performance-approach goals did not predict language learning achievements (Troia et al., 2013).

Incongruence between perceived parents' and teachers' achievement goals in different subjects

Results of the response surface diagram and previous analysis reveal that students' mathematics performance improves linearly with the congruence level of parents' and teachers' performance and mastery goals; however, this pattern does not extend to language performance. Congruence in perceived parents' and teachers' mastery goals alone can predict students' language achievement, with a medium level of congruence promoting students' language academic performance more effectively. Additionally, the congruence of performance goals did not correlate with language performance.

Prior research indicates that students can hold different goal orientations simultaneously, adopting various orientations across disciplines or knowledge fields (Anderman & Maehr, 1994; Friedel et al., 2007; Pintrich, 2000). This difference was also reflected in the response surface in the present study. One possible explanation for the observation that congruence in performance goals improves students' performance only in mathematics may be associated with engaging in challenging tasks and

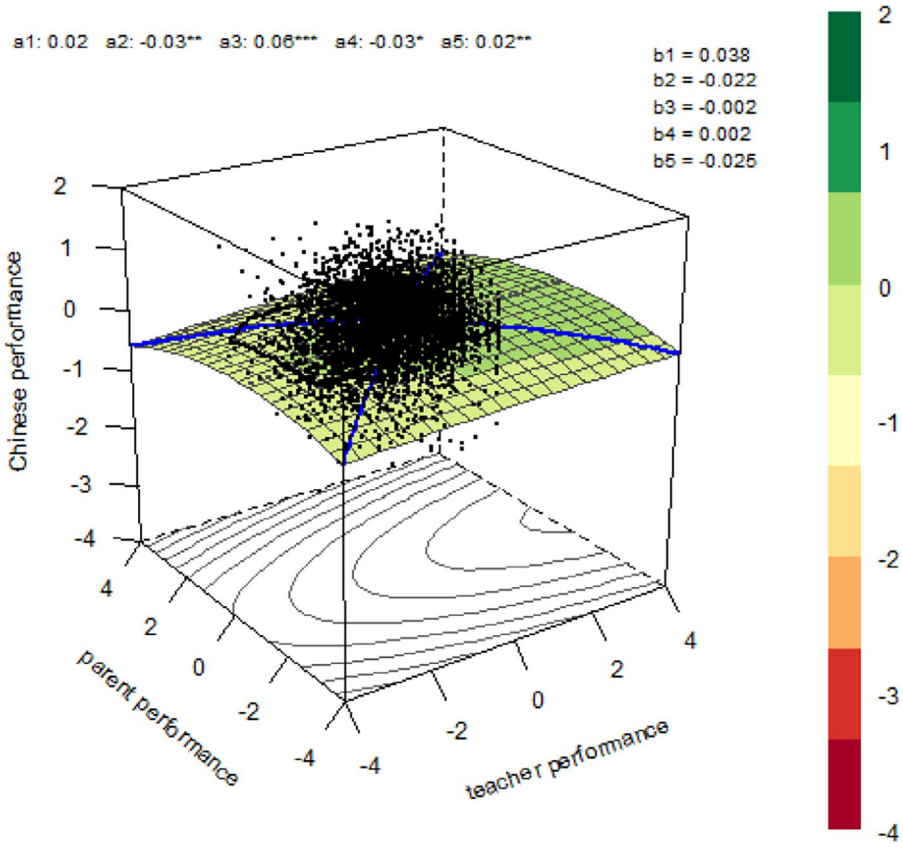

FIGURE 4 Response surface of the performance goals on students' language performance.

requiring deep cognitive processing, which are integral to mathematics learning (Friedel et al., 2007; Gherasim et al., 2013). Therefore, when both teachers and parents prioritize the mastery of knowledge, it can significantly enhance the efficacy of students' mathematics education. In the context of Chinese educational system, where academic performance is highly valued (Qian & Lau, 2022), achievement orientations are particularly suited to the competitive academic environment. However, language learning emphasizes knowledge mastery and accumulation; therefore, focusing on knowledge mastery plays a crucial role in influencing students' language performance. Apart from deep cognitive processing, surface-level memory and other strategies also play a crucial role in language learning. Hence, excessive emphasis on in-depth mastery by parents and teachers may hinder improvements in students' language performance (Ng, 2018).

This study also found that when the perceived achievement goals of teachers and parents were incongruent, teachers' goals had a more significant impact on students. This observation aligned with that of Larrivee et al. (1997), concluding that teachers are the primary factor in students' learning at school. Hence, when there is a discrepancy in the achievement goal levels of parents and teachers, students may pay more attention to the teachers' goal orientation. Teachers' support and adaptive instructions, particularly their achievement goals, often have a substantial influence on students' academic performance (Ho & Lau, 2018; Qian & Lau, 2022). This effect might be more pronounced in the sample of this study, which is chiefly composed of migrant children who spend more time at school with teachers than with parents, thus making teachers' goal orientations more influential (Li et al., 2010).

Even though teachers' goal orientation is more effective in predicting students' academic performance when a discrepancy exists between teachers' and parents' goal orientation, parental involvement remains an important factor for students' academic performance. As Hill and Tyson (2009) noted, when the information between home and school is consistent, students understand the information more clearly and accurately. Therefore, schools and teachers should enhance communication and cooperation with parents to jointly promote students' performance.

Implications and limitations

This study reveals the combined effects of perceived teacher achievement goals and parental achievement goals on students' academic achievement, with a detailed analysis conducted according to different types of goals and subjects. The findings have implications for educational practice and future research.

The positive correlation between the congruence of parents' and teachers' performance and mastery goals with students' mathematics achievement suggests that consistency in goals can significantly enhance students' performance in mathematics. This finding further underscores the importance of home–school collaboration and communication, particularly in coordinating learning goals and strategies in mathematics. Therefore, schools need to establish mutually trusting and respectful home–school partnerships. This involves not only setting up consistent communication channels to facilitate contact, such as phone calls, emails and digital platforms (Stamatis & Chatzinikola, 2021), but also including parents in the educational process by organizing workshops (Steiner & Cassano, 2017) and teaching them how to set goals and support their children.

The perceived congruence of parent and teacher goals exhibits different characteristics in relation to language achievement. Regarding performance goals, the findings indicate that the congruence of performance goals is negatively associated with students' language performance, suggesting that future research should further explore the mechanisms by which different factors influence language achievement. Compared to performance goals, mastery goals are more likely to help improve students' language achievement. Therefore, parents and teachers should create a learning environment that prioritizes understanding and skill development. Professional training can equip both parents and teachers with the necessary skills and knowledge to support this approach (Hornby & Witte, 2010). Future interventions might explore ways to strengthen the congruence of mastery goals between parents and teachers to enhance student success in language subjects. However, at high levels of congruence, the positive correlation between mastery goal congruence and language achievement weakens or even reverses. This finding serves as a caution for parents and teachers, when setting mastery goals in language subjects. Setting overly ambitious expectations may not necessarily benefit student performance (Marsh et al., 2023). Instead, teachers and parents should avoid excessive demands and focus on fostering interest and personal growth in language learning.

Beyond the differences in subjects and goal types, the study also found that when there is incongruence between parental and teacher goals, the teacher's goals tend to have a greater impact. This highlights the pivotal role of educators. In educational practice, teachers can take on a leading role by providing parents with resources and training (Fan & Chen, 2001), as well as offering feedback and recommendations (Cheatham & Ostrosky, 2011). This approach helps create a supportive home environment, reinforcing the effectiveness of teachers' goals (Suizzo et al., 2023). Optimal student progress and personal growth can only be achieved when both parents and teachers effectively fulfil their respective roles.

Despite these findings, the study has limitations. First, the effect sizes are relatively small and should be interpreted with caution. Although the findings of this study are consistent with previous research (Ogg et al., 2021; Tiedemann, 2000), student achievement is influenced by multiple factors, including individual differences and external environmental conditions. Academic performance is directly affected by more significant factors, such as the learning environment and goal specificity (Sattar et al., 2022). The involvement of parents and teachers results in relatively minor differences

in academic outcomes. This suggests that, while the goals of parents and teachers are statistically significant, their overall impact is limited. Additionally, students' understanding of goals can affect how these goals influence academic outcomes. Mouratidis et al. (2018) found that students' preferences for certain types of goals can influence their perception of classroom objectives. As a result, if students misunderstand the goals of their parents or teachers, they may fail to take appropriate actions. For example, Ciciolla et al. (2017) discovered that when students perceive that their parents or teachers place excessive emphasis on achievement, they experience anxiety and stress, especially when they feel incapable of meeting these expectations. Misunderstanding of goals is particularly evident among younger students, as they are in a developmental stage where they may struggle to comprehend the subtle differences between various goals. In this study, although the Patterns of Adaptive Learning Scale (PALS) has been validated for its appropriateness among primary and middle school students (Ross et al., 2002), this validation only confirms its reliability and validity in measuring perceived goals. However, we cannot rule out the possibility of students misperceiving the goals of their parents and teachers. This also calls for future studies to include other variables, such as learning motivation and relationships with parents and teachers.

Second, it only distinguished between types of achievement goals, focusing on the influence of the achievement approach goal; however, it did not consider the approach–avoidance distinction within the mastery goal. Hoon et al. (2024) suggest that focusing on avoiding failure, rather than achieving mastery, can result in negative academic consequences. This indicates that future research should further differentiate between specific goal types to explore more stable connections between parents' and teachers' goals and academic achievement.

Third, while exploring the influence of the perceived achievement goals set by teachers and parents on students' academic performance, students' personal achievement goals were not considered to possibly mediate this relationship. When students face multiple goals simultaneously, their strategies for prioritizing specific goals based on the environment can lead to varying academic outcomes (Darnon et al., 2010). In other words, students' perceptions of their parents' goals do not directly predict their own goal orientation; rather, this relationship is mediated by their self-regulation motivation (Kim et al., 2010). Consequently, the perceived congruence of achievement goals between teachers and parents may also influence students' personal achievement goals in varying ways, which merits further investigation. Lastly, demographic data were not included in the analysis due to the complexity of the model.

CONCLUSION

This study examined the achievement goals set by parents and teachers, as perceived by students, at varying levels of congruence and their impact on students' academic performance in language and mathematics. Moderate enhancement of students' academic achievement goals by parents and teachers within a certain range was found to improve students' performance. However, significant discrepancies between the goals set by parents and teachers may lead to poorer academic performance. Additionally, the applicability of different types of achievement goals needs to be considered when setting discipline-specific goals.

AUTHOR CONTRIBUTIONS

Ningning Zhao: Writing – original draft; conceptualization; methodology; supervision; funding acquisition. **Xiaohan Chen:** Writing – original draft; writing – review and editing; formal analysis; data curation. **Fumei Chen:** Investigation; data curation. **Rui Luo:** Writing – original draft; writing – review and editing; investigation; formal analysis. **Diya Dou:** Writing – original draft; writing – review and editing; supervision; funding acquisition. **Xiaoqin Zhu:** Writing – review and editing. **Guo-Xing Xiang:** Writing – review and editing; writing – original draft.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The corresponding authors can be contacted to request the data used in this study upon reasonable request.

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