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Ability self-concepts and parental support may protect adolescents when they experience low support from their math teachers

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ABSTRACT

Introduction: Experiencing low support from teachers can be associated with low academic achievement. Nonetheless, individual- (i.e., ability self-concepts) and contextual-level (i.e., parental support) protective factors may help adolescents to display academic resilience. This study examined whether high school students' math ability self-concepts and parental support can mitigate the possible negative association between perceived low math teacher support and their math achievement.

Method: Correlational data were drawn from the High School Longitudinal Study (N = 14,580, M_{age} = 17.42 in 11th grade, 51% female), a nationally representative study of high school students in the U.S. The measures of protective factors (i.e., math ability self-concepts and parental support) were obtained from the surveys administered to students and parents in 9th grade. Students' perceived teacher support and their math achievement score were measured in 11th grade. A series of linear regression analyses were estimated to test our hypotheses.

Results & Conclusions: Perceived low teacher support was negatively associated with adolescents' math achievement. Adolescents' math ability self-concepts were directly and positively associated with their math achievement. The interaction between perceived low teacher support and ability self-concepts in predicting adolescents' achievement varied by parental support. The association between perceived low teacher support and adolescents' math achievement was not statistically significant when adolescents were high on one of the protective factors. That is, high parental support may be protective for adolescents with low math ability self-concepts. This study highlights the interaction between adolescents' academic motivation and parental support in demonstrating resilience to perceived low teacher support.

1. Introduction

Adolescents' high school math achievement is considered a gateway to many STEM (Science, Technology, Engineering, and Mathematics) courses, college majors, and occupations with math ability serving as a core skillset in numerous STEM disciplines (Wang, 2013; Watt et al., 2017). Despite the importance of adolescents' math skills, only one in four U.S. high school students perform at or above proficiency for higher education in mathematics (NCES, 2015). Scholars have argued that having an unsupportive teacher may contribute to adolescents' underachievement in math (Murray, 2009; Roorda et al., 2011) given the importance of social support within educational contexts for adolescents' academic success (Chong et al., 2018; McGrath & Van Bergen, 2015).

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However, the extent to which low support from teachers is associated with adolescents' math achievement may vary depending on the individual- and contextual-level protective factors available to the adolescents (Rutter, 1987; Zimmerman et al., 2013). One of the strongest predictors of students' achievement is their beliefs about their abilities, as known as ability self-concepts (Wigfield et al., 2015). Because adolescence is a time when individuals are developing a keen understanding of who they are and what they believe they are good at (Eccles, 2009), adolescents who feel competent in math may be more likely to overcome the challenge of having a less supportive math teacher. For adolescents who lack this individual-level protective factor, academic support from parents (e.g., providing math-related experiences, co-participating in math activities) might help them display academic resilience. Though one hallmark of adolescence is autonomy, parents continue to be involved in adolescents' schooling and serve as a central source of support particularly when students encounter challenges (Fall & Roberts, 2012; Zimmerman et al., 2013). Therefore, parental support might function as a contextual-level protective factor.

Despite the significance of studying the role of teacher support in adolescence, relatively little research addresses the possible negative relations between low teacher support and adolescents' academic outcomes or the protective factors that might mitigate the possible negative effects (Roorda et al., 2011; Yu & Singh, 2018). In this study, we examined the extent to which high school students' math ability self-concepts and parental support might weaken the negative association between perceived low teacher support and their achievement on a math standardized test.

1.1. Perceived low teacher support as a challenge

Expectancy-value theory suggests that teachers influence students' motivation and achievement (Eccles & Roeser, 2009; Wigfield et al., 2015). When adolescents perceive their teachers to be emotionally and academically supportive (e.g., teacher is responsive, teacher encourages students to think, not just memorize), they are more likely to feel academically motivated and to perform better (Puklek Levpušček & Zupančič, 2009). Conversely, students who think their teacher is unsupportive may experience declines in their academic performance (Murray, 2009; Roorda et al., 2011). For example, adolescents' perception of low teacher support, such as a lack of fairness, was found to be negatively correlated with teacher-reported grades and standardized math test score (Murray, 2009). In a meta-analysis, Roorda et al. (2011) found that low emotional support from teachers, measured by constructs like neglect and dislike, predicted lower academic achievement. However, the authors noted that there are not as many existing studies that examine negative teacher-student relationships and achievement in secondary schools compared to elementary schools. Researchers who focused on the academic aspect of teacher support (e.g., encourages students to think, not just memorize) found that low academic support also can have negative implications for students' learning (Hiebert & Grouws, 2007). U.S. mathematics classrooms are often geared towards recitation rather than conceptual understanding (Hiebert & Grouws, 2007). When taught by teachers who do not emphasize conceptual development, students may feel less motivated and display lower achievement (Stipek et al., 1998; Urdan & Schoenfelder, 2006). Therefore, low math teacher support in the form of low emotional or academic support may function as a challenge that hinders high school students' learning and math achievement.

Though low teacher support may pose challenges for all students, researchers have posited this may have more negative effects on certain students (McGrath & Van Bergen, 2015). For example, students with low grades or low parental involvement were more vulnerable to the consequences of negative teacher-student relationships (McGrath & Van Bergen, 2015). Because there may be factors that moderate the associations between low teacher support and adolescents' outcomes, we tested whether adolescents' math ability self-concepts and parental support might lessen the negative relation between perceived low support from their math teacher and math achievement.

1.2. Exploring potential protective factors: Ability self-concepts and parental support

Resilience theory suggests that individuals who are equipped with protective factors, factors that can function as moderators and ameliorate the negative consequences of facing challenges, are better at coping with and overcoming contextual challenges (Rutter, 1987; Zimmerman et al., 2013). Drawing upon the expectancy-value theory, adolescents' ability self-concepts and parental support may serve as important individual- and contextual-level protective factors.

For decades, the expectancy-value theory has been used to explain the mechanisms behind students' academic outcomes (Eccles, 2009; Wigfield et al., 2015). The theory argues and empirical findings agree that one of the strongest predictors of students' academic achievement is their ability self-concepts, or one's beliefs about their current ability and ability to succeed in the future (Trautwein et al., 2012; Wigfield et al., 2015). With a strong association between students' ability self-concepts and achievement, students' ability self-concepts may serve not only as a predictor of students' achievement but also as a protective factor. In fact, students with high ability self-concepts are theorized to be less negatively influenced and to display greater effort and persistence when faced with challenges (Bandura, 1989). For example, Chong et al. (2018) found that high ability self-concepts were associated with a higher ability to cope with challenges at school for adolescents. Consequently, high ability self-concepts may serve as an individual-level protective factor where adolescents with high math ability self-concepts display greater resilience when experiencing low support from their math teacher.

The expectancy-value theory also suggests that parental support is one of the central predictors of students' achievement-related outcomes (Eccles, 2007; Wigfield et al., 2015). The Eccles' (1993) parent socialization model argues that parents provide support in various ways, such as providing learning opportunities and co-participating in activities. Though adolescents may feel a greater need for autonomy than children, parents are still a central source of support for adolescents' educational outcomes (Degol et al., 2017; Wang & Sheikh-Khalil, 2014). Accordingly, parents' co-participation in and the provision of math-related activities is associated with

greater engagement and achievement among adolescents (Simpkins et al., 2005; Wang & Sheikh-Khalil, 2014). For example, Wang and Sheikh-Khalil (2014) showed that parental support, such as visiting museums or libraries, was associated with higher academic grades for high school students. Parental support may also serve as a protective factor and moderate the association between adolescents' perceived low teacher support and academic achievement (Hill & Tyson, 2009; Simpkins et al., 2015). In fact, Collie et al. (2017) found that a group of students who had a supportive home environment were more likely to report academic resilience and less likely to report academic adversity. Consequently, adolescents who receive parental support may display greater resilience when experiencing low teacher support.

Parental support may be especially important for adolescents who have limited individual-level protective factors, in this case, low math ability self-concepts. In a review article, researchers posited that students with lower perceived competence may be more sensitive to the quality of parental support because they have a heightened need for resources that build their competence and skills (Pomerantz et al., 2007). Adolescents with low math ability self-concepts who receive low support from their teachers may further doubt their abilities unless someone else counters that narrative. Parental support could help counter such negative developmental processes. Conversely, students who have higher perceived competence may not be as influenced by parental involvement because they already have the resources that are important for competence and skill development. Because parental support may function differently depending on adolescents' level of ability self-concepts, there is a need to examine the moderating role of parental support by adolescents' ability self-concepts.

1.3. The current study

Adolescents' perception of low teacher support is associated with low achievement (Murray, 2009; Roorda et al., 2011). Nonetheless, individual- and contextual-level protective factors may help adolescents to be academically resilient when they perceive low support from their teachers. Drawing on expectancy-value and resilience theories, we tested the extent to which high school students' math ability self-concepts and parental support served as moderators of the association between perceived low math teacher support and math achievement.

In this study, we tested these relations with a nationally representative sample of U.S. adolescents with data collected in 9^{th} and 11^{th} grade ($N = 25{,}210$). We focused on adolescents' perception of teacher support, because not only are adolescents active agents in their development, but the expectancy-value model argues that students' perception and interpretation of their experiences matter in predicting their academic outcomes (Simpkins et al., 2019; Wigfield et al., 2015). Further, we focused on the relation between perceived teacher support and math achievement in 11^{th} grade, because 11^{th} grade is the last year before students begin the admission process for higher education (Kirst, 2001). The quality of learning experience and adolescents' academic achievement during 11^{th} grade may directly influence students' preparation for higher education. Another goal was to test the possible resources the adolescents possessed prior to experiencing low teacher support in 11^{th} grade. Specifically, we examined whether possible protective factors from 9^{th} grade moderated the later developmental processes at 11^{th} grade. Protective factors from 9^{th} grade may be particularly important as adolescents transition from middle to high school (Barber & Olsen, 2004) and encounter new demands and challenges (Mizelle & Irvin, 2000; Roybal et al., 2014). In addition, these protective factors may help adolescents persevere the hardships faced throughout high school (Cohen & Smerdon, 2009). Throughout our analyses, we controlled for covariates that have been shown to be associated with adolescents' academic achievement in math, which were adolescents' gender, race/ethnicity, prior math achievement, type of math course, parents' highest education, occupation, and family income (Else-Quest et al., 2013; Simpkins et al., 2015; Yu & Singh, 2018).

We hypothesized that first, perceived low math teacher support in 11^{th} grade would be negatively associated with students' math achievement in 11^{th} grade. Second, students' math ability self-concepts in 9^{th} grade would moderate the association between perceived low math teacher support and math achievement in 11^{th} grade, where the negative relation would be weaker when adolescents had higher math ability self-concepts. Third, prior parental support in 9^{th} grade would moderate the association between perceived low math teacher support and math achievement in 11^{th} grade for students varying in their level of ability self-concepts in 9^{th} grade. Specifically, parental support would be more protective for adolescents who had low ability self-concepts compared to the adolescents who had high ability self-concepts.

2. Method

2.1. Participants

The High School Longitudinal Study (HSLS) dataset was used for the present study. HSLS is a nationally representative longitudinal dataset from the U.S. National Center for Education Statistics (NCES) designed to explore high school students' educational and vocational trajectories (Ingels et al., 2011). The HSLS dataset used a two-stage stratified sampling design with schools as the primary sampling units. The first stage identified 944 high schools from 10 states. In the second stage, students were randomly sampled within strata defined by race/ethnicity, resulting in a total of 25,210 participants in the base-year study. Four waves of data were collected from 2009 to 2016. The current study used the data from the first two waves when students were in 9^{th} grade (base-year, collected in fall 2009) and 11^{th} grade (first follow-up, spring 2012).

Students who were not enrolled or were missing information about their enrollment status in math classes in 9^{th} grade ($n = 6{,}050$) or 11^{th} grade ($n = 4{,}590$) were excluded from the analyses as they were missing data on math ability self-concepts in 9^{th} grade and teacher support in 11^{th} grade. Thus, the analytic sample consisted of 14,580 participants ($M_{age} = 17.42$ in 11^{th} grade). The analytic sample was 51% female; 55% White, 20% Hispanic, 11% Black, 4% Asian, and 9% Other race/ethnicity. A comparison of the analytic

sample and the excluded sample is provided in Table 1. Of the 13 comparisons, 5 demonstrated at least a small effect; compared to the excluded sample, students in the analytic sample had higher math ability self-concepts in 9th grade ($d = 0.21$), higher math achievement in 9th grade ($d = 0.54$) and in 11th grade ($d = 0.63$). Also, they were more likely to be in more advanced math courses in 9th grade ($d = 0.27$) and be from families of higher socioeconomic status ($d = 0.46$).

2.2. Measures

Students' perception of support from their math teacher was measured using the items from the student survey and their math achievement was measured using their scores on the standardized test administered in the spring of 11th grade. The measures of protective factors were obtained from the parents' and students' 9th grade survey. See Appendix A for the list of items.

2.2.1. Math achievement

Students' math achievement in 11th grade was measured with a unidimensional IRT-estimated score. This achievement test was developed by an expert advisory panel for HSLS to provide an assessment of adolescents' algebraic reasoning (Ingels et al., 2011). The assessment consisted of 118 items that covered six algebraic content domains, such as students' understanding of the language of algebra or equations, and four algebraic processes, such as solving algebraic problems. The IRT-estimated reliability was 0.92 for the items. To ensure that the unidimensionality of the test items were met, a confirmatory factor analysis was conducted (Ingels et al., 2011).

2.2.2. Perceived math teacher support

Students reported their perceived support from their 11th grade math teacher using 5 items on a 4-point scale (α = 0.82; e.g., "11th grade math teacher doesn't let students give up."; 1 = *Strongly agree*, 4 = *Strongly disagree*). Previous studies have also used similar items that examine students' perception of classroom goal structures and teacher emotional support to measure students' perceived teacher support (e.g., Wang, 2009).

2.2.3. Math ability self-concepts

Students' math ability self-concepts are their beliefs about their ability to do well in math (Eccles, 2009; Wigfield et al., 2015). Students reported their perceived math ability self-concepts using 4 items on a 4-point scale (α = 0.86; e.g., "9th grader is confident that he/she can do excellent job on fall 2009 math tests."; 1 = *Strongly agree*, 4 = *Strongly disagree*). The scale was reverse-coded so that high scores signified strong math ability self-concepts (1 = *Strongly disagree*, 4 = *Strongly agree*).

2.2.4. Parental support

Parents reported whether they provided any academic support in the form of co-participation using 5 items (e.g., "went to science or engineering museum with 9th grader in last year."; 0 = *No*, 1 = *Yes*). Previous studies have used conceptually similar items that reflect on parents' behaviors during the after-school hours to capture parental support (e.g., Simpkins et al., 2015; Wang & Sheikh-Khalil, 2014). In the present study, the mean score of the five items was used.

Table 1
Weighted Descriptive Statistics (Analysis Sample Compared with Excluded Sample).

	Analytic sample					Excluded sample					Effect size
	N	Mean	*SD*	Min	Max	*N*	Mean	*SD*	Min	Max	
Outcome											
11th grade achievement	14580	69.41	18.71	25.01	115.10	8620	57.84	18.02	26.00	114.44	.63[a]
Predictors											
Low teacher support	14410	2.15	0.68	1	4	5630	2.11	0.64	1	4	.01[a]
Ability self-concepts	14540	2.97	0.63	1	4	8720	2.83	0.70	1	4	.21[a]
Parental support	13780	0.64	0.26	0	1	10070	0.60	0.28	0	1	.15[a]
Covariates											
Female	14580	0.51	0.50	0	1	10580	0.46	0.50	0	1	.05[b]
White	14580	0.55	0.50	0	1	10580	0.46	0.50	0	1	.09[b]
Hispanic	14580	0.20	0.40	0	1	10580	0.27	0.44	0	1	.08[b]
Black	14580	0.11	0.32	0	1	10580	0.17	0.38	0	1	.09[b]
Asian	14580	0.04	0.20	0	1	10580	0.02	0.14	0	1	.06[b]
Other race/ethnicity	14580	0.09	0.29	0	1	10580	0.08	0.28	0	1	.02[b]
SES	14580	0.05	0.80	−1.75	2.88	10580	−0.31	0.78	−1.93	2.57	.46[a]
9th grade achievement	14580	41.81	11.53	15.87	69.93	10420	35.56	11.66	15.85	69.93	.54[a]
9th grade math course	13750	4.33	1.48	0	11	9890	3.88	1.89	0	13	.27[a]
Observations	14580					10630					

Note. *SD* = Standard deviation. SES = composite of socioeconomic status adjusted for urbanicity. Convention for [a]Cohen's *d*: small 0.2, medium 0.5, large 0.8. [b]Phi coefficient: small 0.1, medium 0.3, large 0.5. Sample size rounded to the nearest ten in accordance to NCES regulation.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

2.2.5. Covariates

Students' demographic information including their gender, race/ethnicity, 9th grade math achievement using the IRT-estimated score (i.e., a criterion-referenced measure of achievement on algebraic reasoning assessment which was similarly constructed and administered as the assessment in 11th grade), and socioeconomic status (i.e., a composite measure of parents' education, occupation, and family income) collected in 9th grade were included in the analyses as covariates. Also, students' highest-level math course taken in 9th grade (1 = *Basic math*, 13 = *AP/IB calculus*) from the high school transcript was included.

2.3. Data analyses

All analyses except the simple slope analysis were performed using Stata 14. All models estimated in this study were weighted to account for the nonresponse rate in the sampling process (WEIGHT = W1PARENT). Also, strata and primary sampling unit (i.e., schools) variables were used to correct standard errors for the stratified design of the data. In all of our regression models, several adolescent and family characteristics, namely, adolescents' gender, race/ethnicity, prior math achievement, type of math course, parents' highest education, occupation, and family income were included as covariates.

To test the hypotheses, a series of linear regression analyses were conducted after mean-centering all continuous predictors (Aiken & West, 1991). When testing interaction effects, researchers suggest mean-centering the predictor variables to reduce multicollinearity (i.e., high correlation between the predictors and the interaction term) and for a direct interpretation of the main effects by the predictors (Aiken & West, 1991; Dawson, 2014). First, we hypothesized perceived low math teacher support would be negatively associated with adolescents' math achievement. Simple regression analysis was conducted to test the association between perceived low teacher support and adolescents' achievement after controlling for several adolescent and family characteristics, including 9th grade math achievement.

Second, we hypothesized adolescents' math ability self-concepts would moderate the association between perceived low teacher support and adolescents' math achievement. We estimated two regression models to test this hypothesis. We estimated a model with the main effects of perceived low teacher support and ability self-concepts predicting adolescents' achievement. Then, we estimated a second model where we added the interaction between perceived low teacher support and adolescents' ability self-concepts.

Third, we hypothesized parental support would moderate the association between perceived low teacher support and math achievement for adolescents varying in their level of math ability self-concepts. Specifically, among adolescents with low ability self-concepts, we expected the negative association between adolescents' perceived low teacher support and their achievement to weaken as parental support increased; we expected a similar pattern among adolescents with high ability self-concepts, but it would not be as pronounced. To test this hypothesis, we estimated two regression models. We estimated the main effects of perceived low teacher support, ability self-concepts, and parental support. Then, we estimated a model that included those three main effects, the three relevant 2-way interactions (teacher support by ability self-concepts, teacher support by parental support, parental support by ability self-concepts), and the 3-way interaction. Using the information from the three-way interaction model, a simple slope analysis was conducted by generating slopes for values ± 1 *SD* from the mean of the moderators to determine the groups that display the significant association (Aiken & West, 1991; Preacher et al., 2006).

To improve estimation procedures, missing values were handled through multiple imputation (Enders, 2010). Twenty datasets were imputed. Most of the missing values were due to parents not responding to the survey (n = 3,550). As a robustness check, we conducted the same analyses after dropping these parent observations.

3. Results

Table 1 shows the descriptive statistics and Table 2 displays the correlations among the variables. As predicted, a negative correlation was found between perceived low math teacher support and 11th grade math achievement ($r = -0.11$). Ability self-concepts and parental support in 9th grade were positively correlated with students' 11th grade achievement ($r = 0.30$ and $r = 0.12$ respectively). A strong positive correlation was found between 9th and 11th grade math achievement ($r = 0.74$).

A series of linear regression analyses were estimated to test our three hypotheses (see Table 3). First, as hypothesized and shown

Table 2
Bivariate Correlations.

Variables		1	2	3	4	5	6	7	8
1.	Math achievement (11th grade)	-							
2.	Low teacher support (11th grade)	-.11*	-						
3.	Ability self-concepts (9th grade)	.30*	-.14*	-					
4.	Parental support (9th grade)	.12*	-.02	.07*	-				
5.	Female	-.03*	.01	-.07*	-.10*	-			
6.	SES	.39*	-.01	.21*	.10*	-.01	-		
7.	Math achievement (9th grade)	.74*	-.08*	.12*	.30*	-.03*	.37*	-	
8.	Math course (9th grade)	.34*	-.03*	.09*	.14*	.02	.24*	.37*	-

Note. *$p < .01$.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

Table 3
Results of the Linear Regression Analyses with 11th Grade Math Achievement as the Outcome.

Results of the Linear Regression Analyses with 11th Grade Math Achievement as the Outcome

Models / Predictors	1. Low teacher support (LTS)	2. Ability self-concepts (SC)	3. LTS X SC	4. SC & PS	5. 3-way interaction
Low teacher support (LTS)	**-1.51*** **	-1.25***	-1.26***	-1.25***	-1.23***
	(0.30)	(0.31)	(0.31)	(0.31)	(0.30)
Ability self-concepts (SC)		**2.51*** **	2.53***	2.51***	2.45***
		(0.37)	(0.37)	(0.37)	(0.35)
Parental support (PS)				0.67	0.38
				(0.73)	(0.75)
LTS X SC			**-0.46**		-0.38
			(0.47)		(0.44)
LTS X PS					2.03
					(1.34)
SC X PS					2.31
					(1.37)
LTS X PS X SC					**-4.38***
					(2.11)
Controls					
Female	-0.33	-0.01	0.00	0.01	0.03
	(0.37)	(0.38)	(0.38)	(0.38)	(0.38)
Hispanic	-0.71	-0.66	-0.66	-0.66	-0.65
	(0.62)	(0.60)	(0.60)	(0.60)	(0.59)
Black	-1.56	-2.02	-2.03	-2.03	-2.00
	(1.18)	(1.16)	(1.16)	(1.17)	(1.16)
Asian	4.22***	4.20***	4.18***	4.25***	4.25***
	(0.76)	(0.78)	(0.78)	(0.78)	(0.78)
Other race/ethnicity	-0.37	-0.45	-0.46	-0.46	-0.47
	(0.71)	(0.71)	(0.71)	(0.71)	(0.70)
SES	2.75***	2.79***	2.79***	2.74***	2.76***
	(0.28)	(0.28)	(0.28)	(0.27)	(0.27)
9th grade math achievement	1.05***	1.01***	1.01***	1.01***	1.01***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
9th grade math course	0.78***	0.75***	0.75***	0.75***	0.75***
	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)
Constant	22.12***	23.88***	23.84***	23.91***	23.83***
	(0.80)	(0.88)	(0.87)	(0.88)	(0.87)
Observations	14580	14580	14580	14580	14580
R-squared	0.595	0.602	0.602	0.602	0.604

Note. Standard errors are in parentheses. White is the reference group. Sample size rounded to the nearest ten in accordance to NCES regulation.
*$p < .05$. **$p < .01$. ***$p < .001$.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

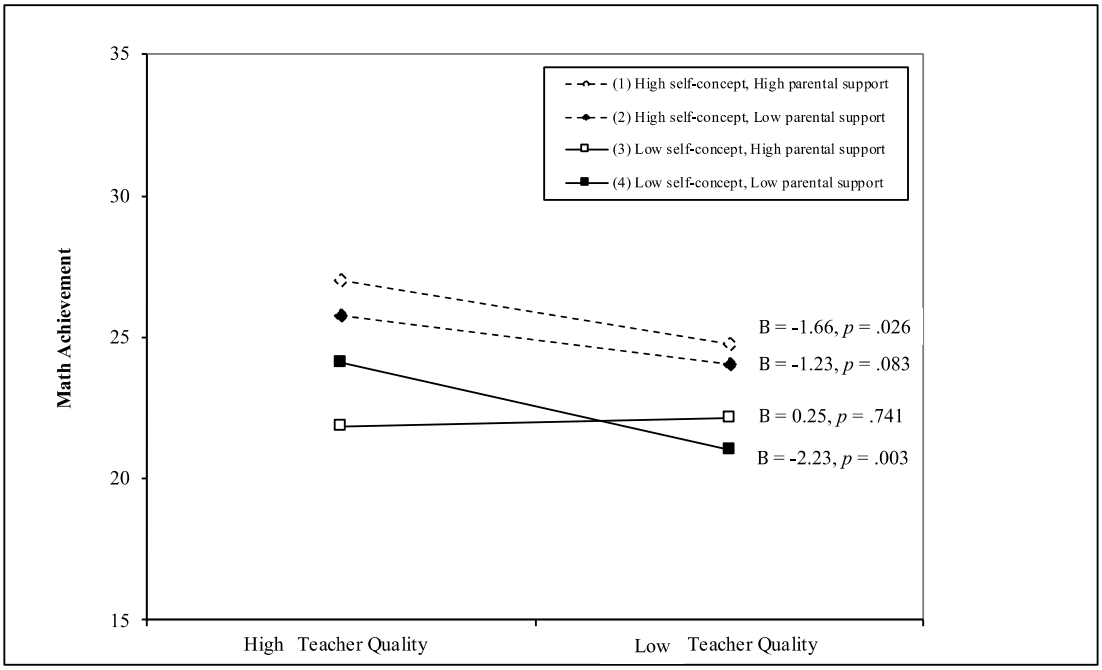
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

under Model 1, perceived low math teacher support in 11th grade negatively predicted students' 11th grade math achievement (B = −1.51, $p < .001$) while controlling for students' demographics, 9th grade math achievement score, and math course. Second, as shown under Model 2, math ability self-concepts positively and directly predicted 11th grade math achievement (B = 2.51, $p < .001$). Contrary to our hypothesis and as shown under Model 3, the relation between perceived low math teacher support and math achievement was not moderated by adolescents' math ability self-concepts (B = −0.46, $p = .329$). Third, as hypothesized and shown under Model 5, the 3-way interaction was found to be statistically significant (B = −4.38, $p < .05$). That is, the interaction between perceived low math teacher support and adolescents' math ability self-concepts in predicting adolescents' math achievement varied by the level of parental support.

The findings from the 3-way interaction were further evaluated using the simple slope analysis (see Fig. 1). As expected, perceived low teacher support was linked to lower achievement when adolescents were low on both protective factors, namely low ability self-concepts and low parental support (B= −2.23, $p = .003$). Also as expected, perceived low teacher support was *not* significantly associated with adolescents' achievement when adolescents with low ability self-concepts received high parental support (B = 0.25, $p = .741$) or when adolescents with high ability self-concepts had low parental support (B = −1.23, $p = .083$). That is, adolescents did not significantly differ in their math achievement under high and low perceived math teacher support when they were high on one of the protective factors. In addition, the simple slope analysis examined the differences between the slopes of the high and low parental support groups among adolescents with low ability self-concepts (Dawson, 2014). In our hypothesis, we expected the negative relation between perceived low math teacher support and adolescents' math achievement to be weaker for adolescents with low math ability self-concepts if they had high parental support compared to low parental support. The slopes of those two groups were significantly different (Fig. 1; t [492] = 25.69, $p < .001$). Specifically, the association between perceived low teacher support and adolescents' achievement was not statistically significant when adolescents with low ability self-concepts had high parental support but was significantly negative when adolescents lacked both ability self-concepts and parental support.

There was one unexpected finding. Perceived low math teacher support was linked to adolescents' lower math achievement when adolescents were high on both protective factors: high math ability self-concepts and high parental support (B = −1.66, $p = .026$). We had expected this relation to be non-significant. We should note that this effect was significant at $p < .05$ with a very large sample size ($n = 14{,}580$).

Finally, we re-estimated all of these models on the sample of 11,030 families that excluded the non-response parent observations. The patterns were similar to the main analyses presented in the text (see Appendix B).



Note. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

Fig. 1. 3-way interaction plot for the comparison between groups with varying levels of ability self-concepts and parental support.

4. Discussion

Based on expectancy-value and resilience theories, we examined students' math ability self-concepts and parental support in 9th grade as moderators of the association between perceived low math teacher support and students' achievement on a math standardized test in 11th grade. We found that perceived low math teacher support in 11th grade was negatively associated with 11th grade math achievement even after controlling for 9th grade achievement. Also, adolescents' math ability self-concepts directly and positively predicted adolescents' achievement. Lastly, the interaction between perceived low math teacher support and adolescents' math ability self-concepts in predicting math achievement varied by the level of parental support.

In line with our first hypothesis, perceived low math teacher support was negatively linked to adolescents' achievement on a math standardized test. This study builds on the emerging prior work suggesting that low emotional support in high school is associated with lower academic achievement (Roorda et al., 2011). To our knowledge, few studies have examined the associations between teachers' emotional and academic support combined and adolescents' academic achievement (e.g., Roorda et al., 2011). A more recent meta-analysis that considered both aspects of teacher support looked at its association with students' academic emotions rather than their academic performance (Lei et al., 2018). Overall, we found a concurrent relation where adolescents were more likely to display lower math achievement when they felt like they received low emotional or academic support from their math teacher. Also, students' achievement was measured using a standardized test administered by the study. Therefore, high school students' perception of teacher support was related not just to their grades assigned by the teacher as shown in prior work (e.g., Crosnoe et al., 2004), but also to their achievement on a standardized test. Though we cannot rule out the effects of adolescent individual differences, such as lower baseline math skills, the findings were still significant even after controlling for adolescents' prior math achievement and a host of demographic indicators, including gender.

Though the findings suggest adolescents' ability self-concepts are associated with their math achievement, these relations were not as expected. We expected adolescents' math ability self-concepts to moderate the association between perceived low teacher support and math achievement. However, we found ability self-concepts to moderate the association between perceived low teacher support and math achievement for only a particular subset of adolescents. First, we found adolescents' ability self-concepts to directly and positively predict adolescents' achievement. This main effect for math ability self-concepts on their subsequent math achievement aligns with prior research and the expectancy-value theory that argue students' ability self-concepts are strong predictors of students' academic achievement even after controlling for their prior achievement (Parker et al., 2014; Wigfield et al., 2015). We had mixed evidence on the extent to which adolescents' ability self-concepts served as a moderator. Among the full sample, ability self-concepts did not moderate the relation between perceived low teacher support and adolescents' achievement; however, our follow-up analysis of the 3-way interaction suggests it did moderate the relation for adolescents who had low parental support. These findings suggest that adolescents' math ability self-concepts might help adolescents to have higher achievement even when they have low parental support and do not feel their teacher is supportive.

Consistent with our third hypothesis, the association between perceived low teacher support and adolescents' math achievement varied across levels of adolescents' math ability self-concepts and parental support. Particularly germane to our hypothesis are differences among adolescents with low math ability self-concepts; specifically, perceived low teacher support was linked to lower achievement if adolescents also lacked parental support, but these indicators were not related if adolescents had high parental support. These findings suggest that parental support may play a protective role for adolescents who did not feel competent in their math ability (Pomerantz et al., 2007). Perceived low teacher support had the strongest negative association with achievement when they lacked both protective factors.

One unexpected finding was that perceived low teacher support was linked to lower math achievement when adolescents had high math ability self-concepts and high parental support. Even though we expected parental support to be less protective for adolescents who already had high ability self-concepts, we did not expect the association to be negative. Nevertheless, scholars argue that parental involvement can have positive or negative effects depending on how parents are involved (Pomerantz et al., 2007). For adolescents, parental support that exceeds the optimal amount and thwarts their desire for autonomy can result in negative consequences on learning (Eccles et al., 1991). Participants in this study were high school students. Adolescents with high math ability self-concepts feel like they have demonstrated their ability in math and are confident that they can master new material; thus, they may find high levels of this type of parent support as unnecessary, over controlling, and not autonomy granting. Our measure of parental support consisted of parents' co-participation in math-related activities. For adolescents with high ability self-concepts, other forms of parental support may be seen as more appropriate (Hill & Tyson, 2009). For example, Kim (2020) reported that parental support in the form of academic socialization, such as communicating to students about education expectations and future plans, may be more beneficial for high achieving adolescents than parents' co-participation in intellectual enrichment activities. Therefore, high parental support may be protective even for adolescents with high ability self-concepts if a different measure of parental support is used, such as academic socialization.

One important caveat to note in our study is that our tests are conservative estimates as we controlled for students' math achievement in 9th grade in all of our models predicting students' math achievement in 11th grade ($r = 0.74$). This demonstrates a strong stability in adolescents' math achievement across the two years. Despite the strong correlation, we kept 9th grade math achievement as a control variable to examine the associations between our predictors and students' math achievement over and beyond students' prior achievement.

Our findings displayed that math ability self-concepts were positively and strongly associated with adolescents' math achievement. Also, when adolescents had low ability self-concepts, support from their parents lessened the negative relation between low teacher support and their achievement. However and unexpectedly, parental support did not have the same effect on the association for

adolescents with high ability self-concepts. Despite the important findings of the study, it is not without limitations. First, we utilized cross-sectional data for certain aspects of the study. Though parental support and students' ability self-concepts were measured in 9th grade and 9th grade math achievement was included as a control variable, perceived low teacher support and math achievement were both measured in 11th grade. Therefore, we should be cautious about making causal claims with our findings. Second, we examined what parents typically do at home to support their adolescents' learning. Though this type of parental support is critical, less is known about the kinds of support parents provide when adolescents are faced with academic challenges. It will be important to recognize the various ways parents provide support and investigate the types of parental support that specifically responds to academic challenges, such as receiving a poor grade on a test, not getting along with their teacher, or not being treated fairly by the teacher. Third, we focused on ability self-concepts as a possible individual-level protective factor given the strong relations between these beliefs and students' achievement. However, subjective task value beliefs are another set of key motivational beliefs according to the expectancy-value theory (Eccles, 2009; Wigfield et al., 2015). Future studies could also examine how adolescents' value beliefs serve as a potential source of resilience for students.

5. Conclusion

High school math achievement is an important determinant of students' persistence in the STEM pipeline (Wang, 2013). Aligned with expectancy-value and resilience theories, our findings suggest individual- (i.e., ability self-concepts) and contextual-level (i.e., parental support) protective factors were associated with adolescents' academic resilience in high school. Specifically, we found that high parental support lessened negative academic outcomes associated with perceived low math teacher support among adolescents with low ability self-concepts. This study demonstrates that experiencing low teacher support can predict lower achievement even on a standardized test. In addition, our findings suggest that parental involvement may have varying consequences in adolescents. Parental support may be protective for those who have low ability self-concepts but hinder the performance if adolescents already feel capable in their ability. Therefore, there is a need to further investigate the different circumstances and the types of parental support that might have negative consequences for adolescents. Given our findings, teacher training and parent education to promote social support that corresponds to students' needs may help adolescents be resilient in academic settings. This study extends previous research by demonstrating the potential importance of students' ability self-concepts and the varying consequences of parental support for adolescents under academic challenges.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.adolescence.2021.01.008.

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