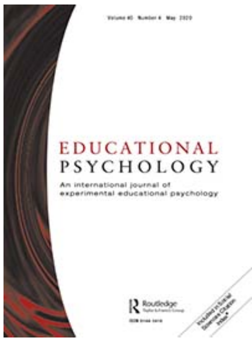

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Supporting Latino high school students' science motivational beliefs and engagement: examining the unique and collective contributions of family, teachers, and friends

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ABSTRACT

High school underrepresented minority students in the US are at an increased risk of dropping out of the STEM pipeline. Based on expectancy-value theory, we examined if Latino students' perception of support from parents, siblings/cousins, teachers, and friends in 10th grade predicted their science ability self-concepts and values, which in turn predicted their classroom engagement. Survey data were collected from 104 Latino high school students and their science teachers. The findings suggest that adolescents' perceptions of overall support and home-based support predicted adolescents' science ability self-concepts at 10th grade while controlling for their 9th grade self-concepts. Although adolescents reported high support from teachers, teacher or school-based support alone was not a strong correlate of their motivational beliefs. Perceived support was indirectly related to classroom engagement through adolescents' ability self-concepts. Feeling supported across home and school may be necessary to sustain adolescents' science motivational beliefs and, in turn, their science classroom engagement.

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Motivation; self-concept; value; Latino; engagement; science

High school is a critical turning point on the road to science, technology, engineering, and math (STEM) college majors and careers (e.g. Maltese & Tai, 2011). Studies have consistently shown that ability is not sufficient to sustain students' persistence in science (e.g. Wigfield et al., 2015). The students most likely to pursue science are those that not only believe they are good at science (i.e. ability self-concept), but also believe that science is valuable (i.e. task value; Wigfield et al., 2015). Yet, these motivational beliefs are fragile and can wane if not supported (Renninger & Hidi, 2016). The declines in students' math motivational beliefs are greatest in high school (Fredricks & Eccles, 2002). In one study, approximately 45% of 10th-grade students interested in pursuing a STEM career lost that interest by the end of high school (Aschbacher, Li, &

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Roth, 2010). The central question, therefore, becomes: What sustains students' motivational beliefs during a time when these beliefs are vulnerable to declines?

According to the Eccles' expectancy-value theory, *feeling supported* helps sustain adolescents' motivation and subsequent achievement-related choices (Wigfield et al., 2015). Feeling supported may be particularly important for underrepresented minority (URM) students as they face numerous challenges in pursuing science, such as lack of role models and being discouraged by school counselors (e.g. Aschbacher et al., 2010). Latinos are currently the largest URM population in the United States, accounting for 24% of the school-aged children and 17% of the overall population, but they only account for 7–10% of bachelor's degrees in engineering and physical sciences (National Science Foundation, National Center for Science & Engineering Statistics, 2015). Though most existing work on URM students in STEM, and Latino students specifically, has focused on the gaps and the challenges students face, it is imperative that the field also examines what promotes Latino high school students' academic success in order to change these trends. Thus, the goal of this study was to examine the extent to which Latino high school students' perceptions of support from parents, siblings/cousins, teachers, and friends predicted their ability self-concepts and values, which in turn predicted their engagement in science class.

Theoretical foundation and empirical research

Ecological theory posits that youth development is the result of youth's prior experiences and the influence of multiple interrelated contexts (Bronfenbrenner & Morris, 2006). Motivation theories have similar tenets; the Eccles' expectancy-value theory and social cognitive career theory assert that students' motivational beliefs are shaped by their *perceptions* of prior experiences and of socializers' behaviors (Lent, Brown, & Hackett, 1994; Wigfield et al., 2015). Socializers teach skills, interpret situations, provide encouragement, and furnish access to additional resources that promote development. Aligning with both theory and previous research on academic support (e.g. Alfaro & Umaña-Taylor, 2015; Wigfield et al., 2015), our conceptualization of science support included instrumental support (e.g. help with science schoolwork), verbal encouragement, and socializer-adolescent co-participating in science activities together.

Though socializers engage in a range of behaviors with the intention of being supportive, all behaviors may not be perceived as supportive through students' agentic interpretation. According to social cognitive and motivation theories, whether students feel supported by others influences their motivational beliefs (e.g. Lent et al., 1994). In addition, although socializers are conceptualized broadly according to theory, much of the existing work focuses on perceived support from teachers or parents (Wigfield et al., 2015). Relatively little is known about support from peer socializers, namely siblings, cousins, and friends, as well as how multiple sources of support coalesce to predict adolescents' motivational beliefs. Therefore, one aim was to extend previous research by examining perceived science support from multiple sources as predictors of motivational beliefs and engagement for a population who often feels overlooked, alienated, and discriminated against at school (e.g. Aschbacher et al., 2010).

It is well documented in the literature that teacher support is associated with overall academic motivation among both youth in general and Latino youth specifically (Alfaro, Umaña-Taylor, & Bámaca, 2006; Wentzel, Baker, & Russell, 2012). Teachers are also key adult socialisers in STEM domains as well. Students who feel supported by their math and science teachers have higher science self-efficacy (Rice, Barth, Guadagno, Smith, & McCallum, 2013), ability self-concepts across math and science, and values across math and science compared to their peers (Bouchey & Harter, 2005). Similarly, Latino students who feel their math teacher is caring have higher math self-efficacy than their Latino peers (Lewis et al., 2012; Riconscente, 2014).

Parents are another key adult socializer of adolescents' academic outcomes. Among European-American and ethnically/racially diverse adolescents, perceived science support from parents is positively related to adolescents' science ability self-concepts and values (e.g. Bouchey & Harter, 2005; Rice et al., 2013; Simpkins, Price, & Garcia, 2015). Though some work suggests that perceptions of parent support is critical for Latino students (Simpkins, Price, et al., 2015), other work calls this claim into question. For instance, parents' general academic support positively predicted high school students' math self-efficacy among European-Americans but not among Latinos in the US (Fan, Williams, & Wolters, 2012). In addition, some high school students reported that despite their parents encouraging them to graduate high school, students felt parents did not actively support them in science (Aschbacher et al., 2010). With a few exceptions (e.g. Simpkins, Price, & Garcia, 2015), most of the existing work does not focus on family support of Latino students in science despite the centrality of families to Latino cultural practices and beliefs (e.g. familism values).

Although parents are often the main focus concerning the family influence on students' academic success, peers within family systems, namely siblings and cousins, can serve as a powerful "source of inspiration, support, and guidance" (Aschbacher et al., 2010, p. 577). Latino siblings/cousins often support each other in ways that are comparable to middle-class US-born European-American parents, especially when their parents have limited educational attainment, familiarity with the US school system, or time due to demanding work schedules. For example, Latino high school graduates reported that their parents, most of whom had a high school degree or less, provided general encouragement in regard to their schooling, but were less able to help them with specific tasks, such as class selection and assignments (e.g. Hurtado-Ortiz & Gauvain, 2007). However, among those same families, older siblings' level of education predicted Latino students' high school GPA and whether they were currently enrolled in college, suggesting siblings are consequential for Latino adolescents' educational outcomes (Hurtado-Ortiz & Gauvain, 2007). In addition, perceptions of siblings' general academic support predicted Latino high school students' concurrent overall academic motivation (Alfaro & Umaña-Taylor, 2010). Though older siblings and cousins may play a critical role for Latino students due to cultural and immigration processes, their support has rarely been studied in any STEM discipline.

Adolescents' school-based peers and friends become increasingly important as youth age through adolescence (Smetana, Robinson, & Rote, 2015; Suizzo & Soon, 2006). Supportive school-based peer relationships and peer expectations for academic engagement positively predicted Latino students' overall academic motivational beliefs and goals (e.g. Wentzel et al., 2012). Within STEM, supportive peers and friends positively predict high school students' concurrent STEM career goals, STEM engagement, and values across math and science among ethnically diverse samples (Bouchey & Harter, 2005; Fredricks, Hofkens, Wang, Mortenson, & Scott, 2018; Robnett & Leaper, 2013).

Multiple sources of support

Although ecological and motivational theories posit that development is the culmination of multiple influences (Bronfenbrenner & Morris, 2006; Lent et al., 1994; Wigfield et al., 2015), little work addresses how perceived support from multiple sources coalesce to predict adolescents' academic success. Researchers often enter multiple influences in one regression model and examine the unique effect of each social influence on students' academic outcomes. Research using this approach suggests that adolescents' perceptions of parent and teacher support across math and science both uniquely contribute to adolescents' motivational beliefs (Bouchey & Harter, 2005; Rice et al., 2013; Wilkins & Ma, 2003), but perceptions of sibling and friend support usually do not predict once parent or teacher support is controlled (Azmitia, Cooper, & Brown, 2009; Navarro, Flores, & Worthington, 2007; for an exception, see Fredricks et al., 2018). This approach focuses on the unique effects and reflects one possible way of understanding how multiple sources of social support predict adolescents' academic outcomes.

Theory suggests at least three other plausible alternative hypotheses on how these multiple sources of support coalesce to predict adolescents' outcomes. First, the Eccles' expectancy-value theory and social cognitive career theory assert that students combine their perceptions across a variety of experiences (Lent et al., 1994; Wigfield et al., 2015); and that, it is the combined influence that ultimately shapes their outcomes. One way to capture the combined influence is the overall average support. Thus, it is possible that greater overall support from multiple resources, rather than each source's unique contribution, predicts higher positive academic outcomes (Bouchey & Harter, 2005; Furrer & Skinner, 2003; Simpkins, Fredricks, et al., 2015). Second, ecological theory posits that school and family are two central interrelated microsystems of development (Bronfenbrenner & Morris, 2006). Accordingly, both contexts may have a unique influence on adolescents' academic outcomes. Third, based on principles of equifinality, it is possible that youth with different patterns of support across the four sources might have similar outcomes. For example, some adolescents might feel supported by siblings/cousins but vary on whether they also feel supported by teachers or parents. Does that difference matter or do those adolescents have similar outcomes because it more important that adolescents feel supported by multiple people regardless of whom? Moreover, examining average overall support can mask divergent patterns. For example, take two adolescents who both have overall average support. One adolescent might perceive modest support from all sources whereas another might only feel highly supported by parents and not by anyone else. These patterns might be associated with very different outcomes.

We used four strategies to test these four plausible alternative hypotheses concerning how perceived support from multiple sources might coalesce to predict adolescents' science outcomes. First, we tested the common strategy of using multiple separate indicators in one model to examine each source's relative, unique contribution and whether perceived support works in an additive way (e.g. Alfaro & Umana-Taylor, 2015; Furrer & Skinner, 2003; Wilkins & Ma, 2003). Second, based on the perspective that adolescents take into account support from all sources, we tested whether perceptions of overall support across the four sources predicted their science outcomes (Lent et al., 1994; Wigfield et al., 2015). Third, based on ecological theory, we tested if perceptions of home-based and school-based support predicted students' science outcomes (Bronfenbrenner & Morris, 2006). Fourth, we examined if particular patterns or constellations across the four sources using pattern-centered approaches were predictive of adolescents' science outcomes. Capitalising on these four distinct strategies helps triangulate how multiple sources of support coalesce and which aspects might be more consequential.

Cascading indirect effects of perceived support on classroom engagement

Students' math and science classroom engagement impacts their learning, grades, and other important academic outcomes (Fredricks, Blumenfeld, & Paris, 2004; Fredricks et al., 2018; You & Sharkey, 2009). Students' engagement in the classroom is a multidimensional construct that consists of several related but distinct components, including students' behavioral, emotional, cognitive, and social engagement (Fredricks et al., 2004; Fredricks et al., 2018). Behavioral engagement, which was the focus of this study, refers to students' positive conduct and level of participation, effort, concentration and persistence in academic settings. According to expectancy-value theory (Wigfield et al., 2015), students who feel supported are more likely to value and feel more competent in science, which drives them to be more engaged during class.

According to expectancy-value theory, ability self-concepts are stronger predictors of performance whereas values are stronger predictors of engagement and other choices (Wigfield et al., 2015). However, empirical support is mixed. Some findings show values but not ability self-concepts predicted engagement (e.g. You & Sharkey, 2009) whereas other findings show that both values and ability self-concepts positively predicted students' math and science classroom engagement (e.g. Bouchey & Harter, 2005; Fredricks et al., 2018). These inconsistent findings are somewhat unsurprising when one considers the variability in how engagement has been defined and measured (Fredricks & McColskey, 2012).

Students' behavioral engagement includes indicators such as persistence and participating in a class that are theoretically expected to be predicted by ability self-concepts (Wigfield et al., 2015). In recent qualitative studies on math and science, adolescents often associate engagement with doing well in class and report being more engaged when they can demonstrate their knowledge (Fredricks et al., 2018). In fact, adolescents' ability self-concepts were more predictive of behavioral engagement than their values (Wang & Eccles, 2013). This connection between ability self-concept and behavioral engagement might be particularly strong during adolescence and when teacher-reports are utilized. Adolescents are increasingly susceptible to social influences (Wang & Eccles, 2013; You & Sharkey, 2009) and may only voluntarily participate when they are confident of their knowledge and feel they can answer questions correctly in front of their peers. Moreover, teacher-reported behavioral engagement was more strongly associated with students' grades than student-reported behavioral engagement (Wang, Fredricks, Ye, Hofkens, & Linn, 2016). Taken together, we expect that both values and ability self-concept will positively predict students' engagement and that perceived support will indirectly predict Latino students' engagement in science class through their values and ability self-concepts.

Hypotheses

According to ecological and motivational theories, the support high school students believe they receive across variant sources should influence their engagement in science class because of its influence on students' science motivational beliefs during high school. In this study, we tested two hypotheses:

> **Hypothesis 1**: perceived support in 10th grade will predict students' science ability self-concepts and values in 10th grade while controlling for levels of prior motivational beliefs.

> **Hypothesis 2**: perceived support will be indirectly related to teachers' perceptions of students' classroom behavioral engagement through their ability self-concepts and values.

The current study extends prior work theoretically and methodologically by using both traditional and novel statistical approaches to examine theoretically-grounded expectations concerning how support from multiple sources predict changes in Latino adolescents' motivational beliefs for a large, vulnerable URM population in the US.

Materials and methods

Participants

The current study included longitudinal data from Latino adolescents in three public high schools in a large southwestern metropolitan city in the United States. School A (39% Latino, 30% eligible for free/reduced lunch) was a higher-performing school with an International Baccalaureate (IB) program and 68% of the students passed the statewide science exam in 10th grade. School B (23% Latino, 17% eligible for free/reduced lunch) was also higher-performing and 62% of the students passed the statewide science exam. In contrast, School C (36% Latino, 63% eligible for free/reduced lunch) was not considered high performing. Approximately 29% of the students passed the statewide science exam in this Title I school. All schools required students to pass three years of science to graduate. In both Schools A and B, 11% of students taking honors science courses were Latino. In School C, 24% of students taking honors science courses were Latino.

A sample of 104 Latino students ($M_{age} = 14.50$, $SD = .52$ at 9th grade; 86% U.S.-born, 82% Mexican-origin; 40% female) who had at least one eligible parent and an older sibling or cousin (both were inclusion criteria) were recruited. Approximately, 9% took a 9th-grade honors science class and 4.8% had at least one parent with a science-related college degree or job. Average maternal education was high school. The median household income in 9th grade was $40,000–$49,000. In total, 98 adolescents (i.e. 94%) participated in both 9th and 10th grade.

Measures

All indicators were measured when adolescents were in 10th grade unless otherwise noted. Table 1 includes the means and standard deviations for all focal measures.

Perceived science support

A measure of perceived science support in 10th grade assessed science-related support adolescents believed they received from their parents, older sibling/cousin who participated in the study, current science teacher, and friends in their same grade level at school. Each scale is a short 15-item form of a larger support scale, which evidenced measurement invariance across Latino and European-American adolescents (Bouchey & Harter, 2005; Simpkins, Price, et al., 2015; e.g. 'How often does your [person] help you feel better when science is hard?'; 1 = *never*, 5 = *always*; α = .92–.95). Adolescents' responses on all 15 items for each source of support were averaged to create separate indicators for parents, older sibling/cousin, science teacher, and same-grade school-based friends.

These four scales were used to create several additional scales. First, overall perceived support was created by averaging the four scales of perceived support ($\alpha = 0.97$). Second, subscales for perceived home support and school support were created. Home support was the average of perceived support from their parents and older sibling/cousin ($\alpha = 0.97$). School support was the average of perceived support from their science teacher and same-grade school-based friends ($\alpha = 0.95$). Third, using the four support measures, we identified support patterns using cluster analysis (described below).

Adolescent science motivational beliefs

Adolescents' motivational beliefs were measured with two indicators at 9th and 10th grade. *Science ability self-concepts* included four items in each science subject (i.e. biology, chemistry, physics) on a 7-point scale (12 items; $\alpha = 0.93$ and 0.92 at 9th and 10th grade; 'How good at [subject] are you?' [1 = *not at all good*, 7 = *very good*]; 'How good would you be at learning something new in [subject]?' [1 = *not very good*, 7= *very good*]; 'Compared to other 9th grade students, how good are you at [subject]?' [1 = *a lot worse*, 7 = *a lot better*]; 'If you were to list all of the 9th grade students from best to worst in [subject], where are you?' [1 = *one of the worst*, 7 = *one of the best*]). Adolescents' *science value* included five items in each subject on a 7-point scale (15 items; $\alpha = 0.94$ and 0.96 at 9th and 10th grade; 'I find doing [subject]' [1 = *very boring*, 7 = *very interesting*]; 'How much do you like [subject]?' [1 = *a little*, 7 = *a lot*]; 'For me, being good in [subject] is': [1 = *not at all important*, 7 = *very important*]; 'Compared to other subjects, how important is it to be good at [subject]?' [1 = *not at all important*, 7 = *very important*]; 'How useful is what you learn in [subject]?' [1 = *not at all useful*,

Table 1. Correlations, means, and standard deviations (SD) of the central indicators.

Indicators	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Overall average support										
Separate indicators of support										
2. Teacher support	0.85***									
3. Parent support	0.88***	0.64***								
4. Sibling support	0.84***	0.57***	0.74***							
5. Friends support	0.80***	0.65***	0.59***	0.53***						
School vs. home support										
6. School support	0.91***	0.92***	0.68***	0.61***	0.89***					
7. Home support	0.93***	0.65***	0.93***	0.93***	0.60***	0.70***				
10th grade outcomes										
8. Science self-concept	0.33***	0.20*	0.37***	0.28**	0.25*	0.25*	0.36***			
9. Science value	0.43***	0.33***	0.41***	0.37***	0.37***	0.38***	0.41***	0.63***		
10. Classroom engagement	−0.12	−0.14	−0.04	−0.18	−0.02	−0.08	−0.10	0.25*	0.10	
Mean	2.54	3.43	2.50	2.00	2.22	2.85	2.30	4.39	4.62	3.84
(SD)	(0.62)	(0.77)	(0.77)	(0.76)	(0.65)	(0.65)	(0.73)	(0.82)	(1.09)	(0.91)

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

7 = *very useful*]). These scales have evidenced strong psychometric properties, including excellent convergent, face, and discriminant validity in previous studies (e.g. Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Simpkins, Fredricks, et al., 2015) and measurement invariance across 9th grade Latino and European-American male and female students (Simpkins, Price, et al., 2015).

Teacher reported science engagement

Adolescents' behavioral engagement in their science class during 10th grade was reported by their science teacher using a 5-item scale (Wang, Willett, & Eccles, 2011; e.g. 'Does this student participate in science class?'; 1 = *almost never*, 5 = *almost always*; $\alpha = 0.87$). The five items were averaged to create a general indicator for adolescents' science class engagement.

Control variables

Adolescents' gender (0 = *male* 1 = *female*), 9th grade science teacher ratings of adolescents' science ability with a 3-item scale (e.g. 'How good is the student in science?'; 1 = *not at all good*, 5 = *very good*; $\alpha = 0.96$), science course level (0 = *regular* 1 = *honors*), dichotomous codes for Schools B and C with School A as the reference group, and parents' report of their highest level of education across caregivers (1 = *less than high school*, 6 = *beyond BS/BA*) were used as control variables.

Procedure

Data were collected from Latino adolescent questionnaires in 9th (2012–2013 school year) and 10th grade (2013–2014 school year), science teacher questionnaires in 9th and 10th grade, and parent questionnaires in 9th grade. The majority of adolescent and parent data were collected in the participants' homes, but 20% of families came to the university for the family visit. In addition, one family visit was conducted at a local library. During each family visit, adolescents and parents separately completed a questionnaire with a trained, bilingual Latino interviewer from the local area. Forward-translation and panel method approaches were used to translate the surveys from English into Spanish (Knight, Roosa, & Umaña-Taylor, 2009). One adolescent and 43% of parents completed the surveys in Spanish; all other participants completed the surveys in English. Each participant received $50 each year for participating. Adolescents' current science teacher completed self-administered questionnaires each spring and received $5 per student.

Statistical analyses

Our research hypotheses were evaluated using a series of regression models estimated in MPlus v7.11 with full information maximum likelihood (FIML) to impute missing data. Thus, each analysis except for the analyses with the clusters was based on 104 adolescents. Regression models were used instead of path models due to the small sample size.

Hypothesis 1: Perceived support → motivational beliefs. We estimated four sets of linear regressions to test whether support from multiple sources predicted changes in adolescents' motivational beliefs. First, we tested if overall perceived support predicted adolescents' motivational beliefs. Second, we included all four sources of perceived support in one model to test their unique, relative contribution. Third, we tested a model with home-based and school-based support in one model to test each microsystem's unique, relative contribution. Fourth, and lastly, we tested whether the patterns of support across the four sources as determined through cluster analysis predicted adolescents' motivational beliefs.

Each regression predicting adolescents' 10th-grade motivational beliefs included several control variables, including the same motivational belief at 9th grade and teacher ratings of 9th-grade science ability. In addition, we controlled for a variety of demographic characteristics that are important for these outcomes, including adolescent gender, science course level, parent educational attainment, and school (Wigfield et al., 2015). We accounted for the clustering of students at the school level because we were not interested in classroom-level effects and our sample sizes precluded classroom-level nesting; students in 10th grade were nested in 30 classrooms with 1 to 7 students within each, $M = 3$ students and $Mdn = 2$ students.

Before we discuss Hypothesis 2, it is important to describe how the cluster analyses were conducted. Cluster analysis helps identify unique patterns across multiple indicators – in this case, perceived science support from parents, older sibling/cousin, teacher, and friends. Cluster analysis has been proposed as an appropriate analytical method to analyse the contextual influence on educational outcomes (see Roeser & Peck, 2003 for a review). Cluster analysis was used instead of latent profile analysis due to our modest sample size. We conducted cluster analysis on 10th-grade support variables in ROPstat (www.ropstat.com; Bergman, Magnusson, & El Khouri, 2003; Vargha, Torma, & Bergman, 2015). First, ROPstat requires that participants have some data in order to impute the values that are missing. Six participants were dropped from the cluster analysis because of missing values in all four indicators. Second, we tested for multivariate outliers in the cluster variables of which we had none ($n = 0$). Third, we ran a hierarchical cluster analysis using Ward's method on average squared Euclidean distances. The optimal cluster solution was determined by (1) the percent of the error sum of squares that was accounted for ($\geq$50%; Vargha et al., 2015), (2) that the homogeneity coefficient of each cluster ($<$1.0; Vargha et al., 2015), and (3) that the cluster solution included patterns that aligned with theory. Fourth, once the final solution was identified, we used *K*-means relocation to relocate cases from one cluster to another to maximise within-group homogeneity and across-group heterogeneity (Bergman et al., 2003). Finally, contrast codes were created to compare differences across the cluster patterns and are described in the results.

Hypothesis 2: Perceived support → motivational beliefs → classroom engagement. Our second hypothesis was that adolescents' perceived support would indirectly predict students' classroom engagement as rated by their science teachers through their ability to self-concepts and values. To test this hypothesis, we estimated one additional regression model in MPlus with FIML where adolescents' 10th-grade science ability self-concept and value predicted their 10th-grade classroom engagement. The regression coefficients and standard errors from this regression and the previous four sets of regression models described under Hypothesis 1 were used to calculate Monte Carlo 95% confidence intervals for the indirect effects (Selig & Preacher, 2008; see http://quantpsy.org/medmc/medmc.htm).

Results

Descriptive statistics and patterns of support

On average, adolescents believed they received the highest level of support from teachers ($M = 3.43$ on a 5-point scale; $F(3, 309) = 154.83$, $p < .00001$; Table 1) compared to parents ($M = 2.54$), siblings/cousins ($M = 2.50$), or friends ($M = 2.00$). Adolescents who felt supported were more likely to report higher science ability self-concepts and values. Science ability self-concepts, but not values, were positively associated with engagement during science class.

Before we describe the regression findings for Hypothesis 1, we need to summarise the cluster analysis findings as those were used in the regression analyses. We selected the 5-cluster solution as our final solution because: (1) it accounted for 71.49% of the error sum of squares (well above 50% criteria), (2) the homogeneity coefficient of each cluster was good (<1.0), and (3) cluster patterns aligned with theory. The means of perceived support for each cluster are presented in Figure 1. From left to right on the figure, the *Supported* group ($n = 24$) included students who perceived high teacher support and moderate support from the other three sources. Second, the *Supportive Teacher* group ($n = 11$) included students who perceived high teacher support and low support from the other three sources. Third, the *Unsupported*

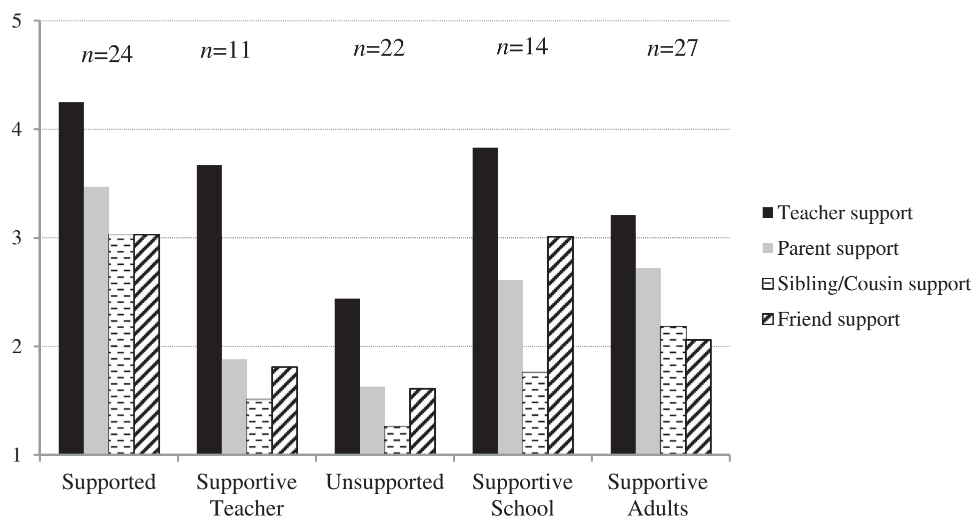

Figure 1. Final 5-cluster solution of perceived science support. Means of support from four sources for each cluster. Each item was measured on a 1–5 scale (1 = never, 2 = a little, 3 = sometimes, 4 = a lot, 5 = always).

Table 2. Standardized regression coefficients predicting 10th grade students' motivational beliefs.

Predictors	10th grade science self-concept β (*SE*)	10th grade science value β (*SE*)
Step 1 of all models		
9th science self-concept/value	0.57 (0.07)***	0.67 (0.06)***
School B	−0.10 (0.08)	0.02 (0.08)
School C	−0.09 (0.08)	−0.02 (0.08)
Parent higher education	0.04 (0.08)	−0.08 (0.08)
9thteacher rated ability	0.18 (0.08)*	0.09 (0.08)
Science course level	0.21 (0.08)**	0.04 (0.08)
Gender	−0.08 (0.08)	−0.08 (0.08)
Step 2 of all models		
Model 1		
Overall support	0.29 (0.07)***	0.29 (0.08)***
Model 2		
Teacher support	0.10 (0.10)	0.01 (0.10)
Parent support	0.09 (0.12)	0.20 (0.12)+
Sibling/cousin support	0.18 (0.11)	0.04 (0.11)
Friend support	−0.03 (0.09)	0.09 (0.09)
Model 3		
School-based support	0.04 (0.10)	0.10 (0.10)
Home-based support	0.27 (0.10)**	0.21 (0.10)*
Model 4		
Contrast 1[a]	0.14 (0.08)+	0.19 (0.08)*
Contrast 2[b]	0.12 (0.08)	0.08 (0.07)
Contrast 3[c]	0.01 (0.08)	0.04 (0.07)
Contrast 4[d]	0.12 (0.08)	0.11 (0.08)

Note. [a]Compared supported, supportive school, and supportive adults to supportive teacher and unsupported. [b]Compared supported to supportive school and supportive adults. [c]Compared supportive school to supportive adults. [d]Compared supportive teacher to unsupported. The control variables included in Step 1 were included in each model for Step 2. $^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

group ($n = 22$) represented students with low perceptions of support from all sources. Fourth, the *Supportive School* group ($n = 14$) included students reporting moderate to high school-based (i.e. teacher and friends) support and little home-based (i.e. parent and sibling/cousin) support. Fifth, the *Supportive Adults* group ($n = 27$) represented moderate adult (i.e. parent and teacher) support, but little peer (i.e. sibling/cousin and friends) support.

Perceived support predicting changes in adolescents' motivational beliefs

We expected that perceived support would positively predict adolescents' science ability self-concepts and values at 10th grade while controlling for their 9th-grade motivational beliefs. As shown in Table 2, adolescents' science ability self-concepts and values had moderate to strong stability from 9th to 10th grade. In addition, science teachers' ratings of adolescents' science ability in 9th grade and whether they were in an honors science course in 9th grade positively predicted science ability self-concepts in 10th grade. Four models assessed whether perceived support predicted adolescents' 10th-grade science ability self-concepts and values while controlling for 9th-grade motivational beliefs.

As shown under Model 1, overall perceived support positively predicted adolescents' science ability self-concepts and values at 10th grade while controlling for 9th-grade motivational beliefs. This analysis, however, provides less insight into which sources account for this association.

As shown under Model 2, perceptions of support from each of the four sources (i.e. while holding others constant) were not statistically significant, with one exception. Parent support positively predicted adolescents' 10th-grade science value. The absence of statistically significant effects for each specific source of support may be the result of the moderate to high correlations among the four sources of support, $r = 0.53–0.74$. Alternatively, it is also possible that no single source made a strong contribution above and beyond the others. Rather, it is their combined contribution as shown in Model 1 that matters.

Because school and home are two distinct microsystems in ecological theory, we examined support from school (average of teachers and friends) and support from home (average of parents and siblings). The findings from Model 3 suggest that home-based support, but not school-based support, positively predicted adolescents' science motivational beliefs.

Model 4 tested differences among the patterns of perceived support. We used four contrast codes because we were interested in four specific comparisons. Based on ecological and expectancy-value theory (Bronfenbrenner & Morris, 2006; Wigfield et al., 2015), adolescents are more likely to have higher motivational beliefs if they feel supported by multiple sources. Thus, Contrast 1 compared adolescents who felt they had multiple sources of support (i.e. the Supported, Supportive School, and Supportive Adults groups) compared to adolescents who felt they had only one or no sources of support (i.e. the Supportive Teacher and Unsupported groups). In support of those theories, we found that adolescents who felt they had multiple sources of support had higher values and ability self-concepts at 10th grade compared to adolescents who felt they had one or no sources of support.

The remaining contrasts delved deeper by examining differences (1) among adolescents who felt they had multiple sources of support or (2) among adolescents who felt they had little or no support. These remaining contrasts were designed to address principles of equifinality and have implications for the types of interventions that might be successful in maintaining adolescents' motivational beliefs. Among those who felt supported by multiple sources, there were adolescents who felt supported (a) by all four sources, (b) largely by individuals at schools (i.e. teachers and friends), and (c) largely by adults (i.e. teachers and parents). Contrast 2 addressed whether adolescents might need support from all four sources versus two of the four sources to boost their motivational beliefs. Contrast 3 examined potential differences among adolescents largely supported by individuals at schools compared to feeling supported by adults at school and home. The non-significant results of Contrast 2 suggest that adolescents who felt supported by at least two sources had similar motivational beliefs. The nonsignificant results of Contrast 3 suggest that adolescents' motivational beliefs were similar among those who felt they were supported by individuals at school or by adults at school and home (i.e. Supportive School and Supportive Adults groups). The final contrast (Contrast 4) examined if feeling supported by teachers might be enough to maintain adolescents' motivational beliefs compared to those who felt unsupported. The nonsignificant results of Contrast 4 suggest that adolescents who felt they had a Supportive Teacher had similar motivational beliefs to adolescents who felt Unsupported.

In addition to these planned contrasts, all pairwise comparisons across the clusters were estimated and are presented in Table A1. The findings from these models suggest Unsupported adolescents had lower science motivational beliefs in 10th grade compared to adolescents who felt they were Supported or had Supportive Schools or Supportive Adults.

Indirect effects of perceived support and classroom engagement

Adolescents' perceived support was indirectly related to their classroom engagement through their ability self-concepts. Adolescents' 10th grade science ability self-concepts, β (*SE*) $=0.32$ (0.13), $p = .011$, but not their science values, β (*SE*) $= -0.11$ (0.13), $p = .408$, predicted science teacher-ratings of their classroom behavioral engagement. Because only adolescents' ability self-concepts predicted their engagement, indirect effects were likely only to emerge in three cases, namely when support significantly predicted adolescents' ability self-concept as shown in Table 2. The Monte Carlo 95% confidence intervals suggest that overall perceived support, 95% CI $=0.014$, 0.180, and home-based support, 95% CI $=0.008$, 0.200, predicted adolescents' classroom engagement via their science ability self-concepts (Selig & Preacher, 2008). In other words, overall perceived support and home-based support positively predicted adolescents' science ability self-concepts in10th grade, which in turn, positively predicted their behavioral engagement in their 10th-grade science class. To be thorough, we tested all other possible indirect effects (i.e. the 19 other indirect effects from support through ability self-concept and value to engagement; see Table 2 for the various indicators of support); none were statistically significant.

Discussion

Based on ecological and motivational theories, the goals of the current study were to examine (a) the extent to which high school students' perceptions of support directly predicted their motivational beliefs and indirectly predicted their classroom engagement and (b) how these perceptions across multiple sources coalesced to predict these academic outcomes. Overall, we found evidence that students who felt supported had higher science ability self-concepts and values in 10th compared to 9th grade. We also found that adolescents' ability self-concepts were one potential mechanism by which perceived support might impact their engagement in the classroom. Though youth's motivational beliefs begin to develop much earlier in life, high school is often a period when students can doubt their abilities and see diminishing value in a variety of domains (Wigfield et al., 2015). These findings suggest that feeling supported might help impede these typical declines.

The current results align with previous work suggesting that adolescent development is the synergy of multiple, simultaneous influences (e.g. Simpkins, Fredricks, et al., 2015). Specifically, adolescents in the current study who felt supported by multiple people were more likely to experience positive changes in their science ability self-concepts and values than their peers. This pattern aligns with findings from Bouchey and Harter (2005) study where students' perceived combined math and science support across family and school settings positively predicted their academic motivation and scholastic behaviors. Our models estimating the unique effects of each source of support suggest that each source may not have a unique impact, but prior work with larger samples sizes document that teacher and parent support uniquely predict youth's STEM motivational beliefs (Bouchey & Harter, 2005; Rice et al., 2013; Wilkins & Ma, 2003). Though most previous work examines support from multiple sources as if they function separately, the interrelated nature of multiple sources of support challenges both the statistical (i.e. potential multicollinearity; Navarro et al., 2007) and theoretical grounding for delineating their effect on student motivation separately.

Much of the literature on family involvement in youth's education suggests that parents of high school or URM students are under involved or not involved (e.g. Pomerantz, Moorman, & Litwack, 2007). Our findings suggest that support from the home environment remains important for Latino high school students. In several tests of the rival hypotheses, support from families (i.e. home-based support) or parents emerged as a predictor of high school students' motivational beliefs, which aligns with prior work suggesting that parent support predicts youth's motivational beliefs even after accounting for teacher support (Bouchey & Harter, 2005; Rice et al., 2013; Wilkins & Ma, 2003). In contrast, in our study, feeling supported by key people at school (i.e. teachers and friends) or simply by one's science teacher was not a consistent predictor of students' science outcomes – though it has been in prior work (e.g. Alfaro, Umaña-Taylor, & Bámaca, 2006; Bouchey & Harter, 2005; Rice et al., 2013). Taken together, the results question whether interventions only targeting school-based support would be enough to move the needle on youth's science outcomes. Connections across school and home as well as feeling consistently supported in both contexts are likely optimal for development (Bronfenbrenner & Morris, 2006).

Although adolescence is a time of increasing autonomy, data from the current study suggest they still need to feel supported. Work on interest development suggests that support is not only important to develop an interest, but it is also important in maintaining that interest (Renninger & Hidi, 2016). Initially, other people in youth's lives, particularly families and teachers, often take the lead in sparking youth's initial interest by exposing them to various domains. When youth gain a better sense of their interests and skills, socializers may be more likely to follow youth's lead. However, even when youth's expertise surpasses the knowledge of other people in their lives, such as when youth's science expertise surpasses their parents' expertise, support from others in terms of advice and helping cope with negative or stressful experiences is still beneficial.

Our analysis strategy also underscores the importance of various analytic decisions, and that such decisions should be driven by theory. The findings from this study highlight the advantages and the limitations of particular strategies, as well as the utility of leveraging multiple analytic strategies to triangulate the relations under investigation. Scholars should consider using person-centered approaches in addition to variable-centered approaches as well as various theoretically-grounded indicators of support to understand the potential influence of embedded social contexts.

Motivational beliefs and behavioral engagement

The findings also suggest that one way support can change students' behavior in the classroom is by increasing their science ability self-concepts. Contrary to our hypotheses, adolescents' values did not predict their behavioral engagement though the current small sample size limited our ability to detect a relationship between value and engagement found in previous studies (e.g. Wang & Eccles, 2013). But there are other substantive explanations for such unexpected null findings.

First, we relied on teacher reports of high school students' behavioral engagement in the current study. Although teacher reports of students' behavioral engagement are correlated with student reports of engagement (Fredricks & McColskey, 2012), previous work suggests that students' values only predicted self-reported, but not teacher-reported measures of engagement (Guo et al., 2016). Moreover, prior research suggests that teacher reports of student engagement can reflect biased estimates of classroom behaviors for Latinos and other URM students (e.g. Bingham & Okagaki, 2012; Tyler, Boelter, & Boykin, 2008). While including teacher reports strengthened the current methods by having data from multiple reporters, the typical positive associations found between students' motivational beliefs and their engagement may be weakened.

Another possible explanation of the nonsignificant findings for students' values is that our measure focused on behavioral engagement and not the other dimensions of engagement. Recent work suggests values may be stronger predictors of how students feel about and cognitively approach a subject, which are aspects of their emotional and cognitive engagement (Fredricks & McColskey, 2012; Wang & Eccles, 2013). In contrast, the more discernable nature of behavioral engagement, such as paying attention and voluntarily participating in class, is facilitated by feeling that one has strong ability and can successfully demonstrate that ability in front of their classmates and teachers (Fredricks et al., 2018).

Although either of these explanations may be true, one needs to also take into account how the social context may influence students' motivation and engagement. For example, these patterns may change depending on whether Latino students perceive themselves as a member of the minority or majority group (Chen & Hamilton, 2015). Being one of only a few minority students in a science classroom may serve as a contextual cue indicating that their cultural norms, beliefs, and behaviors are different from those of their peers, thereby reducing their sense of belonging and triggering a sense of stereotype threat (e.g. Thoman, Smith, Brown, Chase, & Lee, 2013). Prior research on stereotype threat suggests that the anxiety induced when a student expects to be judged negatively based on a group stereotype may diminish their willingness to participate in the classroom, confidence in their science abilities, and interests in pursuing a STEM degree (Beasley & Fischer, 2012).

Limitations and future directions

The present study contributes to the literature on students' science motivation and social support in important ways; however, it is not without limitations. First, although the analytic strategies employed in the current paper are a key strength, the results are based on a relatively small sample of participants and therefore must be interpreted with caution. For example, we lacked the statistical power needed to detect small but noteworthy effects. Our statistical approaches aligned with the properties of the data and underlying theory associated with each type of analysis (e.g. recommendations on cluster analysis; Steinley & Brusco, 2007). A larger sample of participants would help improve both the validity and the generalizability of the results. All of our analyses should be replicated with larger samples and samples that vary on key demographic characteristics.

Second, it will be important to conduct complementary work delineating how adolescent 'outcomes' determine the support youth receive and how those relations may shift over development. In elementary school, one would expect that if children show a deficit in an academic domain that individuals would help youth catch up. In high school, students might similarly increase their efforts or, alternatively given adolescents' age, socializers might 'give up' and conclude science is 'not for them.' In addition, it is also possible that once high school students are proficient, these individuals may provide less or different support in an effort to provide adolescents increasing autonomy (e.g. Pomerantz et al., 2007).

Finally, we used adolescents' report of support because it is individuals' interpretation and understanding of the support that is theorized to influence their beliefs and behaviors (Wigfield et al., 2015). In addition, individuals' interpretation of behavior may differ from the supporter's original intent. For example, the same parent supportive behavior may be interpreted as controlling by one adolescent and supportive by another, which will have dramatically different implications for their motivation (Pomerantz et al., 2007). Moving forward, it will be important to understand adolescents' perceptions of support relative to the actual support provided.

Conclusions

High school is a turning point in the STEM pipeline due to dramatic declines in motivational beliefs and that most high schools in the U.S. do not require students to take four years of science to graduate (e.g. Maltese & Tai, 2011). Aligned with the Eccles' expectancy-value theory and ecological theory more broadly, support from multiple people across home and school contexts helped sustain Latino adolescents' science motivational beliefs and subsequent classroom engagement. Although prior research addresses support from parents and teachers, these findings contribute to the emerging literature on friends and siblings/cousins as well as examining support across social contexts simultaneously that has important methodological and theoretical implications for supporting URM student success.

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Appendix

Table A1. Standardised regression coefficients predicting 10th grade students' motivational beliefs from all pairwise comparisons of the clusters.

Predictors	10th grade science self-concept β (*SE*)	10th grade science value β (*SE*)
Unsupported cluster compared to		
Supported	−0.30 (0.09)***	−0.31 (0.09)***
Supportive Teacher	−0.12 (0.08)	−0.12 (0.08)
Supportive School	−0.15 (0.09)$^{+}$	−0.21 (0.08)*
Supportive Adults	−0.17 (0.09)$^{+}$	−0.21 (0.09)*
Supported cluster compared to		
Unsupported	0.30 (0.09)***	0.31 (0.09)***
Supportive Teacher	0.09 (0.09)	0.11 (0.08)
Supportive School	0.10 (0.08)	0.05 (0.08)
Supportive Adults	0.14 (0.09)	0.12 (0.09)
Supportive Teacher cluster compared to		
Unsupported	0.17 (0.11)	0.17 (0.11)
Supported	−0.13 (0.12)	−0.15 (0.12)
Supportive School	−0.01 (0.11)	−0.07 (0.10)
Supportive Adults	0.01 (0.12)	−0.03 (0.12)
Supportive School cluster compared to		
Unsupported	0.18 (0.10)$^{+}$	0.25 (0.10)*
Supported	−0.12 (0.10)	−0.06 (0.10)
Supportive Teacher	0.01 (0.09)	0.06 (0.09)
Supportive Adults	0.02 (0.10)	0.05 (0.10)
Supportive Adults cluster compared to		
Unsupported	0.17 (0.09)$^{+}$	0.20 (0.09)*
Supported	−0.13 (0.09)	−0.11 (0.08)
Supportive Teacher	−0.00 (0.08)	0.02 (0.08)
Supportive School	−0.01 (0.08)	−0.04 (0.08)

Note. Because the coefficients are standardized and because we used FIML, some of the coefficients across models vary slightly. These analyses controlled for adolescent gender, prior self-concept or value depending on the outcome, science course level, teacher-rated ability, school, and parent educational attainment (See Step 1 in Table 2 for the complete list). $^{+}p < .10$. $^{*}p < .05$. $^{***}p < .001$.