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Teachers Caring for Students and Students Caring for Math: The Development of Hispanic & Ethnically Diverse Adolescents' Math Motivation

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Abstract

This study utilized growth curves and change models to understand the impact of student perceptions of teacher caring on the development of math motivation for an ethnically and linguistically diverse sample of adolescents in middle school (N = 1,926) and high school (N = 1,531). Using an expectancy-value framework, growth curves revealed declining math motivation for both middle school and high school cohorts. However, perceived teacher caring buffered against these declines and was positively associated with math self-efficacy and subjective task values. Change models revealed that perceived teacher caring at the beginning of the school year increased math motivation by the end of the year. The results shed light on the important role that student-teacher relationships play in influencing math motivation during adolescence.

Keywords: motivation, expectancy-value, subjective task values, adolescence, teacher warmth, teacher caring

Teachers Caring for Students and Students Caring for Math: The Development of Culturally and Linguistically Diverse Adolescents' Math Motivation

Students who perceive their teachers as caring and supportive report stronger feelings of belonging and motivation to engage in school (Roorda et al., 2011). Students' motivational attitudes are especially important for educational attainment. Motivated students are stronger achievers, aspire higher, and ultimately, attain greater educational success (Eccles & Wigfield, 2002; Simpkins et al., 2006). The evidence to date is largely derived from studies of White U.S. and European student populations (Safavian & Conley, 2016). However, the U.S. public school population is no longer predominantly White and continues to diversify with rising proportions of first-generation immigrant youth. Within the next forty years only one-third of the population will be White (Colby & Ortman, 2015), and the U.S. Census projects individuals from Asian and Hispanic backgrounds to be the two largest non-White racial groups in the U.S. Additionally, first- and second-generation immigrants in the U.S. will account for most of the growth in the working-age population in the next thirty years (Pew Research Center, 2013). These projections are consistent with the growing diversification of current public schools. As of 2016, 48% of the student body enrolled in U.S. public schools were from a non-European-American background, with a majority of non-European-American students being of Hispanic origin (25%; Musu-Gillette et al., 2017). The lack of scholarship on achievement motivation for non-White students presents a critical research gap at a time when growing diversification of the U.S. population necessitates understanding how teachers can support the motivation and educational success of first-generation and underrepresented youth. As gatekeepers to college and in-demand STEM-skilled professions, students' math motivation and achievement are especially important to study. Furthermore, Latino students have been found to perform worse than their peers in math and understanding how teachers play a role in addressing these disparities is warranted (Aud et al., 2010). We address this research gap by investigating the development of math motivation and the impact of perceived teacher caring on motivation for first generation and low-income minority youths.

Caring in the Classroom: Teacher Influences on Student Success

Teachers are central actors within the socially constructed academic environments of youth and influence their academic socialization (Eccles et al., 1993; Wentzel, 2016). A vast body of research demonstrates that student perceptions of student-teacher relationships affects their motivation across adolescence (Lazarides et al., 2018; Quin, 2017; Roorda et al., 2011; Ruzek et al., 2016; Wentzel, 1996). A meta-analysis investigating the impact of perceived teacher support on students' academic emotions, including interest and enjoyment, found important differences based on the students' socio-demographic backgrounds (Lei et al., 2018). The impact of perceived teacher support was stronger for older students and for female students. They also found that perceived teacher support had stronger associations with students' academic emotions for East Asian students than for Western European and American students. Therefore, studying the influence of student-teacher relationships on math motivation and achievement may be particularly important for students from minoritized backgrounds.

Cultural and Linguistic Diversity and a Caring Student-Teacher Relationship

A caring and emotionally supportive relationship with a teacher might be particularly important for underrepresented minority students and English learners. Teacher caring is a complex construct that includes listening and taking interest in what students have to say, considering their feelings, building trust, and helping them achieve to the best of their ability (Noddings, 1995; Noddings, 2012). Students from minoritized backgrounds often face systematic disadvantages due to their socio-economic status (Garcia-Reid et al., 2015). A large proportion of the underrepresented minoritized student population are also first- and second-generation immigrants and many are English learners. Lack of English language fluency may present challenges with communication and learning for immigrant youth (Turney & Kao, 2009). Research also suggests that immigrant youth are more likely to be unfamiliar with the mainstream educational culture and to have fewer social connections (Garcia-Reid et al., 2015). Evidence suggests that experiencing a supportive relationship with a teacher is important to positive school engagement and counterbalances the social resources and capital that immigrant youth might be missing (Brewster & Bowen, 2004). A number of studies have shown the importance of teacher support for ethnically diverse underrepresented minority student populations with regards to their achievement for middle school (Reyes et al., 2012) and high school students (Crosnoe et al., 2004; Muller, 2001). Additionally, some evidence also supports the positive associations of a perceived supportive teacher relationship with student engagement and motivation for ethnically diverse underrepresented middle school students (Garcia-Reid et al., 2005, 2015; Kiefer et al., 2015; Riconscente, 2014). Fewer scholars have investigated this association for underrepresented high school youths (e.g., Rosenfeld et al., 2000). Muller (2001) found that a positive perceived student-teacher relationship was particularly important for at-risk students. Other studies have also found a positive impact of perceived teacher support on student engagement (Brewster & Bowen, 2004) and achievement (Murray, 2009) for low-income at-risk Hispanic youths.

The experiences of ethnic minority students also appear to influence the quality of their relationships with teachers. Sosa and Gomez (2012) found that low-income Hispanic youth described supportive teachers as being sensitive towards their specific challenges, such as immigration status and considering the use of Spanish as an asset. In contrast, McHugh and colleagues (2013) found that Hispanic, Asian, and African American students described negative stereotypes held by teachers towards them as one of the reasons for negative relationships with their teachers.

Immigrant generational status and limited English proficiency may moderate the impact of a supportive student-teacher relationship on students' educational outcomes. For instance, Lewis et al. (2012) found that perceived teacher caring was positively related to Hispanic students' self-efficacy, especially for low-achieving Hispanic English learners in middle school. Watkins and Melde (2010) corroborated this finding in a sample of Hispanic and Asian eighth and ninth graders. They found that students fluent in their native languages had a more favorable perception of educator quality than did exclusively English-speaking students. Thus, a caring relationship with the teacher might be particularly important for English learners in overcoming the negative effects of the existing language and cultural barriers. Peguero and Bondy (2011) found that tenth-grade Hispanic, Asian American, and Black/African-American first-generation students reported stronger relationships with their teachers than third-generation White students. More importantly, first-generation Hispanic students reported a stronger relationship with their teachers than second and third-generation Hispanic students. In contrast, Watkins and Melde (2010) found that first- and second-generation Hispanic and Asian eighth and ninth grade students did not differ in their perceptions of the quality of their educators. More research is needed to explore these dynamics.

Impacting student success: The importance of students' motivational beliefs

Students' motivation is one key factor to consider in understanding the impact of teacher caring on students' success. Student-teacher interactions are among one of the many social and contextual experiences that inform students' motivated attitudes according to the Eccles and colleagues' Expectancy-Value theory (EEVT) of achievement motivation (Eccles et al., 1983). Students' perceptions of teacher caring are processed and internalized into subjective ability beliefs (i.e., expectancy for success) and task attitudes (i.e., subjective task values). Both expectancy for success and subjective task values are considered the proximal components of motivated behavior that influence subsequent academic choices, persistence, and achievement-related outcomes (Eccles et al., 1983; Wigfield et al., 2017).

Expectancy for success refers to self-perceptions of competence and it is often measured using scales of self-efficacy or self-concepts of ability, which are both empirically indistinguishable among adolescents (Wigfield et al., 2006). Students' self-perceptions of competence are linked to effort, task persistence, achievement, and career aspirations (Simpkins et al., 2006; Umarji et al., 2018; Wigfield & Eccles, 1992). Subjective task value refers to the aspects of a task that contribute to the increasing or decreasing probability than an individual will engage in and accomplish the task (Eccles et al., 1983)). The subjective value of a task includes (a) attainment value, or the value an activity has in fulfilling one's identity or self-image; (b) interest value, which refers to the expected enjoyment in task engagement; and (c) utility value, which is how useful the task is in fulfilling various short and long-term goals. Subjective task values are associated with self-regulation, effort, educational and occupational aspirations, and achievement and course enrollment (Berger & Karabenick, 2011; Luttrell et al., 2010; Nagy et al., 2006; Perez et al., 2014; Simpkins et al., 2006; Watt et al., 2006).

Adolescents' math-related expectancies for success and subjective task values decline in middle and high school (Jacobs et al., 2002; Watt, 2004, 2006). Eccles and colleagues' (1993) Stage-Environment Fit theory posits that the developmental decline of math-related expectancy-values are a function of the poor fit between adolescents' academic environments and the developmental needs of adolescents (Eccles et al., 1993).

EEVT has been instrumental in understanding math-related motivation in largely middle-class White youth, leaving us with much more to learn about non-White populations (Wigfield & Cambria, 2010). Prior research has documented racial/ethnic mean-level differences in students' expectancy-value beliefs (e.g., Chen & Stevenson, 1995; Conley, 2012; Fuligni, 1997; Safavian & Conley, 2016). For example, U.S., Canadian, and English students endorsed higher self-efficacy (including self-concept) as compared to East Asian and Russian youth (Elliot et al., 2001). Similarly, White youth report higher self-efficacy relative to Hispanic youth (Stevens et al., 2006). There are also examples of mean-level race-ethnic differences in students' endorsements of subjective task values in middle and high school (e.g., Chen & Stevenson, 1995; Conley, 2012; Safavian, 2013; Safavian & Conley, 2016). For example, research points to higher endorsements of math interest and utility among Asian and East Asian youth relative to White youth (Chen & Stevenson, 1995). East Asian youth also endorsed a higher degree of math importance relative to Hispanics (Safavian, 2013; Safavian & Conley, 2016). Additionally, English Learners of Hispanic and East Asian backgrounds endorsed math learning as more costly relative to English fluent peers (Conley, 2012). Some research has suggested that stronger subjective task values of immigrant youth might be connected to a more positive sense of educational opportunity of immigrant youth, whose families often left their countries of origin due to a lack of opportunities (Kao & Tienda, 1995; Saito, 2002).

Connecting these motivational differences to achievement, numerous studies have found that students' math importance, interest, and utility value are important mediators of math course grades for Hispanic, East Asian, Filipino, European, and first-generation immigrant students

(Fuligni, 1997). Hispanic youth were more likely to persist in science, technology, engineering, and math (STEM) when they also endorsed STEM learning as useful (Andersen & Ward, 2014). Similarly, Hispanic youth received stronger math grades when they endorsed higher math interest, utility, and attainment values (Safavian & Conley, 2016).

In summary, the development of expectancy-values across adolescence for ethnically diverse samples is less well understood than for White and European middle-class samples. Developmental trends in expectancy-values amongst underrepresented first-generation and English learner youth need to be explored further, especially relating to how motivation is affected by having caring teachers.

Current study

In the current study, we investigated the development of student motivation (i.e., self-efficacy and subjective task values) and its association with perceptions of teacher caring for a socio-demographically and linguistically diverse sample consisting primarily of first and second generation Hispanic and Vietnamese students to address the following research questions (RQ):

1. What are the trajectories of self-efficacy and subjective task values for linguistically diverse adolescents throughout the first two years of middle school and high school?
2. To what extent does perceived teacher caring relate to the development of these motivational trajectories?
3. To what extent does English learner status moderate the effects of perceived teacher caring on math motivation?
4. To what extent do perceptions of teacher caring predict changes in math motivation?

With regards to our first research question (RQ1), we hypothesized that trajectories for self-efficacy and all subjective task values would decline over time for both the middle school and high school students (H1), similar to trajectories found in White middle-class samples (Musu-Gillette et al., 2015). In relation to RQ2, we predicted that perceived teacher caring would be positively related to all motivational constructs (H2), consistent with prior findings (Garcia-Reid et al., 2005, 2015). For RQ3, we hypothesized that English language learners would benefit more from perceiving their teachers as caring (H3). In other words, we hypothesized a positive interaction between perceived teacher caring and EL status (Lewis et al., 2012; Watkins & Melde, 2010). For our final research question (RQ4), we predicted that perceived teacher caring would predict a positive change in motivation from one year to the next (H4; Riconscente, 2014).

Method

Participants

The data used in this study originated from the California Achievement Motivation Project (CAMP)—a longitudinal study conducted in Orange County, California, and an extension of the Math and Science Motivation Assessment Program supported by the National Science Foundation Math and Science Partnership Program. It was designed to examine the development of math motivation in a population of predominantly low-income adolescent Hispanic, Vietnamese, and English language learners. The data used in this study were collected from two cohorts of students, consisting of a cohort in middle school (Grades 7-8) and a cohort in high school (Grades 9-10). The study sample included 1,926 students in middle school and 1,531 students in high school. Student demographic information (gender, ethnicity, SES, and language fluency) were collected from school district records and participants were predominantly Hispanic[1] (64%) and Vietnamese (11%), low income (61%), and 51% were female. Additionally, 41% of the students were classified as English language learners. The participants came from seven middle schools and four high schools in three districts in Orange County, California. All participating schools were Title I schools (i.e., schools that serve high proportions of low-income families). The data used in this study were obtained from students and school districts over two years (Grades 7 and 8 for the middle school cohort and Grades 9 and 10 for the high school cohort). Students' math standardized test scores were collected from school record data. Missing data and attrition are discussed below.

Procedure and Measures

Students completed researcher administered surveys assessing their math motivation and perceptions of their math class in the Fall and Spring for two consecutive years. Students' math motivation-related beliefs and teacher caring were assessed via student surveys in Fall 2004 (W1), Spring 2005 (W3), Fall 2005 (W4), and Spring 2006 (W6). Expectancy–value items were validated with Hispanic and Vietnamese middle school and high school youths in previous studies (Conley, 2012; Safavian, 2013; Safavian & Conley, 2016). All items were assessed at every wave using a 5-point Likert scale anchored from 1 (not at all true) to 5 (very true). See Appendix B for all items used. Sociodemographic covariates and moderators of interest were estimated within analyses.

Subjective Task Values. Subjective task value constructs for interest value, utility value, and attainment value were assessed at each Wave. Although subjective task-value components

[1] We use the term *Hispanic* to be consistent with the school district records identification of race. The California Department of Education defines *Hispanic* as "A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin" (https://www.cde.ca.gov/).

are correlated, they are theoretically and empirically distinguishable (as demonstrated by confirmatory factor analysis) and often modeled as separate outcomes. Items from previously developed measures by Eccles and colleagues (Eccles & Wigfield, 1995) were used, in addition to newly developed items that had been previously validated (Conley, 2012). Six items were averaged to measure interest value (scale $\alpha = .95$; sample item, “I enjoy the subject of math”), seven items to measure utility value ($\alpha = .84$ to .88; sample item, “In general, how useful is what you learn in math?”), and seven items to measure attainment value (scale $\alpha = .87$ to .90; sample item, “Thinking mathematically is an important part of who I am”).

Self-efficacy. Self-efficacy items were adapted from the Academic Efficacy Scale from the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 2000). Although PALS has been previously validated, we reworded items from the first person to second person. Four items (scale $\alpha = .79$ to .83) assessed students’ competence beliefs for learning and completing math assignments (sample item, “How certain are you that you can learn everything taught in math?”).

Perceived teacher caring. Four items measuring teacher caring were used from existing scales. Three items were taken from Fast and colleagues (2010) who validated their measure of perceived teaching caring and one item was taken from the Individualized Classroom Environment Questionnaire (ICEQ; Fraser & Fisher, 1986). These four items (scale $\alpha = .80$ to .83) assessed student perceptions of teacher caring, consideration, listening, and personal interest in students[2] (sample item, “Our math teacher cares about how we feel.”).

Math achievement. Students’ mathematics achievement was operationalized by their performance on the California Standards Test (CST). Administration of the CSTs is a part of the

[2] Although we used the scaled score for our HLM analyses, we tested the factor structure of the construct. The four items loaded onto one latent factor with good model fit ($\chi^2(2) = 103.529$, $p<.001$; RMSEA=.067; CFI=.993). Factor loadings were all at acceptable levels (.55, .76, .72, .81).

Standardized Testing and Reporting Program (STAR) in compliance with the accountability requirements under the No Child Left Behind (NCLB) Act of 2002 (https://star.cde.ca.gov/). The CSTs are a standards-referenced test in which examinations are aligned with the state's academic content standards (in this case, we focused on mathematics) to measure and evaluate students' achievement. CSTs are administered annually in the spring to all students enrolled in California public schools in Grades 2–11. Students take the criterion-referenced statewide end-of-course exam for the highest level of mathematics completed. Scaled scores range from 150 to 600. The CST benchmark scores are defined as "advanced", "proficient" (350+), "basic" (300-349), "below basic", and "far below basic." The state's target is for all students to score at or above proficiency (score of 350). See Appendix A for details about the CST.

Sociodemographic covariates. Student gender and sociodemographic background have been found to relate to math motivation and were included as covariates. Females were coded as the reference group for gender. Low income was defined as qualifying for the National Free and Reduced Lunch Program (NSLP) as determined by the school district records, with non-qualifying students coded as the reference group for income. Ethnicity was coded with non-Hispanic students (primarily Vietnamese, White, and other Asian) as the reference group[3].

Moderators. Language status was included as a key moderator. English Learner[4] (EL) status was determined based on school district classifications, with non-English learners as the reference group.

Attrition and Missing Data

[3] Due to the small sample sizes of the other ethnic groups no further subgroup analyses were examined and all other ethnicities were combined.

[4] English Learner (i.e., from a language-minority home and not yet proficient in English) was reported by the school districts in accordance with standards set forth by the CA Department of Education.

The data from CAMP included a complex pattern of complete and missing data. From an initial sample of 1,926 middle school students and 1,531 high school students, those with missing data on Level 2 variables (e.g., gender, language status, low income) were dropped from our analysis (~6% of cases), as hierarchical linear modeling software, by default, drops cases with missing values at Level 2 (Raudenbush & Bryk, 2002). We conducted *t*-tests of the key constructs to diagnose the missing data mechanisms for Level 1 and Level 2 variables. Students with missing data on any of the Level 2 variables generally had the same levels of motivation as students without missing data. Thus, we did not need to impute the missing data as we were not concerned that our estimates would be biased, as the missing data was ignorable, and the remaining cases appropriately represented our sample. However, students with missing data on the Level 1 repeated measures in Wave 6 (end of Year 2) were found to have lower math achievement than students without missing data. This suggested that the pattern of missing data was likely to be missing at random (MAR), as there appeared to be a systematic relationship between missing values and the observed data, but not the missing data. We address how we deal with missing data at Level 1 in more detail below. The final analysis sample consisted of 1,821 middle school students and 1,424 high school students.

Analysis Plan for Research Questions 1, 2, and 3

Hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002) was used to model growth curves for each of the motivational constructs, which included self-efficacy, interest value, utility value, and attainment value. Eight separate growth models were estimated, consisting of four models for the middle school cohort and four models for the high school cohort. Repeated measures of the motivational constructs (Level 1) were nested within students (Level 2). Growth curves allowed us to model the development of math motivation over the two years of middle school (i.e., grades 7 and 8) and high school (i.e., grades 9 and 10), including an examination of the associations between student perceptions of teacher caring and their math motivation. Analyses were conducted using the following steps. First, an unconditional growth model was estimated to determine appropriate specification of fixed and random effects for subsequent models (Singer & Willet, 2003). Second, addressing RQ1 we included all time-invariant (Level 2) predictors, including gender, ethnicity, income (NSLP), and prior math achievement. Third, to address RQ2, we included the time-varying predictor (Level 1) of perceived teacher caring. All the predictors were grand-mean centered, allowing us to analyze inter-individual differences (Enders & Tofighi, 2007). Finally, we included our primary interaction term of language status and perceived teacher caring. This allowed us to test for the potential moderation effects articulated in RQ3.

To address missing data issues, restricted maximum likelihood (REML) was used for estimation of variance and covariance components. REML estimates of variance components account for the uncertainty of the fixed effects and produce more accurate posterior variances when Level 2 units are small (Raudenbush & Bryk, 2002). Full maximum likelihood estimates were computed as a robustness check, and the results were very similar as expected with a large sample. All analyses were estimated using HLM 7 software (Raudenbush et al., 2011) and robust standard errors.

Time was equally spaced at each of four semesters over two years, defining a time interval of t = 1, 2, 3, and 4. For the intercept to represent the true initial status at the start of junior high or high school, we rescaled time by subtracting one (t = 0, 1, 2, and 3). The Level 1 and Level 2 unconditional growth model for each motivational construct were defined as:

(1) $Y_{ti} = \pi_{0i} + \pi_{1i}*(\mathrm{TIME}_{ti}) + e_{ti}$

(2) $\pi_{0i} = \beta_{00} + r_{0i}$

(3) $\pi_{1i} = \beta_{10} + r_{1i}$

Equation 1, Y_{ti}, represents the self-reported motivation (e.g., interest value, self-efficacy) of the *i*th student on the *t*th occasion of measurement and e_{ti} represents the level-1 residual. The intercept in equation 2, β_{00}, represents an estimate of the true mean level of motivation for the population when t=0 (e.g., the beginning of junior high or high school). The slope parameter in equation 3, π_{1i}, represents the average change in motivation over the two years (e.g., Grades 7 to 8 or Grades 9 to 10). Heterogeneity in the intercept and slope are captured by the random effects (e.g., r_{0i} for the intercept and r_{1i} for the slope). In defining each Level 1 growth model, we tested a linear versus a quadratic fit, with the linear models fitting best. The final conditional models were:

Level-1 Model

(1) $Y_{ti} = \pi_{0i} + \pi_{1i}*(Time_{ti}) + \pi_{2i}*(TeacherCaringth_{ti}) + e_{ti}$

Level-2 Model

(2) $\pi_{0i} = \beta_{00} + \beta_{01}*(HISPANIC_i) + \beta_{02}*(NSLP_i) + \beta_{03}*(MALE_i) + \beta_{04}*(EL_i) + \beta_{05}*(MATH_i) + r_{0i}$

(3) $\pi_{1i} = \beta_{10} + \beta_{11}*(HISPANIC_i) + \beta_{12}*(EL_i) + r_{1i}$

(4) $\pi_{2i} = \beta_{20} + \beta_{21}*(HISPANIC_i) + \beta_{22}*(EL_i) + r_{2i}$

Analysis Plan for Research Question 4

Although the growth curves models provide general associations between variables, they do not allow for inferring the directionality between the time-varying covariate of teacher caring, π_{2i}, and the motivational outcome, Y_{ti}, as both constructs were measured at the same time. To determine the unique effect of perceived teacher caring on the development of subsequent student motivation (RQ4), change models were run. Hierarchical linear models were used to account for the nested structure of the data, with students nested in classrooms. Nesting students in classrooms reduces potential aggregation bias and misestimation of standard errors (Raudenbush & Bryk, 2002). Furthermore, as students in similar grades may be in different math classes and take different standardized exams (e.g., algebra CST or geometry CST), grouping students by classrooms was essential to account for student differences in classrooms. Motivation at the end of Year 2 was modeled as the outcome variable, and all the demographic predictors from the previous growth models were included at the student level (i.e., Level 1). Motivation from the end of Year 1 was included to partial out the motivation related to the previous year, including any influence of prior perceived teacher caring on motivation. Then, perceived teacher caring at the beginning of Year 2 was included as a predictor, allowing for the unique effect of the new teacher to relate to changes in student motivation. Finally, the interaction between perceived teacher caring and EL status was included. The subscripts represent student *i* in classroom *j*.

Level-1 Model

$$Y_{ij} = \beta_{0j} + \beta_{1j}*(HISP_{ij}) + \beta_{2j}*(TeacherCaring\_W4_{ij}) + \beta_{3j}*(NSLP_{ij}) + \beta_{4j}*(MALE_{ij}) +$$

$$\beta_{5j}*(MOTIVATION\_W3_{ij}) + \beta_{6j}*(EL_{ij}) + \beta_{7j}*(MATH3_{ij}) + \beta_{8j}*(ELxTeacherCaring_{ij}) + r_{ij}$$

Results

Descriptive Findings

Before presenting our findings on the development and changes in motivation and relations with perceived teacher caring, we provide a summary of the descriptive findings as a necessary backdrop to the forthcoming analyses. Descriptive statistics and t-tests between groups are reported in Table 1 for the middle school cohort and Table 2 for the high school cohort. Correlations for all study variables are found in Table 3 and Table 4. For the middle school cohort, mean levels for subjective task values, self-efficacy, and perceptions of teacher caring declined each semester. EL students in middle school had higher math subjective task values than non-EL students ($p<.05$), although they had significantly lower math self-efficacy ($p<.05$). For the high school cohort, mean levels of math motivation were typically lower than reported by the middle school cohort. EL students reported significantly higher math attainment and utility value ($p < .05$), although their math self-efficacy was lower ($p < .05$).

Development of Motivation

We begin by presenting an overview of the results for the growth curve models, followed by a detailed explanation for each construct for each cohort. See Table 5 for complete growth curve results. To answer RQ1 (the development of motivational trajectories across adolescence) we first ran unconditional growth curve models for the middle school and high school cohorts, with separate models for the repeated measures of math interest value, utility value, attainment value, and self-efficacy. Most models had a fixed linear slope that was significant and negative, implying that math motivation generally declined during the two years of middle school and the first two years high school. The only exception was the model for math self-efficacy for high school students, which had a positive slope indicating an increase in math self-efficacy. All the models also had significant random intercepts ($p < .001$) and random slopes ($p<.05$), implying that students had varying initial levels of math motivation and varying rates of change in middle school and high school. The interclass correlations for all the motivational constructs were between .52 and .61, implying that between 52% and 61% of the variance in motivation is attributable to differences between students. To explain the variance in motivation between students, we ran conditional growth curves that included time-varying and time-invariant predictors. Adding these predictors allowed us to determine how semester specific perceptions of teacher caring and invariant person-level factors related to motivation.

With respect to RQ2, perceived teacher caring was positively associated with all motivational math constructs in both cohorts after including all other predictors ($p<.05$). The random slope was also significant, with a standard deviation of 0.45, suggesting that the relation between perceived math teacher caring and math motivation varied between students. In answering RQ3, the interaction between perceived teacher caring and being an EL student was significant and positive for both cohorts for most motivational constructs. This meant that the association between perceived math teacher caring and math motivation was stronger for EL students. Detailed results for each construct in middle school and high school are provided below.

Interest. Initial math interest value at the start of middle school and high school was predicted by math achievement (B=.31/.27, $p<.001$), EL status (B=.33/.25, $p<.001$), being male (B=.09/.08, $p<.001$), and ethnicity (B=-.20/-.10, $p<.05$). In the middle school sample, low income status was associated with higher initial math interest (B=.14, $p<.01$), but was not a significant predictor in the high school cohort ($p=.41$). Math interest declined over time for both the middle and high school cohorts (B=-.18/-.05, $p<.001$), although the slope for high school students was much smaller in magnitude. EL students in middle school had a less steep decline in math interest than non ELs. There was a significant interaction between perceived math teacher warmth and EL status (B=.08/.06, $p<.05$) on student interest in both cohorts. English learners' math interest did not decline as quickly (e.g., slope of decline was not as steep) if they perceived their teaching as caring.

Attainment value. Initial math attainment value at middle and high school transition (i.e., grades 7 and 9) was predicted by math achievement (B=.16/.17, $p < .001$) and EL status (B=.23/.28, $p<.001$). For the middle school cohort, being male (B=.09, $p<.05$) and having a low-income (B=.07, $p<.05$) was positively associated with initial math attainment value. Attainment value declined on average for both the middle and high school cohorts (B=-.16/-.08, $p<.001$). There was a significant interaction between perceived math teacher caring and EL status (B=.04/.09, $p<.05$) on math attainment value in both cohorts.

Utility value. Initial math utility value at the middle and high school transition was predicted by math achievement (B=.06/.10, $p<.001$) and EL status (B=.08/.18, $p<.001$). For the middle school cohort, being male (B=-.07, $p<.05$) was negatively associated with initial math utility. For the high school cohort, low-income status was positively associated with initial math utility (B=.08, $p<.05$). Math utility value declined on average for both the middle and high school cohorts (B=-.11/-.13, $p<.001$). For the middle school cohort, EL status was associated with a less steep decline in math utility value (B=.05, $p<.001$). For both cohorts, the interaction between perceived math teacher caring and EL status on math utility value was not significant (p=.06/.14).

Self-Efficacy. Initial self-efficacy at middle and high school transition was predicted by math achievement (B=.30/.26, $p<.001$) and being male (B=.17/.21, $p<.001$). Self-efficacy for math declined on average for the middle school cohort (B=-.06, $p<.005$), but increased on average for the high school cohort (B=.03, $p<.05$). For the middle school cohort, the interaction between perceived teacher caring and EL status on self-efficacy was significant (B=.04, $p<.05$).

Perceived math teacher caring predicts changes in math motivation

To address RQ4, change models were run separately for the middle school and high school cohorts (see Table 6 for middle school results and Table 7 for high school results). The interclass correlations for all the motivational constructs were between .07 (self-efficacy) and .11 (interest value), implying that between 7% and 11% of the variance in motivation was attributable to differences between classrooms.[5] By using change models that controlled for prior motivation, we investigated whether perceptions of teacher caring uniquely explained changes in math motivation from year to year. For both cohorts, perceived math teacher caring at the beginning of the second year positively predicted gains in math motivation at the end of the second year, while controlling for prior math motivation from the end of the first year (unstandardized betas ranged from 0.05 to 0.15). The change models explained between 31% and 39% of the variance in motivational outcomes.

For the middle school cohort, prior math motivation was the strongest predictor (B=.46 to .57, p<.001) of future motivation across all motivational constructs. Neither ethnicity nor low income status were significant predictors of any changes across all four motivational constructs (i.e., self-efficacy, interest, utility, and attainment value). Being male was associated with a change in lower math utility value (B=-.13, p < .01) and higher math self-efficacy (B=.13, p < .01) relative to females, but not associated with any change in math interest or attainment value. EL status was a significant predictor of change in interest value (B=.18, p<.001) but not a significant predictor of change across the other expectancy-value constructs. Perception of math teacher caring was also a significant predictor for all motivational constructs (B =.05 to .10, p <

[5]Additional analyses showed that the shared classroom variance of perceived teacher caring did not predict the development of students' motivational beliefs above and beyond individual perceptions. This points to the importance of students' subjective perceptions for the development of their beliefs and behaviors as proposed in EEVT.

.05), controlling for demographics, prior math motivation, and math achievement. However, the interaction between perceived teacher caring and EL status on motivation was not significant (p=.89).

For the high school cohort, neither ethnicity nor math achievement were related to changes in motivation. Income and being male were not associated with change in subjective task values (i.e., interest, attainment, and utility). However, low income (B =.12, $p < .05$) and being male (B = .19, $p < .001$) were both positively associated with change in math self-efficacy. EL status was positively related to change in attainment and utility value. Perception of teacher caring was a significant predictor for all motivational constructs (B = .09 to .15, $p < .05$) in high school, but the interaction between perceived teacher caring and EL status on motivation was not significant.

Discussion

Framed by Eccles et al. (1983) EEVT, we examined the development of math motivational trajectories for a culturally and linguistically diverse population of adolescents in middle school and high school, focusing on the role of perceived teacher caring on motivation.

Development of Motivation

Our sample of linguistically and ethnically diverse students had declining subjective task values in the two years of middle school and first two years of high school. This finding is consistent with findings from prior research on predominantly White populations (Fredricks & Eccles, 2002). Surprisingly, students rated math as having relatively high utility value, yet their interest and attainment value were significantly lower. This finding was in contrast to prior studies of White students that have found strong correlations between utility value and the other components of subjective task value. The relatively higher levels of utility value reflect the general message communicated to youth about the usefulness of math. However, despite understanding the usefulness of math in their future careers and lives, these students neither found math very interesting nor identified with it. These overall declines and disparities between components of task value may reflect a developmental mismatch between the needs of adolescents and the environments of middle and high school (Eccles et al., 1993). Although adolescent needs for autonomy support may be high, both middle and high school teachers often provide fewer opportunities for student decision making and enforce stricter discipline than in elementary school (Anderman & Mueller, 2010; Eccles et al., 1993). This may be especially true for the needs of low-income and linguistically diverse student populations and the institutional affordances available to them within schools situated in communities with high proportion of low-income families.

Additionally, there may be a cultural mismatch between the school environments and minority students' linguistic and socioemotional needs (Ceballo et al., 2010). How teachers negotiate negative stereotypes and stigmas about particular ethnicities and English learners in the classroom can have implications on how students experience the classroom. The ways in which those experiences are internalized and crystalized will influence motivation and subsequent choices and behaviors. As math interest in middle school and high school is a strong predictor of selecting college majors that require math (Musu-Gillette et al., 2015), understanding the causes of low math interest is important for future research.

Impact of perceived teacher caring on motivation

Perceived teacher caring was a significant time-varying predictor of self-efficacy and subjective task values in middle school and high school as hypothesized. Students who perceived their math teacher as caring at each wave reported higher levels of math motivation. In the growth curve models, we also found EL status moderated the association between perceived teacher caring and motivation. However, we could not make any claims on the directionality of the impact of teacher caring on motivation as both constructs were measured concurrently.

To assess the unique impact of teacher caring on the development of motivation, we used change models. The change models, which investigated change in motivation from the end of Year 1 to the end of Year 2, found a main effect for perceived teacher caring on changes in student motivation. However, results indicated no significant interaction by language status. We believe that this finding, which was contrary to our hypothesis, may have been due to our measure of EL status not being the most precise. EL classification was based on school records at Wave 1, and students may have been reclassified at a later wave, masking the true association between perceptions of teaching caring and motivation for English learners (Abedi, 2004). Alternatively, if language abilities had been tested directly as a continuous measure of language fluency rather than relying on initial district classifications, a more accurate representation of language status may have been achieved. Additionally, EL status was used as a proxy for generational status in the United States, as we did not have a direct measure of generational status.

Nevertheless, students who perceived their teacher as caring at the beginning of Year 2 reported higher motivation at the end of Year 2, while controlling for motivation from the end of Year 1. This finding is important in our understanding of the teacher as a socializer of math motivation. Teaching and learning, although typically thought of as cognitive, involve socioemotional acts based on relationships and social interactions (Eccles & Roeser, 2011). Teachers influence both the task value and self-efficacy that students have for math through building relationships based on caring and support. However, it is important to consider that student reports of teacher caring are subjective perceptions. Students likely have different conceptions of what constitutes a caring relationship.

This is further supported by the fact that there was significant variation within classrooms in student perceptions of teacher caring and classroom aggregates of perceived caring did not predict motivation above and beyond individual student perceptions. Therefore, it is reasonable to question the existence of a shared classroom perspective on how much a teacher cares for his or her students (Schenke et al., 2017). What may really matter is simply what a student personally perceives as caring, which is likely informed by cultural and personal expectations of what constitutes a caring relationship between a teacher and a student. Therefore, as an important educational implication, rather than simply encouraging teachers to be caring, it is important for teachers to be sensitive to cultural and individual differences in what constitutes caring.

Finally, we found that EL students reported higher math subjective task values relative to their non-EL peers. This finding is supported by research that immigrant-origin youth generally express positive attitudes and optimism toward their schooling (Kao & Tienda, 1995; Suarez-Orozco & Suárez-Orozco, 1995). However, despite endorsing higher subjective task values, EL students reported having significantly lower math self-efficacy. The disparity between self-efficacy and subjective task values is not typically found in middle-class White populations and may be due to several factors, including previous negative experiences with achievement-related tasks, weaker math skills due to past instruction, and vicarious experiences of friends and family. Additionally, being targeted for linguistic support services could inadvertently communicate the message ‘you are not capable’ (Dabach, 2014). Furthermore, ELs are also more likely to be instructed by teachers with relatively less classroom experience (Abedi, 2008; Gandara et al., 2005), and these teachers may have low efficacy beliefs (Hoy & Spero, 2005) that transfer over to their students' own efficacy (Midgley et al., 1989). Teacher efficacy may also vary intra-individually, where teachers feel less efficacious teaching low track courses (Raudenbush et al., 1992), which EL students often find themselves in. Karabenick and Noda (2004) found that teachers reported lower teaching efficacy when instructing EL students, but that teachers with more positive attitudes toward EL students were more likely to endorse mastery learning approaches in their classroom, which is beneficial for learning. This is an avenue of future research that warrants greater exploration.

Limitations and Future Research

The current study was one of the first to employ growth curves and change models to understand the role of perceived teacher caring on the development of math motivation in an ethnically diverse population of adolescents. The findings support the general developmental declines in math motivation found in other student populations and the importance of perceived teacher caring on student motivation. There are a few limitations that must be considered when interpreting the results. First, our data were not experimental, so we cannot make strong causal claims. Second, our sample was uniquely diverse with predominantly low-income Hispanic and Vietnamese students. To account for the diversity of students, we controlled for ethnic background in the current study. However, our findings may not generalize to students from other ethnic backgrounds. We believe additional research with other diverse populations would further support the generalizability of these findings and allow for a more detailed exploration of the role of ethnicity. Third, in order to better understand the mechanisms by which perceived teacher caring relates to motivation, cultural differences in what constitutes teacher caring should be investigated to learn more about the nature of students' subjective perceptions. Future research should also investigate other perceived teacher behaviors, including fairness and respect, support for collaboration, and encouragement of help seeking and questioning. Investigating these multifaceted components of the teacher-student classroom relationship will ultimately aid in our understanding of the development of student motivation and in creating meaningful interventions and professional development for teachers working with culturally and linguistically diverse students.

Conclusion

In addition to the theoretical and research implications previously mentioned, the present study has practical implications for teachers and school psychologists. First, teachers should recognize their ability to motivate students through inculcating a positive and caring relationship with their students. Therefore, in addition to considering the importance of pedagogical enhancements in improving math motivation and outcomes, teachers should invest time in building caring relationships with students to support their academic growth. Second, when students lack confidence in their math ability or do not value mathematics, school psychologists should investigate student-teacher relationships as a possible factor of low motivation. Finally, schools should consider investing in professional development for teachers and staff focused on developing positive and caring relationships with students. Although math motivation in middle and high school typically declines, teachers are capable of supporting students' self-efficacy and value for math through building caring relationships.

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Table 1

Means, standard deviations, scale alphas, and Differences for the Middle School Cohort

	Mean	SD	Scale α	non-Hispanic vs Hispanic	non-EL vs EL
Interest 0	3.14	1.28	.95	0.21***	-0.15**
Interest 1	2.69	1.21	.95	0.34***	-0.07
Interest 2	2.70	1.18	.95	0.27***	-0.22***
Interest 3	2.57	1.15	.95	0.22***	-0.17**
Attainment 0	3.43	0.90	.87	0.02	-0.16***
Attainment 1	2.98	0.97	.89	0.19***	-0.09*
Attainment 2	2.95	0.95	.89	0.11*	-0.24***
Attainment 3	2.82	0.98	.90	0.19***	-0.11*
Utility 0	4.39	0.74	.84	-0.05	-0.04
Utility 1	4.15	0.89	.87	0.04	-0.12**
Utility 2	4.06	0.92	.88	0.01	-0.24***
Utility 3	4.02	0.95	.88	0.09	-0.09
Self-efficacy 0	3.49	0.88	.79	0.21***	0.12**
Self-efficacy 1	3.36	0.94	.82	0.28***	0.20***
Self-efficacy 2	3.41	0.87	.81	0.18***	0.08
Self-efficacy 3	3.35	0.90	.83	0.18***	0.12**
PTC 0	3.64	1.00	.80	0.00	-0.03
PTC 1	3.15	1.10	.82	0.17**	-0.02
PTC 2	3.32	1.06	.81	0.23***	0.02
PTC 3	3.07	1.13	.83	0.42***	0.17**
CST Math Score	340.9	61.7	-	44.58***	47.34***

Note: SD=Standard Deviation. All survey items are on a scale of 1 to 5. PTC= Perceived teacher caring; EL=English learner; NSLP = National School Lunch Program; CST= California Standards Test; The numbers 0,1,2, and 3 after each construct represent different Waves (0 is baseline). Differences were tested using t-tests.

* p<.05, ** p<.01, *** p<.001

Table 2
Means, standard deviations, and t-tests for the High School Cohort

	Mean	SD	non-Hispanic vs Hispanic	non-EL vs EL
Interest 0	2.75	1.16	0.11*	-0.14**
Interest 1	2.62	1.12	0.14**	-0.03
Interest 2	2.50	1.08	0.06	-0.14*
Interest 3	2.57	1.11	0.13*	-0.12
Attainment 0	3.09	0.93	-0.04	-0.24***
Attainment 1	2.87	0.96	0.07	-0.11**
Attainment 2	2.76	0.96	0.02	-0.15**
Attainment 3	2.78	0.99	0.08	-0.15*
Utility 0	4.13	0.84	-0.10**	-0.17***
Utility 1	3.88	0.96	0.00	-0.13**
Utility 2	3.71	0.99	-0.04	-0.18***
Utility 3	3.71	0.98	0.11	-0.15**
Self-efficacy 0	3.26	0.88	0.13***	0.12**
Self-efficacy 1	3.30	0.92	0.15***	0.10*
Self-efficacy 2	3.21	0.88	0.05	0.12*
Self-efficacy 3	3.34	0.91	0.22***	0.13*
PTC 0	3.59	0.95	0.08	0.04
PTC 1	3.37	1.01	0.02	-0.01
PTC 2	3.29	1.03	0.00	0.04
PTC 3	3.23	1.07	0.14*	0.09
CST Math Score	312.68	50.80	10.69***	26.19***

Note: SD=Standard Deviation. All survey items are on a scale of 1 to 5. PTC= Perceived teacher caring; EL=English learner; NSLP = National School Lunch Program; CST= California Standards Test; The numbers 0,1,2, and 3 after each construct represent different Waves (0 is baseline). Differences were tested using t-tests. * $p<.05$, ** $p<.01$, *** $p<.001$

Table 3
Correlations for study variables for the Middle School Cohort

	Interest	Attainment	Utility	Efficacy	PTC	Male	Hispanic	EL	NSLP	MathCST
Interest	1.00									
Attainment	0.64***	1.00								
Utility	0.47***	0.66***	1.00							
Efficacy	0.57***	0.56***	0.44***	1.00						
PTC	0.30***	0.32***	0.32***	0.20***	1.00					
Male	0.02	0.01	-0.06**	0.07***	-0.07**	1.00				
Hispanic	-0.08***	-0.00	0.00	-0.12***	0.00	-0.01	1.00			
EL	0.06**	0.09***	0.04*	-0.06**	0.02	0.07***	0.32***	1.00		
NSLP	0.07***	0.08***	0.03	-0.02	0.02	-0.00	0.33***	0.26***	1.00	
MathCST	0.23***	0.14***	0.11***	0.34***	0.02	-0.05*	-0.35***	-0.38***	-0.14***	1.00

Note. All variables are from the first timepoint (Wave 1). PTC=Perceived teacher caring; EL=English learner; NSLP = National School Lunch Program; CST= California Standards Test. Correlations are Pearson coefficients.
* p<0.05, ** p<0.01, *** p<0.001

Table 4

Correlations for study variables for the High School Cohort

	Interest	Attainment	Utility	Efficacy	PTC	Male	Hispanic	EL	NSLP	MathCST
Interest	1.00									
Attainment	0.64***	1.00								
Utility	0.52***	0.70***	1.00							
Efficacy	0.59***	0.53***	0.43***	1.00						
PTC	0.32***	0.34***	0.34***	0.27***	1.00					
Male	0.04	0.01	-0.04	0.07**	-0.11***	1.00				
Hispanic	-0.01	0.04	0.08***	-0.03	-0.01	-0.01	1.00			
EL	0.06**	0.12***	0.12***	-0.06**	-0.02	0.11***	0.28***	1.00		
NSLP	0.05*	0.07**	0.09***	0	0.01	0.05*	0.21***	0.24***	1.00	
MathCST	0.24***	0.14***	0.08***	0.30***	0.02	0	-0.23***	-0.26***	0.01	1.00

Note. All variables are from the first timepoint (Wave 1). PTC=Perceived teacher caring; EL=English learner; NSLP = National School Lunch Program; CST= California Standards Test. Correlations are Pearson coefficients.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 5

Growth Curves for Subjective Task Values and Self-Efficacy for Middle School and High School Transitions

	Interest		Attainment		Utility		Self-Efficacy	
	MS	HS	MS	HS	MS	HS	MS	HS
Fixed Effects								
For Intercept, π0								
Intercept, β_{00}	2.83***	2.59***	3.13***	2.89***	4.27***	3.97***	3.36***	3.15***
	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Hispanic, β_{01}	-.20***	-0.10*	-0.04	0.00	0.05	0.03	-0.05	-0.07
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
NSLP, β_{02}	0.14**	0.04	0.09*	0.03	0.03	0.08*	0.01	0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
Male β_{03}	0.09*	0.08*	0.07*	0.05	-0.07**	-0.05	0.17***	0.21***
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
EL, β_{04}	0.33***	0.25***	0.23***	0.28***	0.08*	0.18***	0.05	0.01
	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
CST Math, β_{05}	0.31***	0.27***	0.16***	0.17***	0.06***	0.10***	0.30***	0.26***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
For Time slope, π1								
Intercept, β_{10}	-0.18***	-0.05***	-0.16***	-0.08***	-0.11***	-0.13***	-0.06***	0.03*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EL, β_{12}	0.04*	0.00	0.03	-0.02	0.05***	0.02	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
For PTC slope, π2								
Intercept, β_{20}	0.28***	0.30***	0.19***	0.20***	0.14***	0.21***	0.17***	0.23***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
EL, β_{22}	0.08***	0.06*	0.04*	0.09***	0.04	0.04	0.04*	0.03
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)
Random Effects (Variance)								
Intercept, r_0	0.86***	0.70***	0.38***	0.43***	0.24***	0.32***	0.33***	0.35***
Time slope, r_1	0.05***	0.04***	0.03***	0.02***	0.02***	0.02***	0.03***	0.02***
Teacher Caring slope, r_2	0.20*	0.05***	0.04***	0.04*	0.03*	0.05*	0.03*	0.04***

Note: All coefficients are unstandardized, except CST Math is standardized. Standard Errors are in parentheses. NSLP = National School Lunch Program; EL=English Learner; CST=California Standards Test. For random effects, variances are presented. Significance for random effects are based on chi-squared results and degrees of freedom. ***$p< 0.001$; **$p< 0.01$; *$p< 0.05$

Table 6

Change Models for Subjective Task Values and Self-Efficacy for Middle School Cohort

	Interest		Attainment		Utility		Self-Efficacy	
Fixed Effects								
Intercept	2.45***	2.44***	2.77	2.79***	4.08***	4.13***	3.28***	3.24***
	(0.07)	(0.10)	(0.06)	(0.09)	(0.06)	(0.10)	(0.06)	(0.09)
Hispanic	-0.08	-0.08	-0.07	-0.07	-0.08	-0.08	0.05	0.05
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)
PTC	0.09***	0.09***	0.05*	0.05	0.10***	0.09**	0.06*	0.07*
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
NSLP	0.11	0.11	0.10	0.10	0.01	0.01	-0.05	-0.05
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Male	-0.03	-0.03	-0.02	-0.02	-0.14**	-0.13**	0.13**	0.13**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)
Previous Motivation	0.51***	0.52***	0.57***	0.57***	0.52***	0.52***	0.46***	0.46***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
EL	0.18***	0.20	0.10	0.04	0.08	-0.04	0.05	0.15
	(0.05)	(0.15)	(0.05)	(0.15)	(0.05)	(0.18)	(0.05)	(0.15)
CST Math Score	0.12***	0.12***	0.09**	0.09**	0.05	0.05	0.14***	0.14***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
EL x PTC		-0.01		0.02		0.04		-0.03
		(0.05)		(0.04)		(0.05)		(0.04)
Random Effects								
SD/Variance of RI	.25/.06***	.25/.06***	.12/.02*	.12/.02*	.13/.02*	.13/.02*	.15/.02***	.15/.02***
$\chi 2$(dof)	192.0(89)	191.8(89)	118.6(89)	118.5(89)	120.5(89)	120.8(89)	140.9(89)	140.7(89)

Note: All coefficients are unstandardized, except CST Math is standardized. Standard Errors are in parentheses. NSLP = National School Lunch Program; EL=English Learner; CST=California Standards Test; PTC=Perceived teacher caring.

For random effects: SD=standard deviation; RI=Random Intercept; dof=degrees of freedom

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 7

Change Models for Subjective Task Values and Self-Efficacy for High School Cohort

	Interest		Attainment		Utility		Self-Efficacy	
Fixed Effects								
Intercept	2.47***	2.47***	2.66***	2.66***	3.68***	3.68***	3.22***	3.22***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)
Hispanic	-0.04	-0.04	0.01	0.01	-0.06	-0.06	-0.08	-0.08
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)
PTC	0.09**	0.08*	0.12**	0.09**	0.15***	0.14***	0.14***	0.14***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)
NSLP	0.07	0.07	0.02	0.02	-0.02	-0.02	0.12*	0.12*
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(.05)	(.05)
Male	0.09	0.09	0.09	0.09	-0.01	-0.01	0.19***	0.19***
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Previous Motivation	0.58***	0.57***	0.62***	0.62***	0.49***	0.49***	0.45***	0.45***
	(0.03)	(0.03)	(0.03)	(0.03)	(.03)	(.03)	(.03)	(.03)
EL	-0.04	-0.04	0.14**	-0.09	0.16*	0.16*	-0.04	-0.09
	(0.21)	(0.21)	(0.05)	(0.17)	(0.06)	(0.06)	(0.05)	(0.19)
CST Math Score	0.05	0.05	0.07*	0.07*	0.03	0.04	0.11***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
EL x PTC		0.04		0.07		0.05		0.01
		(0.06)		(0.05)		(0.06)		(0.05)
Random Effects								
SD/Variance of RI	.21/.04***	.21/.05***	.19/.04***	.19/.04***	.27/.07***	.27/.07***	.18/.03**	.18/.03**
$\chi 2$(dof)	246.7(183)	247(183)	259.9(183)	259.9(183)	295.37(183)	295.37(183)	234.2(183)	234.2(183)

Note: All coefficients are unstandardized, except CST Math is standardized. Standard Errors are in parentheses. NSLP = National School Lunch Program; EL=English Learner; CST=California Standards Test; PTC=Perceived teacher caring.

For random effects: SD=standard deviation; RI=Random Intercept; dof=degrees of freedom

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Appendix A

The California Mathematics Standards Tests have 65 multiple-choice questions. The scale score that divides basic scores from below basic is 300 for every grade. The score that divides basic scores from proficient scores is 350 for every grade. The target is for all California students to score at proficient or above.

The State Board of Education set five benchmarks to indicate a student's proficiency on the CST. These levels are "advanced," "proficient," "basic," "below basic," and "far below basic," and are based on a student's scale score on the test. For example, students who score between 300 and 349 fall within the performance level "basic." The cut scores for "basic" and "proficient" stay the same every year (300 and 350, respectively) but the cut scores for other achievement levels may vary slightly among grade levels and from year to year. The State Board of Education has established "proficient" or above as the desired achievement goal for all students.

- **Advanced** — This category represents a superior performance. Students demonstrate a comprehensive and complex understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.
- **Proficient** — This category represents a solid performance. Students demonstrate a competent and adequate understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.
- **Basic** — This category represents a limited performance. Students demonstrate a partial and rudimentary understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.
- **Far Below/Below Basic** — This category represents a serious lack of performance. Students demonstrate little or flawed understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.

Appendix B

Scale items for self-efficacy, subjective task values, and perceived teacher caring

All items measured on a Likert scale from 1 (not at all true) to 5 (very true).

Self-efficacy

1. How certain are you that you can learn everything taught in math?
2. How sure are you that you can do even the most difficult homework problems in math?
3. How confident are you that you can do all the work in math class, if you don't give up?
4. How confident are you that you can do even the hardest work in your math class?
5. Even if a new topic in math is hard, how confident are you that you can learn it?

Interest Value

1. I enjoy the subject of math.
2. I like math.
3. I am fascinated by math.
4. I enjoy doing math.
5. Math is exciting to me.
6. How much do you like doing math?

Utility Value

1. Being good at math will be important when I get a job or go to college.
2. How useful is learning math for what you want to do after you graduate and go to work?
3. Compared to most of your other school subjects, how useful is what you learn in math?
4. Math helps me in my daily life outside of school.
5. In general, how useful is what you learn in math?
6. Math concepts are valuable because they will help me in the future.
7. Math will be useful for me later in life.

Attainment Value

1. Thinking mathematically is an important part of who I am.
2. It is important to me to be a person who reasons mathematically.
3. I feel that, to me, being good at solving problems which involve math or reasoning mathematically is.
4. It is important for me to be someone who is good at solving problems that involve math.
5. Being someone who is good at math is important to me.
6. Being good at math is an important part of who I am.
7. Compared to most of your other school subjects, how important is it for you to be good at math.

Teacher Caring

1. Our math teacher cares about how we feel.
2. Our math teacher listens to what I have to say.
3. Our math teacher takes a personal interest in students.
4. Our math teacher considers students' feelings.