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Raising the stakes: How students' motivation for mathematics associates with high- and low-stakes test achievement☆

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Abstract

This study uses data from an urban school district to examine the relation between students' motivational beliefs about mathematics and high- versus low-stakes math test performance. We use ordinary least squares and quantile regression analyses and find that the association between students' motivation and test performance differs based on the stakes of the exam. Students' math self-efficacy and performance avoidance goal orientation were the strongest predictors for both exams; however, students' math self-efficacy was more strongly related to achievement on the low-stakes exam. Students' motivational beliefs had a stronger association at the low-stakes exam proficiency cutoff than they did at the high-stakes passing cutoff. Lastly, the negative association between performance avoidance goals and high-stakes performance showed a decreasing trend across the achievement distribution, suggesting that performance avoidance goals are more detrimental for lower achieving students. These findings help parse out the ways motivation influences achievement under different stakes.

Keywords

Motivation; Achievement goal theory; Expectancy value theory; High-stakes testing; Quantile regression

1. Introduction

The No Child Left Behind (NCLB, 2002) legislation spurred an era of accountability motivating an upsurge in standardized testing. Like many states across the nation, California engaged in the development and usage of these standardized tests. Specifically, California sought to enhance student achievement by adopting academic content standards, measuring student progress toward these standards using the California Standards Test (CST), and attaching school- and district-level sanctions and incentives to these test scores (California Department of Education, 2006). This accountability system is predicated on the assumption

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that exams such as the CST accurately represent students' abilities. However, this assumption is unlikely to hold if students are not motivated to perform highly on these exams (Ryan, Ryan, Arbuthnot, & Samuels, 2007). Although the CST has consequences for schools and districts within California, there are few personal consequences for individual students. As such they may not elicit maximum effort from all students. Studies suggest that students who take exams that have little personal consequence, but still require effort, may experience resentment and decreased effort in performance (Braun, Kirsch, & Yamamoto, 2011; Duvall, 1994; Warren, 1998).

California students must also take the California High School Exit Exam (CAHSEE), which was created in 1999 as a high-stakes exam, the passing of which was required for students to earn a high school diploma (California Department of Education, 2013a,b). In contrast to the CSTs, the CAHSEE is high-stakes for students, because they must score above a minimum threshold on the test in order to graduate and receive their diploma. In this paper, we investigate the extent to which externally-imposed stakes moderate the relation between student motivation and standardized test score achievement. We hypothesize that external stakes provide an additional source of student motivation and thus may reduce the predictive power of individual differences in motivational beliefs in predicting test score achievement. Accordingly, we expect to see a stronger relationship between course-based motivational beliefs and student achievement on low-stakes tests than on high stakes tests. We test this hypothesis in two ways: First, we compare the association between students' motivational beliefs about their current math course with their mathematics scores on the low-stakes CST and the higher-stakes CAHSEE. Second, we take a closer look at the association between motivational beliefs and achievement for students who score close to the passing threshold on these two tests. Because the CAHSEE is a uniquely high-stakes exam for students who score near the passing threshold, we expect the association between motivational beliefs and achievement to be attenuated for these students. Third, we examine if the associations between students' motivational beliefs and math outcomes vary across the achievement distribution and if the differences vary by type of exam.

1.1. High- versus low-stakes tests, test-motivation, and effort

Prior research suggests that attaching significant consequences to test performance prompts students to work harder and learn more (Angrist & Lavy, 2009; Bishop, 1997; Braun et al., 2011; Roderick & Engel, 2001). Bishop (1997) provided evidence that the implementation of high-stakes exit exams increased students' math scores, which he attributed to increases in students' efforts and support from parents, teachers, and school administrators. In Roderick and Engel (2001), students, on average, reported an increase in their work effort, attention to classwork, and studying outside of school when the Iowa Tests of Basic Skills (ITBS) high-stakes assessment became a mandated requirement for grade promotion in Illinois. Positive effects from increased stakes may be limited to the incentivized tests themselves, but there may be detrimental outcomes that extend beyond the incentivized test, particularly among at-risk student populations and students who exhibit low academic performance (see e.g., Bishop & Mane, 2001; Dee & Jacob, 2007). Studies of these tests have found increases in dropout rates, superficial learning, and loss of interest in the subject matter (Bishop & Mane, 2001; Dee & Jacob, 2007; Harlen & Crick, 2003; McNeil, Coppola, Radigan, & Heilig, 2008; Sheldon & Biddle, 1998). In short, high stakes tests can lead students to increase their effort and achievement on incentivized tests, but these positive outcomes may not hold for extremely low-performing students or those otherwise at risk.

Relative to high-stakes tests, low-stakes tests do not engage student motivation in the same way and therefore may not accurately reflect students' knowledge (Cole & Osterlind, 2008; Napoli & Raymond, 2004; O'Neil, Sugrue, & Baker, 1995; Wise & DeMars, 2005). In low-stakes situations, students must value the non-consequential test (i.e., have high test motivation) to expend effort. Cole, Bergin, and Whittaker (2008) demonstrated that college students' value beliefs regarding low-stakes exams such as perceptions of usefulness and importance influenced their effort, which, in turn, predicted their scores on low-stakes tests. Essentially, if students do not perceive importance or usefulness of an exam, their effort suffers, and consequentially, so does their test score. Further, Sundre and Kitsantas (2004) compared the relation between students' test-motivation and achievement outcomes by comparing students' graded (consequential) and ungraded (non-consequential) class exams. Neither college students' reports of how hard they tried nor their reports of the value they attached to a given test predicted their final test scores for graded, high-stakes exams, but both of these reports did predict their tests scores for low-stakes, non-consequential exams. Essentially, stronger relations between students' motivational beliefs and test outcomes were present in low-stakes testing cases. Thus, we expect greater variance in students' effort when they take low-stakes exams as compared to high-stakes exams.

1.2. To what extent do students' motivational beliefs predicts low- and high-stakes tests

Empirical studies show that various subject-matter-specific motivational beliefs predict students' course grades and performance on low-stakes mathematics standardized test achievement (Fast et al., 2010; Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006; Keys, Conley, Duncan, & Domina, 2012). For example, in Keys et al.' (2012) study of middle school students' math-class-related achievement goals and mathematics CST scores, endorsing a mastery goal orientation toward one's performance predicted both higher grades and better CST scores when controlling for a full set of prior achievement and demographic controls. Similarly, in Kenney-Benson et al. (2006), study of 5th and 7th grade students, both students' mastery goals and mathematics self-efficacy predicted their standardized test achievement scores (mastery goals indirectly through their impact on learning strategies and self-efficacy directly). Taken together, these studies suggest that one way to increase scores on low-stakes standardized tests is to increase students' math-course-specific mastery goals and self-efficacy.

However, very little research has actually focused on the link between students' math-course-specific motivation-related beliefs (such as their achievement goals for their current math course, their confidence in their ability to do well in their math course and the value they attach to doing well in that course) and their performance on high-stakes math tests. Instead, researchers interested in predicting high-stakes performance have focused on students' test-taking motivational beliefs (e.g., Cole et al., 2008; Sundre & Kitsantas, 2004). In one of the few studies that did focus on the association between course-based motivational beliefs and in-class high-stakes exam performance, Malpass, O'Neil, and

Hocevar (1999) found that gifted students' course-based math self-efficacy, but not their course-based achievement mastery goal orientations, predicted their performance on the high-stakes Advanced Placement exam taken at the end of their Advanced Placement Calculus course.

1.3. The current study

This study examines the relation between students' motivational processes and their performance on high-stakes and low-stakes mathematics exams. Our main research question is: Are students' motivational beliefs about their current math course associated differently with their mathematics scores on tests that have either high or low stakes for students? Further, we examine the extent to which this association differs across the test score distribution. We hypothesize that externally imposed stakes can urge even academically unmotivated students to put forward effort on standardized tests. As a result, we expect the association between course-specific motivational beliefs and achievement on the high-stakes CAHSEE to be lower than the association between these motivational beliefs and achievement on the low-stakes CST. Further, we expect that the association between motivational beliefs and achievement will be particularly weak for students who are at risk of failing the CAHSEE (and thus not earning a high school diploma).

The rest of the paper is organized as follows: the remainder of Section 1 situates our work within the theoretical frameworks in the motivation literature; in Section 2, we discuss the method used in our analysis; in Section 3, we present our results; and in Sections 4 and 5, we discuss our findings and provide our conclusion.

1.4. Theoretical framework

Motivational beliefs are one psychological mechanism that influences students' motivation to exert effort on learning tasks (Wigfield & Cambria, 2010; Wigfield & Eccles, 2000). We draw on two widely used frameworks for studying motivational beliefs and academic achievement — expectancy-value theory and achievement goal theory —to operationalize motivational beliefs in order to provide a more complete picture of student motivation (see Wigfield & Cambria, 2010; Wigfield, Byrnes, & Eccles, 2006). These two frameworks were designed to explain complementary but different phenomena: expectancy-value theory is initially designed to explain and predict which activities individuals choose to engage (Wigfield & Eccles, 2000); achievement goal theory was designed to explain why a learner engages in specific achievement-related behaviors (Kaplan, Middleton, Urdan, & Midgley, 2002).

1.4.1. Expectancy and value—According to expectancy-value theory, "individuals' choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity" (Wigfield & Eccles, 2000, p. 68). Research grounded in both Eccles et al.'s expectancy-value theory (Eccles, Adler, Futterman, et al., 1983) and in Bandura's self-efficacy theory (Bandura, 1977, 1986; Pajares, 1996; Schunk, 1991) has provided strong support for the importance of positive expectations for success in motivating behavioral engagement (see Schunk, Pintrich, & Meece, 2007).

Expectancy-value theories also stress the role of subjective values in motivating engagement and performance. Eccles and her colleagues operationalized subjective task value in terms of attainment value, intrinsic value, utility value, and perceived cost (Wigfield & Eccles, 2000). Attainment value (linked to student identity-related processes) is the level of importance the individual places in light of how much he/she identifies "the self" with the task. Intrinsic value is enjoyment one gets from engaging in the task and is akin to the student's interest in the material. Utility value is determined by how well the task relates to the individual's other short- and long-term goals. Lastly, value is influenced by the perceived cost involved in doing the task. Cost may include negative effects of doing the task on emotions, social rejection, the requirement of a lot of time or effort, and the opportunity cost of forgoing other activities to engage in the specified task.

Eccles and colleagues stress the fact that engagement is determined jointly by all aspects of a task that relate to the individual's expectation for success on that task and that relate to the relative value of the task to the individual in the moment. Applying expectancy-value theory to the situation in the current paper results in the prediction that beliefs related to a student's confidence in her math abilities and the value she attaches to doing well in her current math course will predict performance on a standardized math test given in association with her math course. This prediction may not hold in different testing situations, however. In a high stakes testing situation, for example, a student may work as hard as possible regardless of her feelings about her current math course. If so, then Eccles expectancy-value theory leads to the prediction that the nature of the stakes involved in the test should influence the predictive power of other more general (non-test specific) motivational beliefs. This is our main prediction.

1.4.2. Achievement goals—Achievement goal theory focuses on the purposes a learner adopts for achievement behavior (Middleton, Kaplan, & Midgley, 2004). Our operationalization of the theory is based in a trichotomous achievement goal framework: mastery, performance-approach, and performance-avoidance goals. Mastery oriented students intrinsically value learning and exert effort to in order to master the material (Dweck & Leggett, 1988; Pintrich, 2000). Performance oriented students are very concerned about how well they are doing compared to other students (Elliott & Dweck, 1988). Performance-approach oriented students are motivated to outperform their peers; performance-avoidance oriented students are motivated to avoid appearing less than their peers (Anderman & Wolters, 2006; Elliott & Dweck, 1988; Elliot & McGregor, 2001).

Students with a mastery goal orientation experience more engagement and greater learning than do students with performance goal orientations, particularly students with a performance avoidance orientation (Rosen, Glennie, Dalton, Lennon, & Bozick, 2010). In their review of motivation literature, Rosen et al. (2010) concluded that mastery goal orientations, along with high intrinsic motivation, high task value, and high expectations for success, consistently predict higher achievement, educational attainment, and other academically-favored outcomes like effort and engagement. Although performance-approach goals predict academic achievement (Elliot & Church, 1997; Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002; Midgley, Kaplan, & Middleton, 2001), they also predict the increased the use of superficial learning strategies and increased negative affect after failure (Meece, Blumenfeld, & Hoyle, 1988; Pintrich, 1989). Performance-avoidance goals have consistently been linked to lower performance, higher levels of anxiety, and other maladaptive behavioral outcomes such as procrastination and cheating (Elliot & Harackiewicz, 1996; Elliot, McGregor, & Gable, 1999; Middleton & Midgley, 1997; Skaalvik, 1997; Urdan, 2004; Zusho, Pintrich, & Cortina, 2005).

1.5. Hypotheses

Both expectancy-value and achievement goal perspectives posit relations between motivational beliefs and academic achievement (Wigfield & Cambria, 2010). We propose that the association between students' motivational beliefs and test scores will differ based on the stakes of the test because such stakes provide a different source of motivation that may override the impact of individual differences in motivational beliefs on test engagement. Drawing on Eccles et al., expectancy-value theoretical framework, the idea of utility value suggests that anything that increases the importance of a task for achieving one's short or long term goals should influence engagement. The essence of a personally high-stakes test is that one's performance on this test has greater utility value to the individual than a low-stakes test.

Prior research supports the link between self-efficacy (or the related concept of expectancy) with performance and achievement (Fast et al., 2010; Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Kenney-Benson et al., 2006; Watt, 2005; Wigfield, 1994; Wigfield et al., 2006), regardless of the stakes of the exam. This link has been conceptualized broadly: it is apparent that there is an association between self-efficacy and both low- and high-stakes test achievement. Furthermore, math self-efficacy scores are very stable over time. Thus, they may also be stable across tasks. If so, then math course self-efficacy may be equally important for both high- and low-stakes tests because this measure is a good proxy for test-taking self-efficacy. The predictive power of subjective task value for the current math course, however, may be more influenced by the stakes of the test. In the case of the high-stakes test, utility value for the outcome of the test may be more salient than that of the course. In this case, the subjective task value of the course might be less relevant for a high-stakes test but more relevant for a low-stakes test because this task implicates a more general orientation toward engaging with math-related tasks when there is no external motivator operating.

The specific prediction for the achievement goal orientation measures is less obvious because less is known about the association of mastery goals, and achievement goals generally, across these testing situations. In Keys et al. (2012), a mastery goal orientation predicted students' low-stakes test scores — whether this is also true for high-stakes tests has not been tested. But, we hypothesize that mastery goals will be more predictive in low-stakes than in high-stakes exams because we hypothesize that the predictive strength of students' motivational beliefs related to their math course will be weaker in the high-stakes CAHSEE situation in which more students will be motivated to pass and graduate high school, regardless of their specific motivational beliefs about their math course. This hypothesis is grounded in Sundre and Kitsantas (2004) study demonstrating that there was less variation in the amount of effort students exerted in a high-stakes test. We expect that this distinction will be particularly salient within an achievement goal framework, where motivation represents the students' purposes for engaging in specific mathematics activities, as opposed to an expectancy-value framework, where self-efficacy beliefs may relate to a broader swath of math-related behaviors.

We also propose that motivational beliefs may impact students' performance differently at different levels of the achievement distribution. To explore this, we test the association between students' math course-related motivational beliefs and high- and low-stakes tests across the distribution of student performance with particular attention to these associations at the cutoff of proficiency on the CST and of passing on the CAHSEE. Whereas the CAHSEE is generally thought of in terms of pass or fail, the State Board of Education (SBE) approved five performance levels for reporting for the CSTs: advanced, proficient, basic, below basic, and far below basic. The cutoff of proficiency on the CST occurs at the score of 350 and is used for this analysis because this is the score set by the SBE to represent proficiency as required under NCLB (California Department of Education, 2013a,b). Because of this, students, teachers, and administrators often think of the results as "passing" if students received a score of proficient or higher, or failing if students did not. The proficient performance level is used as a comparative reference to the cutoff of passing the CAHSEE because, like failing the CAHSEE, scoring less than proficient on the CST has repercussions for the teachers/schools, even if not for the student.

Prior research examining students' test motivation and subsequent achievement has shown that students' effort does not predict scores on high-stakes tests for low achieving students in the same way that it does for their higher achieving peers (e.g. Bishop & Mane, 2001; Dee & Jacob, 2007, 2011; Roderick & Engel, 2001). Therefore, we expect that the relation between students' course-related motivational beliefs and achievement scores will also vary across students with different mathematic abilities. A few possibilities arise. First, we expect that all students will expend maximal effort on the CAHSEE and thus their math course-based motivational beliefs should be less strongly associated with their achievement at the pass-point of the CAHSEE. Second, it may be that the CAHSEE is only truly *high-stakes* for those students at risk of failing — in this case students near the threshold for passing would show reduced association between motivation for their mathematics course and CAHSEE score. Students well above the threshold may be those who are not be worried about failure; therefore, their more general mathematics motivations influence performance. A final alternative hypothesis is that the association between course-related motivational beliefs and CAHSEE performance may be *stronger* at the threshold. It could be that a high-stakes situation strengthens the application of motivation to increase effort and students who are in danger of failing might experience some benefits from their course-based motivational beliefs. Given this explanation, we would not expect a similar association to occur at the proficiency cutoff on the CST because "passing" this test does not have the same consequences for students, meaning that they do not have a similar incentive to increase their effort and therefore have greater gains.

2. Method

2.1. Sample

Data are from the California Motivation Project — Mathematics (CAMP-Math). CAMP-Math is a part of the larger Math and Science Partnership — Motivation Assessment Program (MSP-MAP) funded by the National Science Foundation (NSF) to study the role of motivation-related beliefs in students' achievement in mathematics and science (see Conley, 2011). Our sample is a portion of students drawn from four high schools within a large urban unified school district. The school district included over 50,000 K-12 students enrolled during the 2004–2005 school year (California Department of Education, 2009).

Students were included in the analyses if they met all of the following criteria: (1) student was in tenth grade Algebra or Geometry courses in either the 2004–05 or 2005–06 school year and had valid California High School Exit Exam (CAHSEE) and California Standards Test (CST) mathematics scores, and (2) student had valid covariate measures and a valid score for the motivational measures for the fall motivational surveys given during students' tenth grade year. Our full sample consisted of 1018 students who were in tenth grade Algebra or Geometry in either 2004–05 or 2005–06 and had valid CAHSEE and CST scores. We consider this as our sample for two reasons. First, taking Algebra or Geometry in tenth grade represents the normative practice of the school district — a majority of students took one of these courses (Algebra: 31%, Geometry: 43%) as compared with other more advanced courses (26%). Advanced courses included Algebra 2 (20%) or Summative Math (6%). Second, the content of the CST course exams for these courses was more closely related to the content of the CAHSEE. Additionally, students in tenth grade courses that were more advanced than Algebra or Geometry all passed the CAHSEE, resulting in no variance around the pass point. Listwise deletion of students missing covariate and motivational measures was conducted, resulting in a sample size of 721 tenth-grade students with valid covariate controls and motivational predictors on either of the constructs used in the analyses. The students were largely Hispanic or Vietnamese, with a majority eligible for the National School Lunch Program (NSLP), and a large portion identified as English Language Learners (ELLs). The adjusted study sample was approximately 71% of the full sample. T-tests revealed that the adjusted study sample did not differ significantly from the full sample on any of the variables used in the analyses. Table 1 provides a summary of the study sample used in our analyses ($N = 721$).

Table 2 provides the descriptive statistics for the study sample by tenth grade course placement. Students who took the Algebra CST comprised approximately 42% of the study sample (300 students) whereas students in Geometry comprised 58% of the study sample (421 students). T-tests show a statistically significant difference in the number of males in Algebra (59%) than in Geometry (44%). There were more Hispanic students (approximately 81% compared with 74%) and fewer Vietnamese students (approximately 8% compared with 13%) in Algebra compared with Geometry. There were a statistically significantly lower proportion of students who were a part of the NSLP (approximately 74% compared with 76%) and a larger proportion of students who were ELL (approximately 63% compared with 50%) that took the Algebra versus the Geometry CST. Lastly, students in Algebra demonstrated significantly lower CAHSEE scores (371 compared with 383), higher CST scores (319 compared with 299), higher levels of self-efficacy (3.18 compared with 3.13), and higher levels of performance-avoid goals (2.16 compared with 2.03) in the fall of tenth grade compared with those in Geometry.

2.2. Measures

Students' motivational belief data were collected via a paper-and-pencil survey administered by trained research assistants in students' regular math classrooms. Research assistants informed students that within the survey, students could confidentially reveal their opinions and beliefs about mathematics. The survey took approximately 30 min to complete. All students in class on the day that the surveys were administered were invited to participate and less than 1% opted out. Surveys were administered during the fall (approximately four weeks after the start of the school year) and spring (approximately four weeks before the end of the school year) during the 2004–05 and 2005–06 school years. Further, student achievement on high-and low-stakes tests and demographic data were simultaneously collected from the district annual testing records and provided to researchers.

2.2.1. High-stakes testing—The CAHSEE is a high-stakes competency exam containing two sections, English/Language Arts (ELA) and mathematics, that high school students must pass in order to earn their high school diploma. The CAHSEE was created in 1999 and was first administered as a graduation requirement to students in the class of 2006 (Becker, Wise, Hardoin, & Watters, 2012). Students first take this test in tenth grade; those who do not pass the first time (about 26%) have up to seven chances to retake any failed part(s) of the test (California Department of Education, 2013a,b). The CAHSEE is intended to serve two primary purposes: (1) to significantly improve students' achievement in public high schools and (2) to ensure that students who graduate from public high schools can demonstrate grade-level competency in reading, writing, and mathematics (California Department of Education, 2013a,b). This exam was intended to help schools in the state of California provide students with the minimum English and mathematics competencies to be prepared for college and the workforce after high school (Carol, Susan, & Perry, 2006). To this end, the ELA section consists of English conventions (e.g., grammar, spelling, punctuation) and other writing tasks whereas the math section is aligned with state academic standards in grades six through eight and tests mathematics content through Algebra I. Each section score ranges from 275 to 450; students must achieve a minimum score of 350 on each section to pass and graduate with a high school diploma.

2.2.2. Low-stakes testing—Under California's Public School Accountability Act (1997), all students in grades two through eleven took the multiple-choice CST in English/Language Arts, mathematics, social science, and science each spring. The CSTs measured students' performance in relation to the California content standards. The present study focuses on the mathematics CSTs for students in tenth grade, when students took the CST corresponding to their enrolled math course. For example, a student enrolled in Geometry took the Geometry CST. The possible mathematics CST options for tenth graders were Algebra I, Geometry, Algebra II, Summative Math (which encompassed Algebra I, Geometry, Algebra II), or Probability and Statistics (California Department of Education, 2006). Students' scores were categorized into advanced, proficient, basic, below basic, or far below basic on a scale from 150 to 600, with proficient being a score greater than or equal to 350. In contrast to the CAHSEE, the CST is low-stakes for students, without personal consequences to students for performing poorly. However, until recently, the CSTs played a major role in California's accountability system and were often considered to be of higher stakes for schools, administrators, and teachers. The CST was last given in 2013. The cessation of the CST was due to California's investigation of new assessment in line with the Common Core, which are currently being tested and implemented (California Department of Education, 2014).

2.2.3. Student motivational beliefs—Students' motivational beliefs were assessed with questionnaires. Items were assessed using a 5-point Likert scale ranging from 1 (*not at all true for me*) to 5 (*very true for me*). Individual items from the specific motivation constructs were averaged based on theoretically recommended constructs and a final score from 1 to 5 was created. The alpha coefficients were quite good (.80–.97) on all eight scales suggesting high internal consistency among the items measuring each construct. Complete adapted scales and Cronbach's alpha coefficients are provided for each scale in the Appendix along with results from confirmatory factor analyses of the measurement models for both the expectancy-value and achievement goal frameworks.

2.2.3.1. Academic self-efficacy: Students' expectancies for success were assessed as competence beliefs measured with the Academic Efficacy scale from PALS (Midgley et al., 2000). Self-efficacy (4 items, α = .93) assessed students' judgments about their ability and confidence to perform adequately in math (e.g., "How sure are you that you can do even the most difficult math work?"). Items were anchored at the endpoints and in the middle with wording that was analogous to the wording of the stem (e.g., Not at all sure, Somewhat sure, Very sure). This conceptualization has been used in both the Eccles et al. expectancy-value and achievement goal research (e.g., Eccles, Midgley, et al., 1993a; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Midgley, 2002). A complete list of items assessing academic self-efficacy is listed in Appendix A.

2.2.3.2. Task value: Task value was assessed with four scales adapted from the work of Eccles, Wigfield, and their colleagues (Eccles, Midgley, et al., 1993; Eccles & Wigfield, 2002; Eccles, Wigfield, et al., 1993; Wigfield et al., 1997). Four subscales — Interest (six items, α = .97), Utility (four items, α = .93), Attainment (six items, α = .95), and Cost (two items, α = .86). These models were confirmed with the current data. Interest referred to students' liking for and enjoyment of math (e.g., "I find math very interesting"). Utility was concerned with students' beliefs about the usefulness of mathematics (e.g., "Math is useful to me for things I do outside of school"). Attainment value referred to students' judgments about the personal importance of math for their identity (e.g., "Thinking mathematically is an important part of who I am"). Cost value assessed students' judgments about the time and effort required to be successful in math (e.g., "Success in math requires that I give up other activities I enjoy"). All but two items were anchored in the middle and at the endpoints with the anchors: not at all true for me, somewhat true for me, and very true for me. Two items ("How much do you like doing math?" and "How useful is math for what you want to do after you graduate and go to work?") used anchors that were analogous to the wording of the item (e.g., Not at all useful, Somewhat useful, Very useful). Confirmatory factor analysis found no error covariances associated with the different anchors (see Conley, 2007). The mean of the four value scales (utility, interest, attainment, and the reverse of cost) is used as an overall measure of task value (α = .87). A complete list of items assessing subjective task value is provided in Appendix A.

2.2.3.3. Achievement goals: Students' achievement goal beliefs were measured with three scales from PALS (Midgley et al., 2000), which is one of the most widely-used measures of students' goal orientations in motivation-related literature. Midgley et al. (1998) reported on the development and validation of the goal orientation scales within this instrument. These beliefs refer to students' purposes when approaching, engaging in, and responding to math instruction. Mastery goals (5 items, α = .84) focus on learning and understanding (e.g., "My goal in math is to learn as much as I can"), performance-approach goals (5 items, α = .86) focus on demonstrating ability and outperforming others (e.g., "My goal in math is to look smarter than other students"), and performance-avoid goals (5 items, α = .80) focus on not looking dumb (e.g., "My goal in math is to avoid looking like I can't do my work"). These scales were anchored in the middle and at the endpoints with the anchors: not at all true for me, somewhat true for me, and very true for me. A complete list of items for each of the achievement goals assessed is provided in Appendix B.

2.2.4. Control variables—Student-level covariates in our analyses included race/ethnicity, gender, free/reduced lunch status (used as a proxy for socioeconomic status), English Learner (EL) status, and 10th grade course placement —to account for the difference in achievement specific to students' math course placement at the time of taking the CAHSEE and CST. Gender was a dummy variable, coded 1 for male and 0 for female. Ethnic categories were White (reference group coded 0), Hispanic, Vietnamese, and Other. Students' eligibility for the NSLP was coded 1 for yes and 0 for no. English Learner status was a dummy variable coded 1 for EL and 0 for non-EL.

2.3. Models

2.3.1. Ordinary least squares (OLS) regression—We used OLS to estimate the association between each motivational construct as measured in the fall of 10th grade and students' subsequent CAHSEE and CST math test scores. The conceptual model of achievement that guides our empirical analysis views CAHSEE and CST achievement as being directly influenced by students' motivational beliefs and other contemporary determinants such as English language fluency, socioeconomic status, gender, and ethnicity. Thus, the achievement of student *i* at the end of period *t* can be expressed as:

$$Y_{it}=\beta_0+\beta_1 Mot_{it-1}+\beta_2 Geo_{it}+\sum_{j=1}^{R}\beta_j{}^{x} X_{jit}+F\delta_{s(i,s)}+e_{i,c}. \quad (1)$$

In Eq. (1), Y_{it} represents student *i*'s CAHSEE or CST math score in the spring of tenth grade (t) and Mot_{it-1} is student *i*'s motivational response at the fall of tenth grade ($t-1$) and represents each of the five measures examined in this study: self-efficacy, task value, mastery goals, performance-approach goals, and performance-avoid goals. Geo_{it} is a dummy indicating student *i*'s 10th grade course placement relative to peers placed in 10th grade Algebra. *X*'s are time-invariant characteristics such as gender, ethnicity, EL status, and NSLP status. Time-invariant school characteristics $\delta_{s(i,\ s)}$ were controlled for in the analysis with school fixed effects using Stata's *xtreg* command (StataCorp, 2011), which is equivalent to including dummy variables for all but one school. The school fixed effects adjustment ensures that the estimated relations between course placement and motivation are based on *within*-school variation and minimizes the biases that arise from the nonrandom assignment of students to schools (Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). Additionally, we cluster standard errors on classroom identification to account for the non-random assignment of students into classrooms. Multilevel modeling using Stata's *xtmixed* command (StataCorp, 2011) and specifying school identification at Level 3 and classroom identification at Level 2 returned similar results. Lastly, to allow for comparability across the different units of measurement of different variables, the regression analysis was based on standardized (z-scored) achievement and motivational belief variables.

2.3.2. Quantile regression—In a recent study contrasting quantile regression with linear regression, Petscher and Logan (2013) concluded that there is a need for quantile regression in the field of educational research. The OLS regression used above focuses exclusively on the means and variances of the distribution of high- and low-stakes math test achievement. The mean reflects the central tendency of the distribution, and the variance provides additional information about the distance from the mean (Penner & Paret, 2008). Although this method is reasonable given the relevance of comparing the predictor variable coefficients returned on the regression analyses, it is not enough to reveal how motivational beliefs behave at various points across the achievement distribution. Whereas motivational processes occurring in the center of the exam distributions deliver some information about the way students' motivational beliefs are associated with test achievement, we cannot assume that the motivational factors affecting central tendencies are the same as the motivational factors affecting tendencies around the exams' cutoff points. Previous studies using these data have found that students' expectancy, value, and achievement goal beliefs relate to achievement differently for differently performing students (Simzar, Domina, Tran, & Conley, 2013). For example, Simzar and colleagues found that students' motivational beliefs changed based on prior achievement in middle school mathematics classes suggesting that the motivational processes did not predict students' achievement in the same way for students performing at the bottom versus the top of the distribution. We used quantile regression analysis to estimate these differential patterns.

Within these quantile regressions, we examined the relation between students' motivational beliefs and test achievement across each decile of the achievement distribution for each exam. We were specifically interested in how students' motivational beliefs predict achievement around the proficiency cutoff of the CST and the passing cutoff of the CAHSEE, both of which occur at a score of 350 or higher. However, the cutoff score for each exam occurs at different points along the achievement distribution, because the percentage of students that are proficient or higher on the CST (approximately 20%) is different from the percentage of students that pass the CAHSEE (approximately 80%). The cutoff of proficiency happens at the 80th percentile of the CST achievement distribution whereas the cutoff for passing the math portion of the CAHSEE occurs at the 20th percentile of the CAHSEE achievement distribution. Thus, examining how students' expectancies, values, and achievement goal beliefs are associated with the bottom of the CST distribution and comparing this association to how they are associated with the top of the CAHSEE distribution delivers more specific information about what happened at the salient point of each exam than does comparing them only at their centers (Grissom & Kim, 2001).

Quantile regression uses least absolute value (LAV), also known as absolute deviations, estimation to estimate the conditional differences in the mean and other quantiles in the distribution. This can be thought of as estimating the percentiles for different values of motivational beliefs of students separately and then observing the difference between students' P percentile at various scores of their motivational beliefs. Essentially, where OLS reports conditional difference in means, quantile regression reports conditional differences in percentiles. The models estimated here take the standard form:

$$y_{it}=\beta_0+\beta_1 Mot_{it-1}+e_i \quad (2)$$

where y_{it} is the standardized math score for student i spring of tenth grade (t) and Mot_{it-1} is a variable that represents standardized self-efficacy, task value, mastery goals, performance-approach goals, and performance-avoid goals. Koenker and Bassett (1978) state that this model can be estimated at the θth quantile by minimizing Eq. (3):

$$\min_\beta \left[\sum_{\{i|y_i \geq X_i\beta\}} \theta|y_i-X_i\beta|+\sum_{\{i|y_i<X_i\beta|\}}(1-\theta)|y_i-X_i\beta|\right]. \quad (3)$$

This is estimating β at different quantiles by changing the weights θ and $1-\theta$ on the positive and negative residuals. For example, at the median ($\theta = 0.5$), the coefficients are estimated by giving positive and negative residuals equal weight so that the sum of absolute deviations is minimized. Models are estimated using Stata's *qreg* command (StataCorp, 2013). The figures presented in the Results section of this paper graph the association of students' motivational beliefs across each decile of the achievement distribution for each exam by plotting the size of β_1 from Eq. (2) on the y-axis and θ on the x-axis.

3. Results

Table 3 presents the standardized regression results for students' expectancy beliefs, value beliefs, and achievement goals predicting CAHSEE and CST math achievement. The analyses focusing on CAHSEE are displayed in Models 1 and 2, and those focusing on the CST are displayed in Models 3 and 4.

3.1. Student motivational beliefs and CAHSEE math achievement

Model 1 is situated in the expectancy-value framework and presents the association between students' self-efficacy and task value and CAHSEE math scores. Model 2 examines the association between students' achievement goals (mastery, performance-approach, and performance-avoid) and CAHSEE math scores.

Of our statistically significant findings ($p < .05$), Model 1 shows that for the students in our sample, having one standard deviation (hereafter σ) above the samples' mean self-efficacy value was associated with a 0.17σ increase in CAHSEE scores. Model 2 shows that for students, having performance-avoid goals in mathematics one σ above the mean was associated with a 0.10σ decrease in CAHSEE scores.

3.2. Student motivational beliefs and CST math achievement

Model 3 examined the association between students' self-efficacy and task value and CST math scores and Model 4 examined the association between students' achievement goals (mastery, performance-approach, and performance-avoid) and CST math scores. Of our statistically significant findings, Model 3 shows that students who had self-efficacy beliefs one σ above the mean were associated with having a 0.21σ increase in CST scores. Model 4 shows that students with mastery goals in mathematics one σ above the mean had a 0.10σ increase in CST scores. Lastly, Model 4 shows that students with performance-avoid goals in mathematics one σ above the mean were associated with a 0.10σ decrease in CST scores.

Wald tests were used to test for differences in the coefficients between the two types of tests. Of the motivational belief predictors, only mastery goals returned a significantly different coefficient between the two exams ($p < .01$). This indicated that the relation between students' mastery orientation and CST achievement was different from the relation between students' mastery orientation and CAHSEE achievement. The relation between each of the other motivational belief predictors and the two types of exams were not different from one another at levels that rose to statistical significance.

3.3. Quantile regression analyses of expectancy and values

The quantile regression results are presented graphically in Figs. 1 and 2. Fig. 1 graphs the results from a series of bivariate quantile regressions of mathematics score on self-efficacy and task value beliefs for each decile of the achievement distribution for the CAHSEE and CST. The x-axes on the graphs are the deciles, and the y-axes are the β_1 coefficients from Eq. (2), so that the graphs show the association between standardized self-efficacy and task value beliefs at each decile. The horizontal black line provides the estimate of the association between self-efficacy or task value beliefs and exam scores at that percentile, and the gray shading shows the 95% confidence interval. The gray horizontal line depicts the OLS regression estimate of the self-efficacy and task value association, and the faint dashed gray lines provide its 95% confidence interval.

We compare Fig. 1a to b to see how self-efficacy beliefs predicted high- (CAHSEE) and low-stakes (CST) math test achievement differently. As Fig. 1a illustrates, the association between self-efficacy beliefs and CAHSEE performance is positive (but not significantly so) for students at the bottom of the achievement distribution. Similarly, there is a positive association between self-efficacy and achievement for students in the top two-thirds of the achievement distribution. However, for students whose scores are close to the CAHSEE passing threshold i.e. those between the 10th and the 30th percentile on the CAHSEE), this association is entirely attenuated. This dip in the association between self-efficacy and CAHSEE achievement is striking, and consistent with the hypothesis that externally-imposed stakes lead even academically disengaged students to exert maximum effort on standardized tests.

The association between self-efficacy and achievement on the low-stakes CST takes a very different shape. As Fig. 1b indicates, self-efficacy is weakly predictive of achievement for students at the bottom of the CST distribution but highly predictive of achievement for students at the top of the CST distribution. However, unlike the pattern in the CAHSEE analyses, there is no evidence of attenuation in the association between self-efficacy and achievement either near the 20th percentile (which corresponds to the CAHSEE passing score) nor near the 80th percentile (which corresponds to the proficiency score on the CST).

Similarly, we compare Fig. 1c and d to see how students' subjective task value beliefs predicted high (CAHSEE) and low (CST) stakes math test achievement differently. Although there is a weak association between subjective task value beliefs and CAHSEE performance for students at the very bottom of the achievement distribution as well as students in the top half of the achievement distribution, this association is entirely attenuated for students who score near the cutoff of passing the CAHSEE (Fig. 1c). In contrast, although the association between task value and CST scores is stronger at the top of the achievement distribution than at the bottom, there is no evidence of any attenuation in this pattern at either the CAHSEE passing threshold or at the CST proficiency threshold, and this association is significant and positive at all points above the 30th percentile on the CST distribution (Fig. 1d).

3.4. Quantile regression analyses of achievement goals

Fig. 2 graphs the results from a series of bivariate quantile regressions of mathematics score on students' mastery, performance-approach, and performance-avoid goals for each decile of the achievement distribution for the CAHSEE and CST.

We compare Fig. 2a to b to see how students' mastery goals predicted high (CAHSEE) and low (CST) stakes math test achievement differently. This analysis suggests that the association between mastery goals and CAHSEE achievement is uniquely attenuated around the CAHSEE passing score (Fig. 2a), but we find no evidence of such attenuation in the association between mastery goals and CST achievement (Fig. 2b).

We compare Fig. 2c to d to see how students' performance-approach goals predicted high (CAHSEE) and low (CST) stakes math test achievement. Comparing students' performance-approach goals at the cutoff for passing the CAHSEE shows that there was no association between students' performance-approach goals and CAHSEE achievement at the 20th percentile of achievement (Fig. 2c). Fig. 2d does not show a significant association between performance approach goals and the CST cutoff for proficiency, nor did it show a consistent trend across CST math achievement. Lastly, we compare Fig. 2e to f to see how students' performance-avoid goals predicted high (CAHSEE) and low (CST) stakes math test achievement. The association of students' performance-avoid goals and CAHSEE achievement around the cutoff of passing in Fig. 2e was larger than the association of students' performance-avoid goals and CST achievement around the cutoff in Fig. 2f. Specifically, performance-avoid goals were associated with a significant 0.11σ decrease in CAHSEE scores at the cutoff of passing whereas students' performance-avoid goals were associated with a lesser, non-significant 0.08σ decrease in CST scores at cutoff for proficiency.

4. Discussion

CAHSEE and CST were implemented in an effort to improve students' achievement in public high schools and to ensure that all high school graduates can demonstrate competency in reading, writing, and mathematics (California Department of Education, 2006; California Department of Education, 2013a,b). High- and low-stakes scores, however, do not only represent students' math abilities. Students' motivational beliefs about mathematics also contribute to their math performance (Ryan et al., 2007). Moreover, test consequences may also influence students' effort, which can lead to different associations between students' class-based motivation and math scores. Thus, we examined the relation between students' class-based motivational beliefs about mathematics and their high- and low-stakes scores.

4.1. Summary and implications

This study informs our understanding of how motivational beliefs matters for students' high- and low-stakes math achievement across the distribution of student performance. Prior literature has focused primarily on students' course-related motivational beliefs and low-stakes testing (e.g., Fast et al., 2010; Kenney-Benson et al., 2006; Keys et al., 2012). In this study, we found evidence that students' course-related motivational beliefs are associated differently with students' math standardized test scores depending on the stakes involved. Consistent with other studies, the students with higher math self-efficacy and with lower performance avoidance goals, on average, score higher on the CAHSEE than their peers in their same math course. Similarly, the students with higher math self-efficacy, higher mastery performance goals, and lower performance avoidance goals, on average, score higher than peers on the CST. Our results align with prior literature showing that students' math self-efficacy is a stronger predictor of test score performance than task value and achievement goals for both high-and low-stakes testing. The strength of the associations, however, was greater between motivational beliefs and CST scores than between motivational beliefs and CAHSEE scores, although this difference only arose to statistical significance in one instance — a mastery goal orientation emerged as a statistically significant predictor only for the low-stakes CST scores. Thus our results support our hypothesis for research question one — course-related motivational beliefs, at least in the instance of mastery goals, were a stronger predictor of CST than of CAHSEE scores. We also found, however, that some course-related motivational beliefs did statistically significantly predict scores for both exams. We had predicted this would be true for self-efficacy beliefs, which are likely to be good proxy for expectations for the exam as well as for course grades. This indicates that these students' course-related motivational beliefs (i.e., motivational beliefs about their current math course) continue to be beneficial even when the test stakes are high and students are motivated by the utility value of the test scores themselves. Nonetheless, as we predicted, the students' course-related motivational beliefs about math were of even greater importance for low-stakes tests, perhaps because there was no addition externally imposed motivational force operating.

Further, this study demonstrates that the associations between students' motivational beliefs and math outcomes vary across the achievement distribution and the natures of these differences vary by type of exam. In both exams, students at higher points along the achievement distribution had greater gains from adaptive motivational beliefs. Self-efficacy grows in predictive power for both CAHSEE and CST achievement toward the upper end of the distribution; however, self-efficacy is more strongly associated with CST achievement than with CAHSEE achievement. The predictive power of task value for achievement on the CAHSEE increases from the 50th percentile onward. In contrast, the predictive power of task value for CST achievement is consistent *across* the achievement distribution. Looking across all measures in Figs. 1 and 2 there is a consistent pattern: for all but one measure there is a notable dip in the predictive strength of motivation around the cut-point for passing the CAHSEE. Although in most instances this dip did not result in coefficients statistically significantly lower than those from the mean-level regressions, the consistency of the pattern is of note. We believe this provides evidence in support of our second hypothesis regarding the distributional analyses: that for students near the cut-point, effort is induced by the stakes of the exam to such an extent that the broader course-based motivational measures lose predictive power.

As an exception to this general pattern, the only course-related motivational belief that had a stronger association with CAHSEE scores than CST scores was students' performance avoidance goals, particularly at the cutoffs. The association between performance avoidance goals and high-stakes scores decreases across the achievement distribution, so that performance avoidance goals appear to be more detrimental for lower achieving students than their higher achieving peers. This finding is in line with prior research that has found negative associations between performance avoidance goals and performance (Day, Yeo, & Radosevich, 2003; Elliot, 1994; Payne, Youngcourt, & Matthew, 2007; Rawsthorne & Elliot, 1999). In addition, this finding is consistent with the established link between performance avoidance goals and test anxiety. In general, test anxiety undermines students' performance on timed tests (see Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2007). Furthermore, test anxiety increases in high-stakes testing situations and becomes even more detrimental for those students most susceptible to high test anxiety. Students who perform at the lower end of the distribution and who also have a performance avoidance goal orientation are a group that is particularly susceptible to high test anxiety. Thus raising the stakes of the test is very likely to increase the negative impact of performance avoidance goals among low performers because it is likely to increase these students' test anxiety to a greater extent than other students.

The converse to our finding that the association between motivation and performance on the CAHSEE is attenuated at the pass-point is the lack of this result at the pass-point for the CST. Although policies in support of the CST and other accountability exams posit student motivation to perform well on these exams, our results suggest that this may not be the case. If lack of association between motivation measure and performance provides evidence of external (exam-based) motivators, there is some evidence that these may be operating on the lower end of the CST distribution. However, policy rationale would suggest that this external motivation should be greatest at the pass-point and yet this is not seen: the strength of association grows linearly for most motivation measures, differing from the pattern of a pass-point dip seen with the CAHSEE.

4.2. Limitations

These findings offer contributions to the literature regarding students' motivational beliefs, externally imposed motivational forces, and achievement scores, despite some of the study's limitations. The first limitation of this study is our measure of self-report motivational beliefs. Our use of PALS, as with use of any measures, is not without criticism (see Elliot & Murayama, 2008; Hulleman, Schrager, Bodmann, & Harackiewicz, 2010). We nevertheless feel that these survey responses provide valuable information regarding student motivation — information that in the current paper predicts variance in student mathematics achievement across two different tests. Another limitation is the context of the motivation questions. Students were asked these questions regarding their specific math course (i.e., Algebra I or Geometry). These courses and questions were aligned with the content measured on the relevant CST exam. As students' motivational beliefs are greater predictors of specific tasks (Pajares, 1996), it may be that associations attributed to the stakes of the exam are instead due to the similarity in content between our motivation measures and the CST — possibly mediated by increased learning for course-specific material during the year. However, the math section of the CAHSEE tests covers content through Algebra I, similar to the content covered on the Algebra CST. As such, we did a robustness check limiting our analysis to only those students enrolled in Algebra I. The results were substantially similar to those including the entire analysis sample.

Although we believe examining the differences in associations between motivation and test scores at the cut-points of each test provides valuable information, especially when viewed as patterns of results across motivation measures, we acknowledge the limitation in comparing the two cut-points. Whether by design or accident, the CAHSEE is an easier test: only 20% of students within our sample score below passing in contrast to the 80% who score below passing on the CST. Replicating our findings with tests of different stakes but similar difficulty levels could provide additional support for the conclusions herein.

The availability of data and concerns regarding comparability of tests limited our sample to 10th graders enrolled in Algebra I or Geometry, living in southern California, and coming largely from specific minority groups. Our results may only be generalizable to similar populations. Although we view the diversity of our sample a strength, we recognize that this population may be viewed as unique and further call into question generalizability. Another limitation of our study is that we do not include prior achievement in any of our models. The CAMP dataset only includes students' prior CST scores, which are different for Algebra I and Geometry students, therefore, scores were not comparable and so not serve as a good prior achievement measure for the CAHSEE.

5. Conclusion

Ideally, standardized testing should encourage students to apply effort to learn mathematics, and the use of standardized testing has proliferated with this goal in mind (see Ryan et al., 2007). Use of standardized tests in this way operates under the assumption that all students will be motivated to succeed on these measures — our study provides evidence that this may not be the case — when stakes are low for students, performance varies more as a function of motivation for mathematics course. This may provide evidence that students are not viewing accountability exams, such as the California Standards Test used in this study, as high-stakes for them, and therefore may not try as hard. This needs to be kept in mind when thinking about what these low-stakes tests actually measure. It is essential that assessment practitioners keep in mind models of achievement motivation when planning, implementing, and interpreting the data from low- and high-stakes assessments. Without consideration of these factors, schools' and teachers' effects on student learning may be inaccurately judged, and more importantly, students may not reap the benefit from a system intended to encourage student learning, and ultimately, success.

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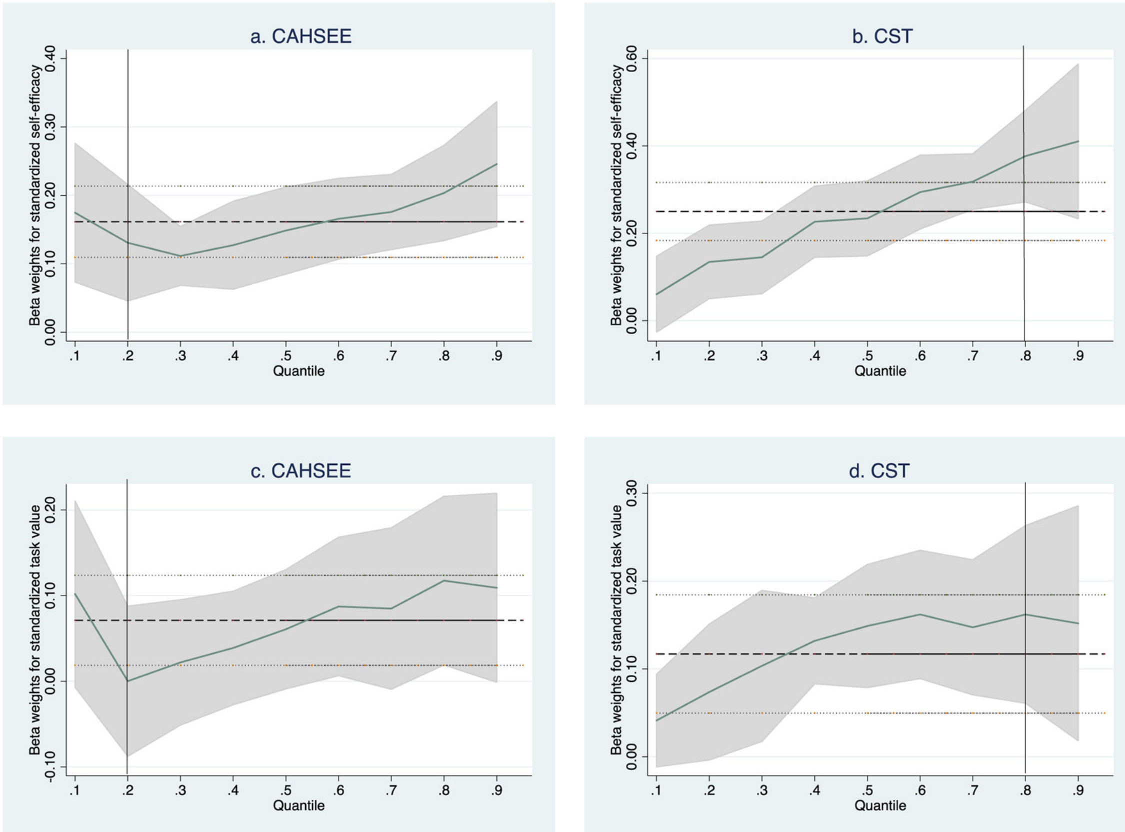

Fig. 1.

The association of standardized self-efficacy and task value on standardized CAHSEE and CST math achievement across the achievement distribution (*N* = 721 students). Note. Black, quantile regression estimate of self-efficacy effect for different percentiles. Gray shading, confidence interval of quantile regression estimate. Gray line, OLS estimate. Dashed gray line (faint), OLS confidence interval.

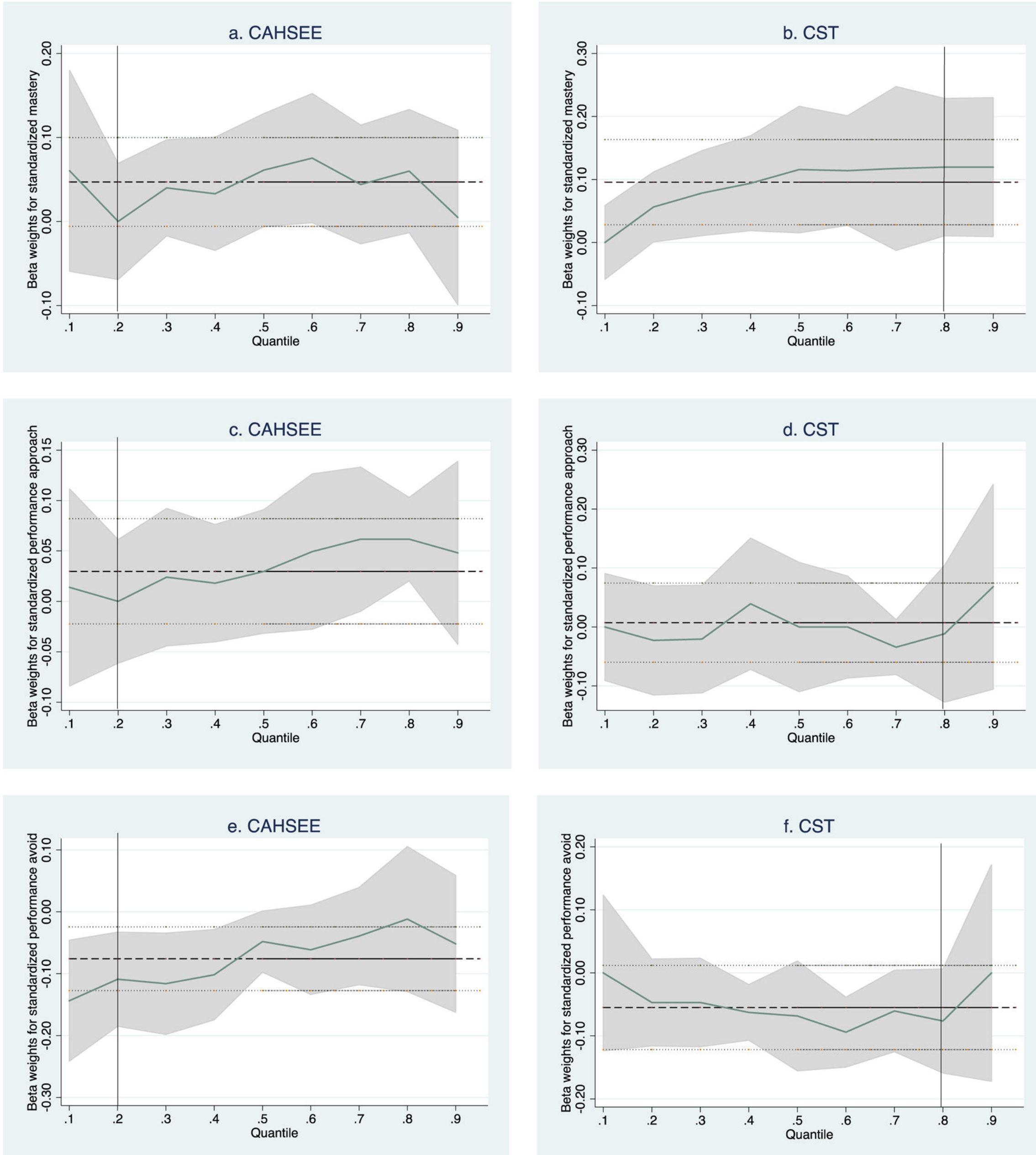

Fig. 2.

The association of standardized achievement goals on standardized CAHSEE and CST math achievement across the achievement distribution (N = 721 students). Note. Black, quantile regression estimate of achievement goal effect for different percentiles. Gray shading, confidence interval of quantile regression estimate. Gray line, OLS estimate. Dashed gray line (faint), OLS confidence interval.

Table 1

Descriptive statistics for study sample (N = 721 students).

	# valid obs.	Mean/%	SD	Min.	Max.
N	721				
Gender					
Male	362	50.2%	0.50	–	–
Race/ethnicity					
Hispanic	555	76.9%	0.42	–	–
White	38	5.3%	0.22	–	–
Vietnamese	81	11.2%	0.32	–	–
Other	47	6.5%	0.25	–	–
Free/reduced lunch (NSLP) and English Learner (EL) status					
NSLP status	541	75.0%	0.50	–	–
EL status	403	55.9%	0.43	–	–
Grade level and year					
Grade 10 in 2005	368	51%	0.50	–	–
Grade 10 in 2006	353	49%	0.50	–	–
Achievement					
CAHSEE score	721	378.30	24.80	303	450
CST score	721	307.58	46.09	191	484
10th grade motivational dimensions, fall					
Self-efficacy	721	3.32	0.67	1	5
Task value	721	3.15	0.89	1	5
Mastery	710	3.54	0.93	1	5
Performance approach	717	2.54	1.03	1	5
Performance avoid	711	2.08	0.95	1	5

Note. All motivation variables represent student beliefs for each motivation construct in the fall of 10th grade prior to taking the CAHSEE exam. Motivation scales = 1–5; CAHSEE score range = 275–450, 350 = pass; CST for both Algebra and Geometry score ranges = 150–600; CST Algebra: 150–252 = far below basic, 253–299 = below basic, 300–349 = basic, 350–427 = proficient, 428–600 = advanced. CST Geometry: 150–246 = far below basic, 247–299 = below basic, 300–349 = basic, 350–417 = proficient, 418–600 = advanced. Free/reduced lunch (NSLP) and English Learner (EL) status scale = 0–1 (1 = yes, 0 = no).

Table 2

Descriptive statistics for study sample by tenth grade course placement (N = 721 students).

	Algebra			Geometry			*p*-Value of difference
	# valid obs.	**Mean/%**	**SD**	**# valid obs.**	**Mean/%**	**SD**	
N	300	41.6%	–	421	58.4%	–	
Gender							
Male	177	59.0%	–	185	43.9%	–	0.00
Race/ethnicity							
Hispanic	242	80.7%	–	313	74.3%	–	0.00
White	15	5.0%	–	23	5.46%	–	0.87
Vietnamese	25	8.3%	–	56	13.3%	–	0.00
Other	18	6.00%	–	29	6.89%	–	0.70
Free/reduced lunch (NSLP) and English Learner (EL) status							
NSLP status	223	74.3%	–	318	75.5%	–	0.00
EL status	193	64.3%	–	210	49.9%	–	0.00
Achievement							
CAHSEE score	300	371	23.7	421	383	24.4	0.00
CST score	300	319	49.0	421	299	42.0	0.00
10th grade motivational dimensions, fall							
Task value	300	3.27	0.67	421	3.35	0.67	0.35
Self-efficacy	300	3.18	0.9	421	3.13	0.88	0.05
Mastery	293	3.48	0.98	417	3.56	0.90	0.90
Performance approach	298	2.50	1.07	419	2.57	1.00	0.41
Performance avoid	293	2.16	0.99	418	2.03	0.92	0.00

Note. All motivation variables represent student beliefs for each motivation construct in the fall of 10th grade prior to taking the CAHSEE exam. Motivation scales = 1–5; CAHSEE score range = 275–450, 350 = pass; CST for both Algebra and Geometry score ranges = 150–600; CST Algebra: 150–252 = far below basic, 253–299 = below basic, 300–349 = basic, 350–427 = proficient, 428–600 = advanced. CST Geometry: 150–246 = far below basic, 247–299 = below basic, 300–349 = basic, 350–417 = proficient, 418–600 = advanced. Free/reduced lunch (NSLP) and English Learner (EL) status scale = 0–1 (1 = yes, 0 = no).

Table 3

Two measures of achievement regressed separately on expectancy-value and achievement goal measures of motivational beliefs (N = 721 students).

	CAHSEE	CAHSEE	CST	CST
	(1)	(2)	(3)	(4)
Self-efficacy	**0.17*** (0.03)**		**0.21*** (0.04)**	
Task value	−0.04 (0.03)		0.01 (0.04)	
Mastery		0.02 (0.02)		**0.10** (0.04)**
Performance approach		0.06 (0.03)		0.03 (0.04)
Performance avoid		**−0.10*** (0.03)**		**−0.10* (0.04)**
R^2	0.28	0.25	0.23	0.20
N	721	708	721	708

Note. Motivation measures collected in the fall of 10th grade, prior to the CAHSEE and CST exams. Included in each sample are those students with non-missing data on demographics, achievement, and relevant motivation measure. Control variables are omitted from the table and include gender, race, English language learner status, 10th grade math class, cohort, and free/reduced lunch status. Dummy variables were used resulting in a reference group this is female, White, English only, not on free/reduced lunch, and in 10th grade Algebra within cohort 2006. Between school variance controlled for by using school fixed effects. The complete Table 3 is in Appendix C.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.00$.

Significant coefficients corresponding to the predictor variables of interest are in bold.

Appendix A

Expectancy value scale items

Scale and items	Reliability
Expectancy	α = .93
How confident are you that you can do even the hardest work in your math class?	
How certain are you that you can learn everything taught in math?	
How sure are you that you can do even the most difficult homework problems in math?	
How confident are you that you can do all the work in math class, if you don't give up?	
Subjective task value	α = .87
Interest value	α = .97
How much do you like doing math?	
I like math.	
Math is exciting to me.	
I am fascinated by math.	
I enjoy doing math.	
I enjoy the subject of math.	
Utility value	α = .93
How useful is learning math for what you want to do after you graduate and go to work?	
Math will be useful for me later in life.	
Math concepts are valuable because they will help me in the future.	
Being good at math will be important when I get a job or go to college.	
Attainment value	α = .95
Being someone who is good at math is important to me.	
I feel that, to me, being good at solving problem which involve math or reasoning mathematically is (not at all to very important).	
Being good at math is an important part of who I am.	
It is important for me to be someone who is good at solving problems that involve math.	
It is important to be a person who reasons mathematically.	
Thinking mathematically is an important part of who I am.	
Cost value	α = .86
I have to give up a lot to do well in math,	
Success in math requires that I give up other activities I enjoy.	

Note. The range for scale reliability is reported for all four waves of motivation surveys included in the analyses. *Source*: Midgley et al. (2000). Measurement model confirmed through CFA of correlated latent variables for expectancy and value; value as a second-order latent variable for interest, utility, attainment, and cost. 2005 fit statistics show CFI: .94, RMSEA: .06. 2006 fit statistics show CFI: .93, RMSEA: .07.

Appendix B

Achievement goal scale items

Scale and items	Reliability
Mastery approach	*α* = .84
Learning a lot of new things is what is important to me in math.	
One of my main goals in math is to improve my skills.	
My main goal in math is to learn as much as I can.	
Really understanding my math work is important to me.	
Learning new skills in math is one of my goals.	
Performance-approach	*α* = .86
In math, doing better than other students is important to me.	
My goal in math is to look smarter than other students.	
One of my goals is to show others that math is easy for me.	
It's important to me that others think I am good at doing math.	
My goal in math is to do better than other students.	
Performance-avoidance	*α* = .80
My goal is to keep others from thinking that I'm not smart in math.	
It's important to me that I don't look stupid in math class.	
An important reason I do my math work is so that I don't embarrass myself.	
I do my math work so that my teacher doesn't think I know less than others.	
My goal in math is to avoid looking like I can't do my work.	

Note. The range for scale reliability is reported for all four waves of motivation surveys included in the analyses. Measurement model confirmed through CFA as three intercorrelated latent variables. 2005 fit statistics show CFI: .94, RMSEA: .07. 2006 fit statistics show CFI: .96, RMSEA: .05.

Source: Midgley et al. (2000).

Appendix C

Two measures of achievement regressed separately on expectancy-value and achievement goal measures of motivation (N = 721 students)

	CAHSEE	CAHSEE	CST	CST
	(1)	**(2)**	**(3)**	**(4)**
Self-efficacy	**0.17*** (0.03)**		**0.21*** (0.04)**	
Task value	−0.04 (0.03)		0.01 (0.04)	
Mastery		0.02 (0.02)		**0.10** (0.04)**
Performance approach		0.06 (0.03)		0.03 (0.04)
Performance avoid		**−0.10*** (0.03)**		**−0.10* (0.04)**
Controls				
Male	0.16*** (0.05)	0.20*** (0.05)	0.10 (0.07)	0.18* (0.07)
Hispanic	0.08 (0.13)	0.09 (0.14)	0.15 (0.19)	0.18 (0.19)
Vietnamese	0.39** (0.15)	0.42** (0.15)	0.48* (0.20)	0.57** (0.20)
Other	0.02 (0.18)	0.09 (0.19)	0.21 (0.22)	0.30 (0.23)
English Learner (EL) status	−0.35*** (0.06)	−0.36*** (0.06)	−0.41*** (0.06)	−0.40*** (0.07)
Free/reduced lunch (NSLP) status	0.14* (0.06)	0.13* (0.06)	0.13 (0.08)	0.09 (0.07)
Cohort 2005 dummy	0.24*** (0.06)	0.19** (0.06)	0.11 (0.08)	0.09 (0.08)
Geometry	0.34*** (0.06)	0.32*** (0.06)	−0.40*** (0.08)	−0.43*** (0.09)
Constant	−0.52*** (0.15)	−0.51** (0.16)	0.03 (0.21)	0.00 (0.21)
R^2	0.28	0.25	0.23	0.20
N	721	708	721	708

Note. Motivation measures collected in the fall of 10th grade, prior to the CAHSEE and CST exams. Included in each sample are those students with non-missing data on demographics, achievement, and relevant motivation measure. Control variables are omitted from the table and include gender, race, English language learner status, 10th grade math class, cohort, and free/reduced lunch status. Dummy variables were used resulting in a reference group this is female, White, English only, not on free/reduced lunch, and in 10th grade Algebra within cohort 2006. Between school variance controlled for by using school fixed effects. The complete Table 3 is in Appendix C.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.00$.

Significant coefficients corresponding to the predictor variables of interest are in bold.

Appendix D

Quantile regression coefficients for CAHSEE achievement regressed separately for expectancy, value, and achievement goal measures of motivation

Dependent variable = CAHSEE achievement	*N*	10%	20%	30%	40%	50%	60%	70%	80%	90%
Self-efficacy	721	**0.17** ***	**0.13** ***	**0.11** ***	**0.13** ***	**0.15** ***	**0.17** ***	**0.18** ***	**0.20** ***	**0.25** ***
		0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.04	0.04
Task value	721	**0.10** **	0.00	0.02	0.04	**0.06** *	**0.09** *	**0.08** *	**0.12** ***	**0.11** **
		0.04	0.06	0.04	0.03	0.03	0.04	0.04	0.03	0.04
Mastery	710	0.06	0.00	0.04	0.03	0.06	0.08	0.04	0.06	0.00
		0.06	0.04	0.03	0.03	0.03	0.04	0.04	0.05	0.05
Performance approach	717	0.01	0.00	0.02	0.02	0.03	0.05	0.06	**0.06** *	0.05
		0.07	0.05	0.04	0.03	0.03	0.04	0.04	0.02	0.05
Performance avoid	711	**−0.14** **	**−0.11** **	**−0.12** ***	**−0.10** ***	**−0.05** ***	**−0.06** *	−0.04	−0.01	−0.05
		0.05	0.04	0.03	0.03	0.01	0.03	0.03	0.05	0.03

Note. Motivation measures collected in the fall of 10th grade, prior to the CAHSEE and CST exams. Included in each sample are those students with non-missing data on demographics, achievement, and relevant motivation measure.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

Significant coefficients corresponding to the predictor variables of interest are in bold.

Appendix E

Quantile regression coefficients for CST achievement regressed separately for expectancy, value, and achievement goal measures of motivation

Dependent variable = CST achievement										
	N	10%	20%	30%	40%	50%	60%	70%	80%	90%
Self-efficacy	721	0.06	**0.13** **	**0.14** ***	**0.23** ***	**0.23** ***	**0.29** ***	**0.32** ***	**0.38** ***	**0.41** ***
		0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.09
Task value	721	0.04	**0.07** *	**0.13** ***	0.04	**0.15** ***	**0.16** ***	**0.15** ***	**0.16** **	0.15
		0.04	0.03	0.03	0.03	0.04	0.04	0.04	0.06	0.09
Mastery	710	0.00	0.06	0.08	0.09	0.12	**0.11** *	0.12	**0.12** *	**0.12** *
		0.05	0.03	0.05	0.05	0.06	0.06	0.07	0.05	0.05
Performance approach	717	0.00	−0.02	−0.02	0.04	0.00	0.00	−0.03	−0.01	0.07
		0.04	0.04	0.04	0.05	0.07	0.06	0.05	0.07	0.10
Performance avoid	711	0.00	−0.05	−0.05	**−0.06** *	−0.07	**−0.09** **	−0.06	−0.08	0.00
		0.06	0.03	0.04	0.03	0.06	0.03	0.05	0.04	0.08

Note. Motivation measures collected in the fall of 10th grade, prior to the CAHSEE and CST exams. Included in each sample are those students with non-missing data on demographics, achievement, and relevant motivation measure.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

Significant coefficients corresponding to the predictor variables of interest are in bold.