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WORKING PAPER

Students with Growth Mindset Learn More in School

Evidence from California's CORE School Districts

While the importance of social-emotional learning for student success is well established, educators and researchers have less knowledge and agreement about which social-emotional skills are most important for students and how these skills distribute across student subgroups. Using a rich longitudinal dataset of 221,840 fourth through seventh grade students in California districts, this paper describes growth mindset gaps across student groups, and confirms, at a large scale, the predictive power of growth mindset for achievement gains, even with unusually rich controls for students' background, previous achievement, and measures of other social-emotional skills. Average annual growth in English language arts and math corresponding to differences between students with fixed and growth mindset in a same school and grade level is 0.07 and 0.05 standard deviations respectively, after adjusting for students' characteristics and previous achievement. This estimate is equivalent to 48 and 35 additional days of learning.

Susana Claro
Pontifica Universidad Católica de Chile

Susanna Loeb
Brown University

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Introduction

Having a growth mindset, i.e. believing that one's current capabilities can be developed (Dweck, 1999), helps maintain motivation for learning (Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Leggett, 1988; see also Hong, Chiu, Dweck, Lin, & Wan, 1999; Nussbaum & Dweck, 2008) and can promote academic achievement (Good, Aronson, & Inzlicht, 2003, Aronson et al., 2005, Blackwell et al., 2007, Paunesku et al., 2015, Yeager et al., 2016). Experiments have found that sessions designed to promote a growth mindset,[1] delivered directly to students, can benefit the academic achievement of students, especially those with initially low grades or at higher risk of failing (Paunesku et al., 2015, Yeager et al., 2016). This evidence has brought growth mindset to the attention of foundations, non-profit organizations, and governmental agencies (Obama, 2014; The White House, 2015; National Science and Technology Council, 2015). In addition, school districts, including the CORE consortium of districts in California, have begun to use surveys to assess students' growth mindsets. Yet even with the promising causal estimates from randomized trials, very little is known about the extent, variation, and effects of growth mindset in the student population across diverse subgroups.

Our current understanding of the impact of growth mindset emerged from field experiments using convenient samples of college and secondary-school students (Good, et al, 2003, Aronson et al., 2005, Blackwell et al., 2007, Paunesku et al., 2015, Yeager et al., 2016), and from experiments (Outes, Sanches, Vakis, 2017; Bettinger et al, 2017) and cross-sectional (Claro et al, 2016) data outside of the US. Yeager, Hanselman, Walton, Murray, … & Dweck (2019) and Destin et al. (2019) present the first and only studies using a representative sample of American students, estimating the effect of growth mindset on 9th grade GPA: both the predictive value of students' pre-existing mindsets (in the control group) (Destin et al, 2019) and the causal effects of an online growth mindset program (in the experimental group) (Yeager et al, 2019). The authors used a pre-registered analysis to show that mindset effects are heterogeneous across students and schools. They found that students with lower prior achievement earned higher grades after receiving the growth mindset treatment, especially when they were in schools that were not already the highest achieving, and when the schools had supportive norms. However Yeager et al. (2019) have not assessed differences in effects by student background characteristics such as ethnicity, gender, or free and reduced priced lunch status, neither have these studies observe other grade levels than 9th grade. Additional knowledge of whether or not growth-mindset studies are generalizable across a wide variety of populations and across grade levels can shed light on the need for and scope of potential policies for cultivating growth mindset.

This study focuses on the two questions: (1) Variation: To what extent does growth mindset vary across grade levels and student characteristics? (2) Effects: To what extent does

[1] For examples of these sessions go to www.perts.net

growth mindset predict academic achievement gains and how does this relationship vary across student groups? To answer these questions, we took advantage of data from the CORE districts in California, a collection of districts that came together to address challenges of instruction and student learning and to apply to the U.S. Department of Education NCLB waiver.

The first six CORE districts began collecting measures of growth mindset (adapted by Farrington et al., 2013), among other social-emotional skills, through surveys for all students in 3rd through 11th grade,[2] in 2015 (Hough, Kalogrides, & Loeb, 2017; West, Buckley, Krachman & Bookman, 2018; West, Pier, Fricke, Hough, Loeb, Meyer, Rice, 2018).[3] Our primary analyses are based on the approximately 221,840 students who were in grades four through seven in 2015 or 2016 in the CORE districts, who completed the survey, and whose responses we can link to administrative data on test scores from Spring 2013, 2015, 2016 and 2017. California did not test students in 2014. The data collected offer an opportunity to assess whether holding a growth mindset, measured by an instrument adapted by Farrington et al (2013), is beneficial to a wide range of students and to document the variation in growth mindset among them.

We observe, aligned to previous studies (West et al., 2018; Snipes & Tran, 2017, Destin et al., 2019), that socioeconomic disadvantage is associated with lower mindset levels. Students who are eligible for free or reduced priced lunch, have been English language learners, have parents with less than high-school education, or are Latinx report more fixed mindsets than their peers.[4] Female students hold greater growth mindset than male students up to 7th grade, where the mindset gap between males and females almost closes. These patterns appear within schools as well as across the population, though gaps within schools are much smaller than across schools. Gaps can be smaller within schools due to the systematic sorting of students across schools, to the effects of schools on students' social-emotional development, or to the existence of some type of reference bias.

To study the relationship between students' mindsets and achievement gains, we ran a series of regression models controlling for a rich array of student characteristics and two years of previous achievement (which may remove prior mindset effects on grades), as well as indicators for each school-grade in each year. These school-by-grade-by-year fixed-effects allow us to account for unobserved characteristics of schools that could affect both mindset and

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[2] Currently, CORE districts survey only applies to 4th grade and older.

[3] The districts that initially applied the SEL survey were Los Angeles Unified School District (LAUSD), San Francisco Unified School District (SFUSD), Fresno Unified School District (FUSD), Santa Ana Unified School District (SAUSD), Long Beach Unified School District (LBUSD), and Oakland Unified School District (OUSD). However, OUSD is not included in this study, because the survey information cannot be linked to student characteristics and achievement. For more information on the CORE Districts and measures see http://coredistricts.org/why-is-core-needed/core-districts/

[4] We do not know why economic disadvantage predicts more of a fixed mindset. Having lower opportunities to interact with adults who have higher attainment may give less chances to imagine a learning path to themselves (Destin et al, 2019; Oyserman & Lewis, 2017). Alternatively, economic disadvantage may lead to less access to growth mindset messages, which might arise if teachers have lower expectations for a student (Rattan et al, 2012).

achievement gains and mask the relationship between them. Moreover, these controls address the potential concern that students report their mindset relative to other students in their schools, known as reference bias (Duckworth & Yeager, 2015), because it compares students within each school grade only.[5] We find, even in the most conservative models which control for other measures of social-emotional learning and prior achievement, that growth mindset predicts achievement a year later. The relationship is not as strong as the simple correlation between growth mindset and achievement levels, but it is meaningful in magnitude. A student with a growth mindset in the spring has ELA and Math test scores in the following year that are approximately 0.07 and 0.05 standard deviation (SD) higher respectively than a similar classmate (i.e., a classmate with same previous achievement and demographic characteristics in the same school) with a fixed mindset. This magnitude is equivalent to 48 and 35 additional days of learning (following a conversion proposed by Hanushek, Peterson & Woessmann, 2012). The effects are similar across most student subgroups, especially in Math. Contrary to previous studies, we do not find that less advantaged students (such as those with lower achievement levels) have greater achievement gains from their growth mindset than their peers. This difference between the studies may be due to difference in outcomes (test scores vs. grades), to difference in the populations and context of the studies, or to differences in the methods employed to isolate the effect of growth mindset.

In what follows, we review the research literature on growth mindset to highlight the contribution of this study, describe the data and methods, report the results, and discuss the implications.

Growth Mindset

Dweck (1999) and colleagues (see Dweck & Yeager, 2012; Dweck &Yeager, 2019 for a review) propose that people's challenge-seeking and their effort and task persistence in challenging situations or after setbacks can be influenced by their implicit beliefs about their own intelligence, beliefs referred to as their "mindsets." Dweck identified two contrasting types of implicit beliefs about intelligence: the view that intelligence is fixed (i.e., an entity theory of intelligence, also referred to as fixed mindset), and the view that intelligence is malleable (i.e., an incremental theory of intelligence, or a growth mindset.) People who subscribe to entity theories, or a fixed view of intelligence, tend to exert less effort, avoid challenges, and be more likely to quit in face of failure than those with a growth mindset (see Blackwell et al., 2007; Dweck & Leggett, 1988; Hong et al., 1999; Nussbaum & Dweck, 2008). These behaviors may reduce individuals' opportunities for learning and limit their development (Dweck, 1999; Blackwell et al., 2007; see Yeager & Dweck, 2012). In contrast, those who consider intelligence to be malleable show higher resilience when faced with challenges and are more likely to seek

[5] This methodology does not address potential reference frame bias based in student subgroups within a school, such as females comparing with females, Asians with Asians, etc., but it does address comparisons to the full group of students within a grade and school since it removes the average for that grade and school from the variation in growth mindset.

out challenges as learning opportunities (Blackwell et al., 2007; Dweck & Leggett, 1988; Robins & Pals, 2001), which eventually could lead to actual improvement (Blackwell et al., 2007).

Experimental field studies provide evidence that beliefs about malleable intelligence impact academic achievement. Several randomized controlled trials in the US have shown that manipulating the mindset of students at a variety of ages (from middle school to college) can positively impact their academic performance, especially for low-performing students (Aronson, Fried, and Good, 2002; Good, Aronson, and Inzlicht, 2003; Blackwell, Trzesniewski, and Dweck, 2007; Yeager et al., 2013; Paunesku et al., 2015; Yeager et al., 2016; Yeager et al., 2019). Blackwell et al. (2007), for example, ran a randomized controlled trial in which students in the control group, who took part in a series of sessions that taught study habits, showed lower gains in their GPA by the end of the academic year, than students in the treatment group, who received training about the malleability of the brain in addition to the sessions on study habits.

These studies provide evidence that implicit beliefs about intelligence are malleable at a low cost. Paunesku (unpublished) estimates that delivering an online intervention tested by Paunesku et al. (2015) would cost approximately $20 per student. This projection amounts to less than one percent of the cost of decreasing class sizes by ten percent, but can have greater projected impact than the latter program (based on Project STAR estimates, Mosteller, 1995). Implementing online growth mindset interventions may be an attractive strategy as one means for improving student achievement, though interventions are still largely in the development stage and their effects may not be robust across diverse populations (Yeager et al., 2019).

Though investing in promoting a growth mindset in schools may seem promising, no large-scale study has assessed the predictive effect of students' mindsets on academic achievement across student subgroups (including gender, race, ELL status, and FRPL status) or middle school grades in experimental or correlational studies. Most studies at the K-12 level in the US have been implemented with small convenient samples (Good et al., 2003; Blackwell et al., 2007; Yeager et al., 2013) or at the high-school level only (Yeager et al., 2019; Yeager et al, 2016, Paunesku et al., 2015). The largest US study, Yeager et al. (2019), explored the effect of an scalable online mindset intervention on end of year GPA through a randomized controlled trial on 6,320 9th graders from a sample of 65 nationally representative public high-schools. This study produced the first evidence showing the impact of growth mindset on GPA that can be generalizable to 9th graders in the US. As the authors expected, they found heterogeneity in the results. They report that students with GPA below the school median who participated in the mindset treatment had a significant increase of 0.1 points in end of year GPA compared to the control group. They found no significant GPA difference for those with previous GPA at or above the school median, as predicted. Similarly, Yeager and colleagues found that the treatment effect was lower at schools with high previous average achievement, presumably because students in the highest-achieving schools already have many supports to prevent failure. The study, however, does not focus on individual-level heterogeneity among other types of student groups – such as by income level, English learner status, parent education, race/ethnicity, or gender – nor does it explore impacts in other age groups than 9th grade.

Past large studies (e.g. Paunesku et al., 2015, Yeager et al., 2016, and Yeager et al., 2019) have focused on the effects of mindset interventions on GPA.[6] We do not know the effects on measures that are more specifically focused on academic achievement nor standardized across schools. While GPA is a desirable outcome to improve, studying changes in GPA may not be the best way to evaluate whether developing a growth mindset benefits academic learning. Teachers may award grades based not only on student achievement or learning, but also on motivation directly. As a result, studies in the US to date may not be identifying the relationship between growth mindset and learning.

The current study aims to assess whether groups of students vary systematically in their mindsets, and whether holding a growth mindset benefits the academic achievement across of students from grades 5th to 8th, across subgroups, and across five school districts in the US.

Data and Methods

The CORE districts assessed social-emotional skills through surveys starting in Spring 2015. We merge the survey information from years 2015 and 2016 with administrative data that includes student characteristics and achievement in standardized tests from the springs 2013 to 2017, depending on the cohort of students. In what follows we describe the measures included the analysis.

Growth mindset: The CORE districts administer social-emotional learning (SEL) surveys to students in their classrooms close to the end of each academic year.[7] The survey included 4 items to measure beliefs about intelligence and learning. This battery was adapted from the Dweck (1999) by Farrington et al. (2013), and is similar to other surveys that have measured Growth Mindset, though not the only way, nor necessarily the most accurate way, to measure this construct.[8] Students are asked to rate how "true" each of the following four statements is using a 5-category Likert Scale (1=Completely True, 5=Not at All True):

Item 1: My intelligence is something that I can't change very much.

Item 2: Challenging myself won't make me any smarter.

[6] Good et al. (2003) did examine standardized math and language scores, but their sample was small, 139 students.

[7] The 2015 CORE survey, included an experimental measure of growth mindset which was administered to a small proportion of students (five percent) randomly selected within the classrooms of three districts. These students were not included in the analysis of this paper because they did not answer the main growth mindset items.

[8] It is important to keep in mind the instrument used before comparing results across studies (Destin et al, 2019; Hwang, Reyes, Eccles, 2016).

Item 3: There are some things I am not capable of learning.

Item 4: If I am not naturally smart in a subject, I will never do well in it.

To create a mindset score, we average the ratings of the four items equally (or of any available items for those with missing information). A lower rating corresponds to a more fixed view of intelligence. The mindset scale ranges from 1 to 5. The scale reliability coefficient is 0.67.[9] Students tend to disagree with the fixed mindset statements, with more than 14 percent answering, "Not at All True" to all mindset items. The average mindset score is 3.70 (SD: 0.97) for all available students in grades 4 through 7. We standardized students' mindset score to have a mean of 0 and a standard deviation of 1 in each grade each year.

We also create a discrete version of the mindset scale. We label as fixed mindset those students with a mindset score lower than one SD below the mean mindset in the corresponding year and grade level; while growth mindset refers to those students with a mindset higher than one SD above the mean mindset in the corresponding grade and year. Finally, middle mindset refers to those students in between.

Other SEL measures included in the survey: The CORE survey measures three other SEL domains. "Self-management" refers to the ability to regulate feelings and behavior. "Self-efficacy," measures how students perceive their abilities to perform academic tasks and succeed in classes. "Social-awareness" measures perceived ability to empathize with others, listen to others' points of view, etc., (see Transforming Education, 2016, for details). We create these variables in the same way as growth mindset with the corresponding items averaged together with equal weights and then standardized within grades to have a mean of zero and standard deviation of one per grade per year.

Student Demographics: Administrative data gathered from each district includes students' gender, race, ever had English Learner (EL) status, free or reduced-price lunch (FRPL) status, and whether their mother completed high-school. If any of this information is missing, but was available in another year, we imputed the data with the information from the following year.

Test Scores: The administrative data include standardized test scores in math and ELA from Spring 2013, 2015, 2016, and 2017. California did not administer an academic assessment during the spring of 2014. As a result, we use 2013 test scores, instead of 2014 test scores, as twice-lagged test scores for 2016 outcomes, although the state used a different test. We standardize test scores by grade, year, and subject to have a mean of zero and standard deviation of one.

[9] It is important to pay attention to what instrument is being used to measure growth mindset across different studies (Destin et al, 2019).

Sample

Our analytical sample includes 221,840 students who answered at least one item from each of the SEL measures in the CORE survey in grades 4th to 7th in at least one of the two years 2015 and 2016, who had math and ELA lagged and twice-lagged test scores as well as outcome scores in the state assessments, and who had information on the school they attended during the survey year.[10]

Table 1 presents the demographic characteristics and survey response distributions for the full sample of students compared to the sample we use in the main analyses. The last column in Table 1 presents the difference and the statistical significance between those students included in the analytical sample and those not included. The missing students have lower achievement, but are less likely to be eligible for subsidized lunch. They are more likely to be categorized as special education students and to show lower levels of mindset. The analytical sample is slightly less white, less black, and more Latinx than those students out of the sample.

Our analytical sample is prominently Latinx (66 percent), with a small proportion of students categorized as non-Latinx white, Asian or African American (ten, eight, and seven percent each). About half of the students had been categorized as EL and 77 percent are eligible for FRPL. The characteristics of students in the analytical sample who participated in the spring 2015 survey differ somewhat from those from the spring 2016 survey, at least in part because using the 2013 data for the twice-lagged score requires the students to be in the sample for longer (see appendix Table A1).

[10] According to administrative data from the state of California, there were 328,478 unique students in grades 4th to 7th in the CORE districts during academic years 2014-15 and 2015-16, who were registered in only one school and grade during at least one year. Of those students, 1.61% were in schools that did not participate implementing the SEL surveys while they were enrolled. Of the potential 323,182 unique students from the 880 participating schools in at least one of the two years, 84.30% completed at least one item of each SEL construct in the CORE survey at least one year. Of that fraction, 81.42% is part of the analytical sample, representing 96.68% of schools of the five districts. In average, 64.48% of the students enrolled in a school grade in a year is included in the analytical sample.

Table 1: Summary Statistics

	All Observations			Analytical sample			Difference in vs out of Analytical Sample	
Characteristic	*mean*	*sd*	*N*	*mean*	*sd*	*N*		
Growth Mindset (std in grade)	0.000	1.000	375841	0.016	0.992	300629	0.082	***
Test scores								
ELA 17 (std by grade16)	0.003	1.001	205011	0.058	0.987	161456	0.258	***
Math 17 (std by grade16)	0.005	1.001	204950	0.054	0.993	161456	0.234	***
ELA 16 (std by grade15)	0.001	1	423036	0.083	0.974	300629	0.282	***
Math 16 (std by grade15)	0	1	423448	0.083	0.975	300629	0.288	***
ELA 15 (std by grade15)	0	1	425443	0.075	0.979	300629	0.255	***
Math 15 (std by grade15)	-0.002	0.999	426395	0.081	0.974	300629	0.281	***
ELA 13 (std by grade15)	0.002	0.999	183595	0.034	0.991	139173	0.132	***
Math 13 (std by grade15)	-0.002	0.997	184599	0.035	0.994	139173	0.154	***
Student Demographics								
FRPL	0.740	0.439	473621	0.773	0.419	300629	0.089	***
Parent less than HS	0.238	0.426	474146	0.246	0.431	300629	0.023	***
Ever ELL based on cat.	0.519	0.500	452223	0.530	0.499	300629	0.035	***
Female	0.488	0.500	474144	0.500	0.500	300629	0.032	***
Special Education	0.125	0.330	468422	0.091	0.287	300629	-0.095	***
White non-Latinx	0.100	0.301	474146	0.095	0.294	300629	-0.014	***
Black	0.090	0.209	474146	0.071	0.195	300629	-0.050	***
Latinx	0.633	0.482	474146	0.658	0.474	300629	0.068	***
Asian	0.073	0.261	474146	0.078	0.268	300629	0.013	***
American Indian/Alaskan Native	0.063	0.243	474146	0.057	0.232	300629	-0.017	***
Pacific Islander/Filipino	0.026	0.158	474146	0.027	0.162	300629	0.003	***
Mixed (non-native)	0.014	0.235	474146	0.013	0.208	300629	-0.002	***
Other SEL measures								
Self-Management full scale	0	1	385423	0.037	0.978	300629	0.168	***
Self-Efficacy	0.000	1.000	383914	0.013	0.993	300629	0.062	***
Social Awareness	0.000	1.000	384194	0.025	0.978	300629	0.115	***
Grade								
4th grade	0.259	0.438	474150	0.281	0.450	300629	0.062	***
5th grade	0.271	0.444	474150	0.262	0.440	300629	-0.022	***
6th grade	0.238	0.426	474150	0.226	0.418	300629	-0.032	***
7th grade	0.233	0.423	474150	0.230	0.421	300629	-0.008	***
Non Missing Variables								
Has lag ELA and Math scores	0.898	0.302	474150	1.000	0.000	300629	0.278	***
Has twice lagged scores	0.846	0.361	474150	1.000	0.000	300629	0.420	***
Has outcome scores	0.848	0.359	474150	1.000	0.000	300629	0.416	***
Has SEL measures	0.790	0.407	474150	1.000	0.000	300629	0.574	***
Has all demographic variables	0.943	0.231	474150	1.000	0.000	300629	0.155	***

Note: "All observations" corresponds to the students enrolled in CORE districts schools that implemented the SEL survey in Spring 2015 or 2016 in grades 4th to 7th. This group does not include districts with no ID information or grades within district that did not participate (e.g. SFUSD 4th grade). Analytical sample corresponds to students who answered the survey and have a mindset score, and have lag, twice lagged and outcome achievement scores (from 2013 to 2017 depending on the base year) and have scores for the other three SEL measures. For non-continuous variables, columns show the share of students with a particular characteristic. SD shown for continuous variables only. Robust standard errors used. ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Analytical Strategy

We examine the contribution of each student's mindset to his or her achievement using the following regression of student *i* in school *s*, grade *g*, at time *t*:

$$Y_{isgt} = \alpha_0 Mindset_{i(t-1)} + \alpha_1 f\left(Y_{i(t-1)}\right) + \alpha_2 f\left(Y_{i(t-2)}\right) + \alpha_3 X_{it} + \alpha_4 SEL_{i(t-1)} + \pi_{sg(t-1)} + \varepsilon_{isgt}, \quad (1)$$

where Y_{isgt} corresponds to either ELA or math test scores of student *i* in year *t* school *s* and grade *g*, standardized within each year and grade (*t*=2016, 2017). We model the two outcomes in separate equations as linear or cubic function of students' available prior achievement, $Y_{i(t-1)}$ and $Y_{i(t-2)}$, in both math and ELA; student demographics, X_{it},[11] including gender, race, FRPL eligibility, special-education status, and EL status; and school-by-grade-by-year fixed effects, $\pi_{(sg(t-1))}$. These fixed effects account for both the sorting of students into schools and the scaling of the measures, and minimizes the chances of reference-bias on self-reported measures (Duckworth & Yeager, 2015; West et al., 2016); and a student-specific error term ε_{isgt}. Given multiple observations per student, we cluster errors at the student level. $Mindset_{i(t-1)}$ refers to the mindset score of the individual student in time *t-1*, standardized to have a mean of 0 and standard deviation of 1 within each grade level in that year. The estimate of interest, α_0, relies only on within school-grade-year variation of mindset and scores.

As robustness checks, we run the same analysis controlling for the other three SEL measures: self-management, self-efficacy, and social awareness. In addition, we run the main model with different samples. First, we run the analysis separately per year to assess whether the results are consistent across time. Second, we consider a sample of students who answered all of the mindset items, to ensure that each student gets a mindset score based on the same items. As Meyer, Wang, & Rice (2018) show, some items give more information than others, and, therefore, SEL scores could be different depending on which items are included. Finally, we use a less restricted sample in which students are not required to have twice-lagged tests scores. Results using these alternative samples provide consistent results, with the exception of the only-2016 survey sample, which produces somewhat smaller estimations, though still significant and meaningful. Finally, we consider a model similar to equation (1) except that instead of a linear control for mindset, it includes indicator variables for three mindset categories described earlier (fixed, mixed, and growth mindset). We report the regression using fixed mindset students as the reference group.

[11] We assume demographics to be time invariant.

Results

Mindset Distribution

Figure 1 describes the variation in growth mindset by subgroups and grades, based on data from the 2016 survey. Table A2 in the appendix presents similar information in table format. Panel A in Table A2 shows overall gaps between students in a determined category (such as having FRPL status) and those outside the category (students without FRPL status). Panel B shows the differences by grade. We observe that students from low-income families have 0.34 SD lower mindset than other students. Students who are or have been EL have lower mindset than other students by 0.32 SD. The second panel of Figure 1 compares Latinx students, the group with the highest proportion of students in the analyzed districts, with students of other races and ethnicities. We observe that white students show the highest levels of mindset, while Asian and black students also show somewhat higher mindset than Latinx students. Students with higher levels of academic achievement also display higher levels of mindset than their peers. For example, students in the lowest quartile of math achievement have a mindset that is .40 SD lower than students with middle achievement. Even within the same school students in the lowest quartile of math achievement have a mindset that is .38 SD lower than other students. For every category, students in the most disadvantaged groups report more fixed mindsets, reflecting a mindset gap that has been reported in other contexts (Claro et al, 2016). These differences are evident, though not quite as great, when looking within schools. Figure 1 also describes differences in mindset between groups within schools across grades. While females show higher mindset than their male classmates, this gap is the smallest of all subgroups and it decreases over time. For the other groups, most of the differences are quite consistent across grades. Data from 2015 shows similar trends.

Figure 1: Mindset Gaps per Characteristics per Grade

Note: Gaps in Mindset by student characteristics per grade, in 2016. Bars show the difference between the subgroup of students labeled compared to peers who are not part of that subgroup (eg, FRPL vs non-FRPL students) or Latinx students in the case of race/ethnicity subgroups. Left column (blue bars) presents gaps across all students, while right column (green bars) presents average gap within schools.

Mindset Effects On Academic Achievement

The primary goal of this paper is to estimate the relationship between a growth mindset and students' academic achievement. In particular, we ask whether otherwise similar students learn more during the course of a school year if they have a more growth-oriented mindset. Table 2 provides the main estimates. The first column models test scores in ELA (panel A) or Math (panel B) as a function of previous year mindset and grade-by-school-by-year fixed effects. The second column adds controls for the prior score in the same subject area. The third column adds prior scores in the other subject area as well as scores in both subjects from two or three years prior, depending on availability. Model 4 adds a rich set of student controls; Model 5 adds quadratic and cubic measures of all prior scores; and Model 6 further controls for student survey reports of self-management, self-efficacy, and social awareness. Model 7 reports results with mindset measured by two indicator variables dividing students into fixed mindset, middle mindset, or growth mindset. The reference group is fixed mindset students.

The coefficient on mindset measures the predicted average gap in test scores that similar students from the same school and grade have if their mindset scores differ by one SD. Two students can differ by a standard deviation in mindset if one has an average mindset and the other has a growth mindset (scores of approximately 3.6 and 4.6, respectively). Likewise, one standard deviation separates a student with an average mindset from a student with a fixed mindset (scores 3.6 and 2.6 respectively).

Model 1 shows that, on average, students in the same school but with one SD higher mindset have 0.284 and 0.270 SD greater ELA and Math scores in the following year. Some of that difference is due to initially higher achieving students having more growth-oriented mindsets. Once we control for lagged and twice lagged test scores, we find that a one SD high growth mindset predicts an approximately 0.025 increases in ELA scores and 0.016 increase in math scores (with standard errors of 0.001 in both cases). The estimates are robust to the inclusion of many prior test scores and student demographics. Once two years of scores are included, the introduction of student characteristics, quadratic and cubic specifications of prior score and even the other SEL measures does not meaningfully change the estimated effect of growth mindset on learning. Finally, model 7 reports that the gap in achievement between a student with a fixed mindset and a growth mindset in a school and grade in a given year (everything else equal) is of 0.067 and 0.048 SD in ELA and math scores respectively, with standard errors of 0.004 in both cases. The estimates provide evidence that the relationship between mindset and achievement is close to linear relationship.

Table 2: Effect of Growth Mindset on Academic Achievement, Varying Models

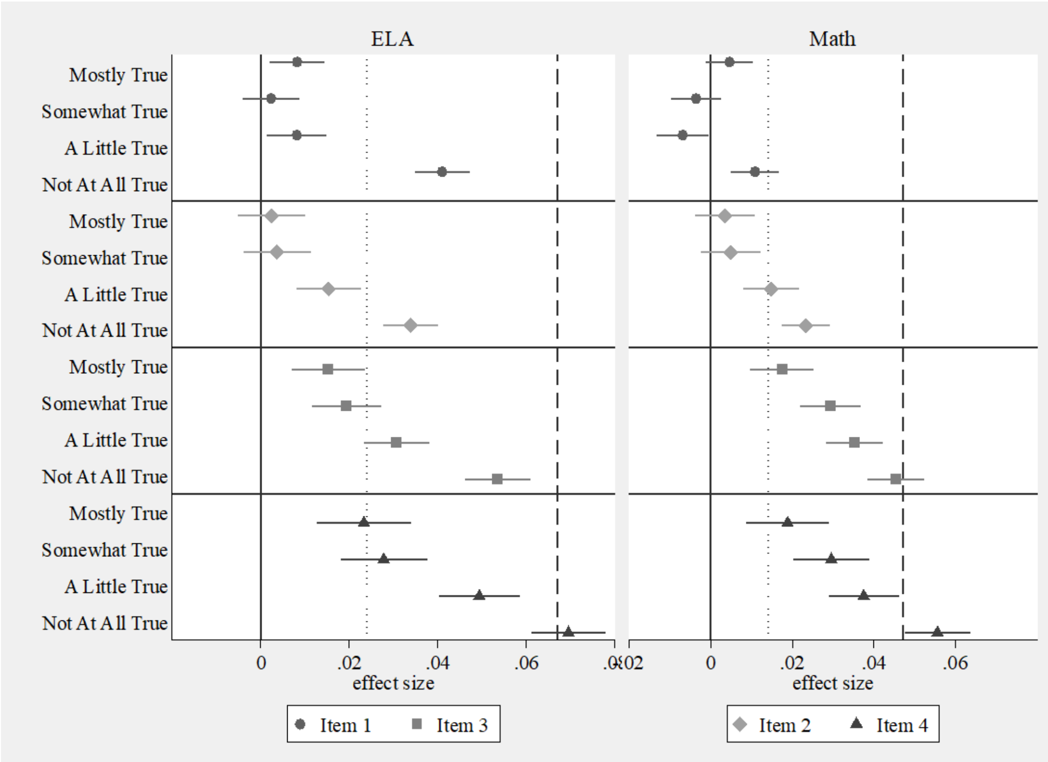
	(1) School-grade F.E.	(2) Controls by test score on same subject	(3) Adds twice lagged tests scores	(4) Adds student characteristics	(5) Adds quadratic and cubic scores	(6) Adds SEL measures	(7) Non-linear GM	(8) 2015 only	(9) 2016 only	(10) Students With No Missing Items Only	(11) Least Restricted Sample
VARIABLES						**Panel A: ELA (std)**					
Growth Mindset (std within grade)	0.284***	0.052***	0.025***	0.026***	0.024***	0.022***		0.027***	0.020***	0.025***	0.031***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
Mixed Mindset (ref: Fixed Mindset))							0.029***				
							(0.004)				
Growth Mindset (ref: Fixed Mindset)							0.067***				
							(0.004)				
						Panel B: Math (std)					
Growth Mindset (std within grade)	0.270***	0.042***	0.016***	0.017***	0.015***	0.011***		0.016***	0.013***	0.015***	0.018***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
Mixed Mindset (ref: Fixed Mindset)							0.029***				
							(0.004)				
Growth Mindset (ref: Fixed Mindset)							0.048***				
							(0.004)				
Lagged and twice lagged scores		Subject	yes	yes	yes	yes	yes	yes	yes	yes	no
Student characteristics				yes	yes	yes	yes	yes	yes	yes	yes
Quadratic and cubic scores					yes	yes	yes	yes	yes	yes	yes
SEL measures						yes					
school-grade-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	300,629	300,629	300,629	300,629	300,629	300,629	300,629	139,173	161,456	276,643	328214

Notes: Main analytical sample is described in Table 1. No students have missing information in this sample. Self-management score is standardized with mean zero and standard deviation of 1 within each grade. Other SEL measures included in model 6 are social awareness, growth mindset and general self-efficacy. Models 8 to 11 use different samples: students with SEL information from spring 2015 or 2016 only, students from both years who answered each of the growth mindset items, and the least restricted sample relaxes the restriction of having twice lagged scores. Standard errors in parentheses, clustered by student. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

We run a series of specification checks in the following columns of Table 2. The estimates are robust to using different samples and specifications. Checks include estimating the mindset effect separated by survey year (Models 8 and 9), using a sample that only includes students who answered all four mindset items (Models 10), and using a sample that does not restrict subjects to have information on their twice lagged performance (Model 11), which allows for a larger sample but only controls for one set of scores. Estimated effects are very similar across models.

Estimated mindset effects may differ depending on the survey instrument used to measure it. The CORE survey uses a mindset instrument that includes four items. Only one of these four items is similar to the traditional mindset instrument developed by Dweck (1999) – "My intelligence is something that I can't change very much." Given the evolving nature of the instrument, it is worth assessing the extent to which the mindset items vary in predictive power. Figure 2 and Table A3 in the Appendix provide the results. The estimated effects are positive and significant across all four items for both ELA and math with a single exception being for one item: the first one, which is most similar to Dweck (1999)'s original instrument. This item predicts a positive and significant increase in ELA only for those disagreeing with the item at the maximum level and has very little discriminate power in math. The other items show more consistent effects. The item, "If I am not naturally smart in a subject, I will never do well in it," is the most predictive, but this predictive ability may come from its greater reading complexity of the item, discriminating students who have better reading comprehension rather than those with lower fixed mindset.

Figure 2: Effect on Achievement by Item from the Growth Mindset Scale



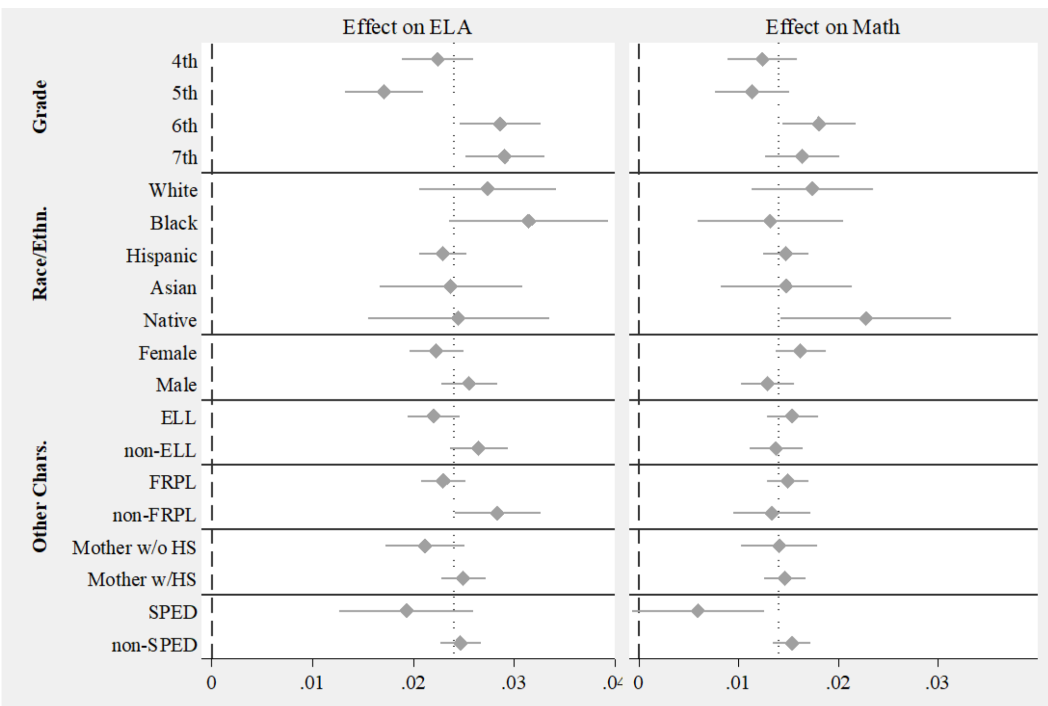
Note: Relationship between achievement and the four items of the growth mindset scale included in the CORE survey. Dots show the estimated increase in ELA and Math scores gained by moving from the lowest level on the item to each other level (from "Extremely true", the reference level, to "Not at all true" which corresponds to the higher growth mindset level in the item). Lines in dots show the effect size of 1SD of mindset score, dash lines show the effect size of having a growth mindset over a fixed mindset.
Items correspond to:
Item 1: My intelligence is something that I can't change.
Item 2: Challenging myself won't make me any smarter.
Item 3: There are some things I am not capable of learning.
Item 4: If I am not naturally smart in a subject, I will never do well in it.

To test the robustness of the estimates to different versions of the mindset instrument, we estimate the models using a mindset instrument that does not include the fourth item which might reflect reading comprehension instead of mindset. The estimated effects are smaller than those estimated with the complete instrument, though generally not significantly different. When we compare the differences across measures for students of different reading levels (e.g. across prior achievement and grade level), we do not see a differential change. This result indicates that it is unlikely that reading problems drive the differential predictive ability of this item. The reliability of the instrument, however, decreases from .67 to .61 when excluding the item. Thus, differences in the mindset effect estimated with or without the fourth item is likely due to a decrease in reliability of the instrument (see Appendix Table A4).

Heterogeneity of Mindset Estimates

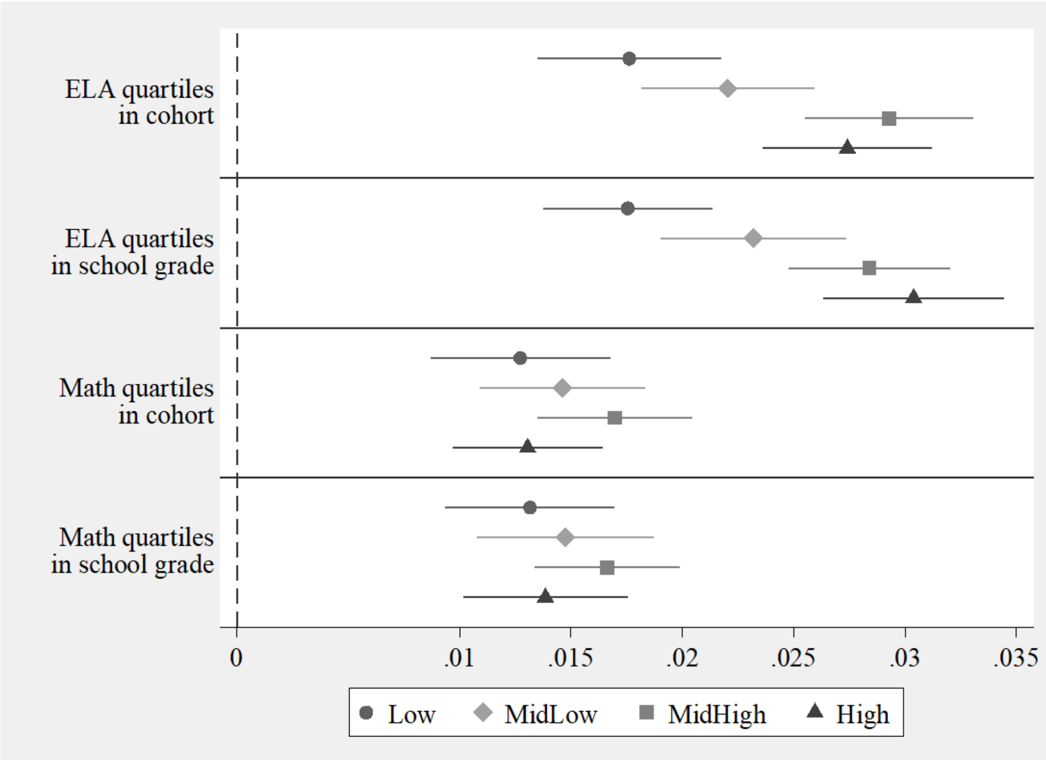
A growth mindset might be more important in some grades than in others or for some groups of students than for others depending on the group norms or learning opportunities (Yeager et al., 2019). Figures 3a and 3b show the estimated effects based on the full model (Model 5 in Table 2) for each available subgroup (details in Table A5 in the appendix). We observe a positive relationship between growth mindset and achievement gains for all subgroups and grades, with the exception to special education students in math. The point estimates are larger in higher grades (for 7th and 8th grade outcomes than for 6th and 5th grade outcomes), which could be due to greater benefits of a growth mindset in higher grades or to more accurate measurement of mindset for older students.

Figure 3a: Heterogeneity of GM Effects by Student Characteristic



Note: Each dot represents the estimated effect of GM for the corresponding subgroup, estimated by independent regressions. Unit is in SD of the corresponding outcome (ELA scores or Math scores). Lines on dots show the 5% confidence interval. The vertical dash line shows the average GM effect.

Figure 3b: Heterogeneity of GM Effects by Previous Achievement



Note: Achievement quartiles in whole cohort and within school grade. Each dot represents the estimated effect of GM for the corresponding subgroup, estimated by independent regressions, in SD of the corresponding outcome (ELA scores or Math scores). Lines mark 5% confidence interval.

Differences in estimated effects across student groups tend to be small in magnitude and often not significantly different from the average effect. While experimental studies have found greater effects for populations of students with fewer resources (Paunesku et al, 2015; Yeager et al., 2019), if anything we find stronger effects for better-resourced students, particularly in ELA scores. The increase in achievement gains predicted by mindset is somewhat lower for English learners, students with FRPL status, students whose mothers did not finish high-school, and special education students, than for their corresponding peers, though differences across groups are relatively small and the estimated effects are consistently positive for all groups.

Figure 3b shows the estimated effect by previous achievement quartiles. The estimated effects are positive and significant for students in each quarter of prior achievement for both ELA and math test performance. In contrast to the experimental evidence assessing effects on GPA (Yeager et al, 2019) the estimated effects are not larger for lower-achieving students, compared to the high-achieving ones. In fact, the estimates are somewhat larger for the higher achieving groups in ELA and not different in math. We also compared students in the bottom half of the school grade achievement distribution with those in the upper half. One SD increase in mindset leads to 0.020 SD (s.e. 0.001) gains in ELA for students in the lowest half of ELA academic achievement and 0.029 SD (s.e. 0.001) for those in the upper half, while in math the estimated effects are .014 (s.e. 0.001) and .015 (s.e. 0.001), respectively. Yeager et al. (2019), instead, finds larger impact of the mindset intervention on GPA for the lower achieving students than for higher achieving students. The differences between our results and Yeager et al.'s may be due to a difference in context or to the difference between GPA and achievement. For example, smaller changes in achievement may lead to greater changes in grades for low-achieving students.[12]

Discussion

Increasing interest in developing a growth mindset in students has grown with little information on how growth mindset is distributed across the population and whether it matters for academic achievement across student groups. The study is the first that we know of to assess the relationship between a students' growth mindsets and their learning gains in a large and diverse sample of middle school students in the US. It offers the first evidence describing the growth mindset distribution among students who vary in parent education and EL status, and it brings the first evidence of the relationship between mindset and standardized achievement gains in the US at a large scale. Using data collected in five California school districts, the analysis identifies a mindset gap across subgroups, even within schools, and it confirms that mindset predicts achievement gains for students, even with unusually rich controls for students' background and schooling. Mindset predicts academic gains for students with different socioeconomic levels, race and ethnicity, gender, EL status, previous academic achievement, and grade level.

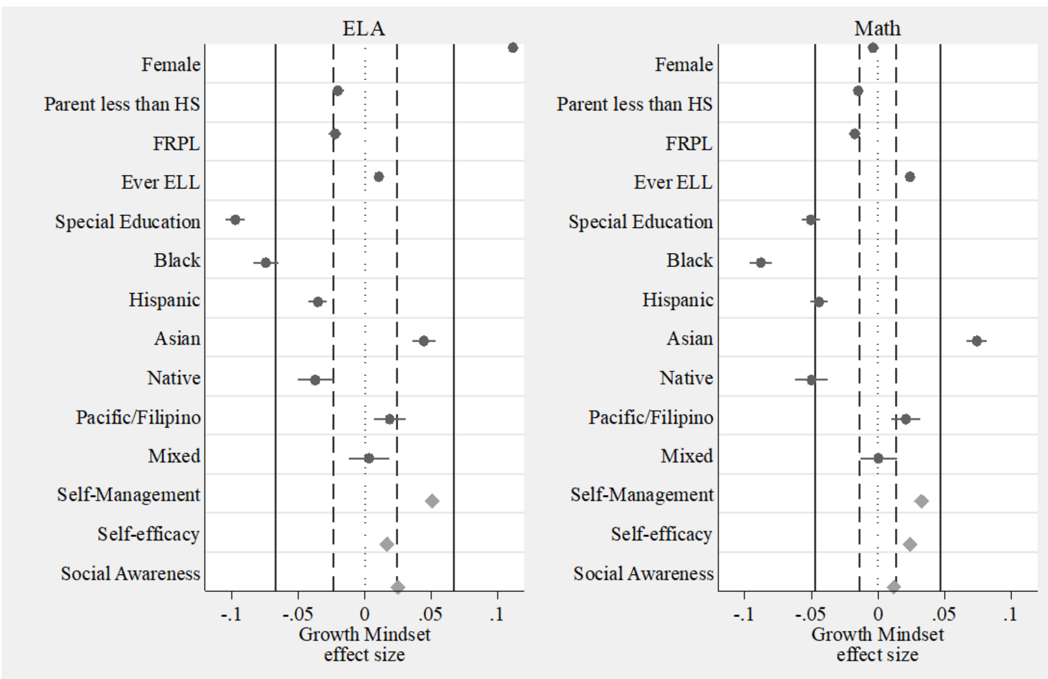
We estimate that the average growth in English language arts and math scores corresponding to the difference between a fixed mindset to a growth mindset (an approximately two standard deviation change) are approximately 0.07 and 0.05 standard deviations in the corresponding test performance. Based on a rough calculation developed by Hanushek, Peterson & Woessmann (2012), these changes are equivalent to more than 35 days of learning. The difference is especially meaningful considering that the evidence that social-emotional barriers such as a fixed mindset can potentially be addressed by low-cost scalable interventions.

As a comparison point, we calculate the effects of several student demographics on achievement, controlling for past achievement in math and ELA. Results are shown in Figure 4 (Table A6 in the appendix). Dashed lines show the increase in achievement gains predicted by one SD change in mindset. The solid line shows the predicted increase that a growth mindset student gains over a fixed mindset student. The figure shows that the mindset effect is greater

[12] Following previous studies, we also evaluated heterogeneity by school characteristics including quartiles by average achievement and average mindset. We find no significant difference across school groups.

or a considerable proportion of the effects of each measured demographic. For example, the ELA test score gap between FRPL students and non-FRPL students in the same school with similar previous achievement is approximately 0.022 SD, not significantly different from the mindset effect size. On the other end, the gender gap in ELA is considerably larger, estimated as 0.11 SD, and the estimated mindset effect is a fifth of this gap. When comparing across SEL dimensions, mindset effect is the second largest for ELA and the third largest in math (see Table A7 in the appendix for the precise estimates).

Figure 4: Comparison of Effects of Different Demographic Characteristics and Growth Mindset Effects



Notes: Each point is an independent regression controlling by quadratic and cubic lag scores and twice lagged, and no other controls, with school by grade by year fixed effects. The dashed lines represent the effect size of growth mindset in the most conservative model. The solid line represents the effect of having a growth mindset level above 1SD of the grade mean, estimated in the same model. Table A4 in the appendix reports the estimated of each coefficient.

The estimated effects of mindset in this study provide evidence that building growth mindset may be a useful tool for supporting students' academic learning from different groups and levels. However, before pursuing a growth mindset campaign across schools, more is needed to understand the validity of the growth mindset measures and how to build growth mindset effectively at scale (although see Yeager et al., 2019). While some students may have less access to growth mindset messages and thus could benefit from increased exposure to this messaging at school, other students' fixed mindset may stem from structural barriers to success and true inequality in access to opportunities (see Kraus et al., 2009). Such sources of differences across students in mindset are unlikely to be overcome solely by low-cost interventions in schools.

Researchers have only begun to develop valid and reliable measures of growth mindset (Gelbach et al., 2018; Farrington et al., 2013). The measure of growth mindset used by the CORE districts is not the same as the instrument created by Dweck and colleagues used in previous studies. Studies such as Yeager et al. (2016), Claro et al. (2016), Paunesku et al. (2015), and Blazar & Kraft (2016) use the traditional mindset instrument developed by Dweck (1999). Farrington et al. (2013) items may be more predictive of academic learning than the initial measure, but still suffers from measurement issues, particularly for younger students (Hough et al., 2017; West, 2016; Meyer et al., 2018).

While this study is just a first step in assessing the effects of mindset on a large population of students and the role of schools in building mindset, the findings provide initial evidence that it may be beneficial to monitor the levels of growth mindset in the population and convey to students that the brain is malleable.

References

Aronson, J., Fried, C. B., & Good, C. (2002). Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. *Journal of Experimental Social Psychology, 38*(2), 113–125

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263

Claro, S., Paunesku, D., & Dweck, C. S. (2016). Growth mindset tempers the effects of poverty on academic achievement. *Proc. Natl. Acad. Sci. U.S.A. 113*, 8664–8668.

Destin, M., Hanselman, P., Buontempo, J., Tipton, E., & Yeager, D. S. (2019). Do student mindsets differ by socioeconomic status and explain disparities in academic achievement in the United States? *AERA Open*. https://doi.org/10.1177/2332858419857706

Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher, 44*(4), 237–251.

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality and development.* Philadelphia: Psychology Press.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273.

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A view from two eras. *Perspectives on Psychological Science, 14*(3), 481-496.

Farrington et al. (2013) Becoming Effective Learners survey development project, Chicago Consortium for School Research.

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *J Appl Dev Psychol 24*(6):645–662.

Hanushek, E. A., Peterson, P. E., & Woessmann, L. (2012). Is the US catching up? International and state trends in student achievement. *Education Next 12*(4).

Hong, Y. Y., Chiu, C. Y., Dweck, C. S., Lin, D. M. S., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology, 77*(3), 588.

Hough, H., Kalogrides, D., & Loeb, S. (2017). *Using surveys of students' social-emotional learning and school climate for accountability and continuous improvement.* Stanford, CA: Policy Analysis for California Education.

Kraus M. W., Piff P. K., & Keltner D. (2009). Social class, sense of control, and social explanation. *Journal of Personality and Social Psychology, 97*, 992–1004.

Meyer R., Wang, Y., & Rice, A. (2018) *Measuring students' socio-emotional learning among California's Core Districts: An IRT modeling approach.* Stanford, CA: Policy Analysis for California Working Papers.

Mosteller, F. (1995). The Tennessee study of class size in the early school grades. *The future of Children,* 113–127.

National Science and Technology Council. (2015). *Social and behavioral sciences team. Annual report*. https://sbst.gov/assets/files/2015-annual-report.pdf. Retrieved October 2015.

Nussbaum, A. D., & Dweck, C. S. (2008). Defensiveness versus remediation: Self-theories and modes of self-esteem maintenance. *Personality and Social Psychology Bulletin, 34*(5), 599-612.

Obama, Barack. (2014) *Weekly address: Everyone should be able to afford higher education*. [video] http://www.whitehouse.gov/photos-and-video/video/2014/08/15/weekly-address-everyone-should-be-able-afford- higher-education. Retrieved October 2015.

Outes, I., Sánchez, A., & Vakis, R. (2017). Cambiando la mentalidad de los estudiantes: evaluación de impacto de ¡Expande tu Mente! sobre el rendimiento académico en tres regiones del Perú. *Documentos de investigación, 83*. Lima: GRADE.

Paunesku D, et al. (2015). Mind-set interventions are a scalable treatment for academic underachievement. *Psychol Sci 26*(6):784–793

Paunesku D. (Unpublished) Doctoral Dissertation. Stanford University

Snipes, J., & Tran, L. (2017). *Growth mindset, performance avoidance, and academic behaviors in Clark County School District (REL 2017-226).* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Education Laboratory West. Retrieved from http://ies.ed.gov/ncee/edlabs.

Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity, 1*:4, 313-336, DOI: 10.1080/15298860290106805

Transforming Education (2016). *Measuring MESH: Student and teacher surveys curated for the CORE districts.* Retrieved: Nov 2, 2018 from https://www.transformingeducation.org/wp-content/uploads/2017/04/160406_MeasuringMESH_ForRelease2.pdf

West, M. R., Buckley, K., Krachman, S. B., & Bookman, N. (2018). Development and implementation of student social-emotional surveys in the CORE Districts. *Journal of Applied Developmental Psychology, 55,* 119–129.

West, M. R., Kraft, M. A., Finn, A. S., Martin, R. E., Duckworth, A. L., Gabrieli, C. F., & Gabrieli, J. D. (2016). Promise and paradox: Measuring students' non-cognitive skills and the impact of schooling. *Educational Evaluation and Policy Analysis, 38*(1), 148–170.

West, M. R., Pier, L., Fricke, H., Hough, H., Loeb, S., Meyer, R. H., Rice, A. B. (2018). Trends in student social-emotional learning: Evidence from the CORE districts. *Policy Analysis for California Education,* Stanford, CA.

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, 47(4), 302-314.

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., ... & Trott, J. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. *Journal of Educational Psychology, 108*(3), 374.

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., … & Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature.* Published online August 7, 2019. https://doi.dx.org/10.1038/s41586-019-1466-y

Appendix Tables

Table A1. Summary Statistics for Analytical Sample per Survey Year

Characteristic	Analytical Sample Year 2015 *mean*	*sd*	*N*	Analytical Sample Year 2016 *mean*	*sd*	*N*	Difference between 2016 and 2015 Samples
Test scores							
ELA 17 (std by grade16)	.	.	.	0.058	0.987	161456	.
Math 17 (std by grade16)	.	.	.	0.054	0.993	161456	.
ELA 16 (std by grade15)	0.105	0.959	139173	0.063	0.987	161456	-0.042***
Math 16 (std by grade15)	0.099	0.963	139173	0.070	0.986	161456	-0.029***
ELA 15 (std by grade15)	0.102	0.961	139173	0.052	0.993	161456	-0.050***
Math 15 (std by grade15)	0.105	0.956	139173	0.061	0.988	161456	-0.045***
ELA 13 (std by grade15)	0.034	0.991	139173	.	.	.	.
Math 13 (std by grade15)	0.035	0.994	139173	.	.	.	.
Student Demographics							
FRPL	0.763	0.425	139173	0.781	0.414	161456	0.017***
Parent less than HS	0.255	0.436	139173	0.239	0.426	161456	-0.016***
Ever ELL	0.536	0.499	139173	0.526	0.499	161456	-0.010***
Female	0.504	0.500	139173	0.496	0.500	161456	-0.007***
Special Education	0.069	0.253	139173	0.110	0.313	161456	0.041***
White non-Latinx	0.094	0.292	139173	0.096	0.295	161456	0.002*
Black	0.069	0.254	139173	0.073	0.26	161456	0.004***
Latinx	0.675	0.468	139173	0.642	0.479	161456	-0.033***
Asian	0.073	0.26	139173	0.083	0.275	161456	0.009***
American Indian/Alaskan Native	0.048	0.215	139173	0.065	0.246	161456	0.016***
Pacific Islander/Filipino	0.028	0.164	139173	0.026	0.16	161456	-0.001**
Mixed (non-native)	0.012	0.109	139173	0.015	0.122	161456	0.003***
Other SEL measures							
SEL- Growth Mindset (std by grade)	0.022	0.989	139173	0.012	0.994	161456	-0.009***
SEL- Self-Efficacy (std by grade)	0.016	0.992	139173	0.011	0.993	161456	-0.006
SEL- Self-management (std by grade)	0.045	0.975	139173	0.030	0.981	161456	-0.016***
SEL- Social Awareness (std by grade)	0.031	0.972	139173	0.020	0.983	161456	-0.011***
Grade							
4th grade	0.271	0.444	139173	0.290	0.454	161456	0.019***
5th grade	0.257	0.437	139173	0.267	0.443	161456	0.011***
6th grade	0.234	0.423	139173	0.219	0.414	161456	-0.015***
7th grade	0.238	0.426	139173	0.223	0.416	161456	-0.015***

Notes: Each year's analytical sample corresponds to students from the analytical sample described in Table 1 who responded the SEL survey in the corresponding year. There are 78,789 students who answered the survey in both years. In 2015, 4th grade students from SFUSD and SAUSD did not participate. This group does not include districts or grades within districts with no SEL or ID information (e.g. all OUSD students, and schools from LAUSD that did not participate). Analytical sample correspond to students who answered the survey and have a growth mindset score, and have achievement scores from 2013 to 2017 and have scores for other SEL measures (self-efficacy self-management, and self-awareness). For non-continuous variables, columns show the share of students with a particular characteristic. SD shown for continuous variables only. Robust standard errors shown. (***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$)

Table A2: Growth Mindset Gaps per Subgroups (year 2016)

	Panel A: Growth Mindset Comparison Across Subgroups in 2016							
	Students in subgroup			Comparison group †			Difference b/n groups sample-wide	Difference b/n groups within schools
Category	*Growth Mindset*	*sd*	*N*	*Growth Mindset*	*sd*	*N*		
FRPL	-0.063	0.995	126038	0.278	0.943	35418	-0.341***	-0.176***
Parent less than HS	-0.159	0.989	38580	0.066	0.989	122876	-0.225***	-0.106***
Ever ELL	-0.138	0.986	84868	0.178	0.975	76588	-0.316***	-0.202***
Female	0.037	0.995	80135	-0.013	0.992	81321	0.050***	0.047***
Special Education	-0.354	1.022	17737	0.057	0.981	143719	**-0.411***	**-0.393***
Latinx	-0.056	0.999	103723	.	.	.	**.**	.
White non-Latinx.	0.411	0.903	15549	-0.056	0.999	103723	0.467***	0.264***
Black	0.063	1.022	11761	-0.056	0.999	103723	0.119***	0.103***
Asian	0.167	0.922	13325	-0.056	0.999	103723	0.223***	0.217***
American Indian/Alaskan Native	-0.258	0.957	10433	-0.056	0.999	103723	-0.203***	0.017
Pacific Islander/Filipino	0.188	0.930	4240	-0.056	0.999	103723	0.244***	0.224***
Lowest ELA quartile in whole grade	-0.436	0.995	36701	-0.047	0.965	82009	**-0.389***	**-0.374***
Highest ELA quartile in whole grade	0.509	0.816	42746	-0.047	0.965	82009	**0.555***	**0.509***
Lowest Math quartile in whole grade	-0.431	1.007	36512	-0.035	0.964	81601	**-0.396***	**-0.382***
Highest Math quartile in whole grade	0.474	0.832	43343	-0.035	0.964	81601	**0.509***	**0.472***
Lowest ELA quartile in school grade	-0.372	1.003	42685	0.005	0.968	80406	**-0.377***	**-0.373***
Highest ELA quartile in school grade	0.455	0.845	38362	0.005	0.968	80406	**0.450***	**0.448***
Lowest Math quartile in school grade	-0.367	1.010	41198	0.011	0.969	82497	**-0.377***	**-0.374***
Highest Math quartile in school grade	0.428	0.854	37758	0.011	0.969	82497	**0.418***	**0.419***

	Panel B: Growth Mindset Gaps by Grade in 2016							
	Difference between subgroups				Difference b/n subgroups w/in schools			
Category	4th	5th	6th	7th	4th	5th	6th	7th
FRPL	-0.328***	-0.346***	-0.332***	-0.359***	-0.126***	-0.168***	-0.204***	-0.207***
Parent less than HS	-0.211***	-0.235***	-0.243***	-0.211***	-0.085***	-0.088***	-0.148***	-0.111***
Ever ELL	-0.304***	-0.305***	-0.337***	-0.325***	-0.168***	-0.171***	-0.251***	-0.225***
Female	0.076***	0.050***	0.040***	0.028***	0.075***	0.050***	0.034***	0.019*
Special Education	-0.319***	-0.397***	-0.496***	-0.463***	-0.309***	-0.385***	-0.465***	-0.439***
White non-Latinx	0.455***	0.471***	0.476***	0.467***	0.227***	0.234***	0.300***	0.291***
Black	0.098***	0.097***	0.126***	0.167***	0.063***	0.089***	0.114***	0.156***
Asian	0.205***	0.186***	0.215***	0.286***	0.159***	0.203***	0.197***	0.298***
American Indian/Alaskan Native	-0.198***	-0.240***	-0.171***	-0.174***	0.025	0.014	0.014	0.012
Pacific Islander/Filipino	0.246***	0.253***	0.219***	0.257***	0.172***	0.252***	0.220***	0.246***
Lowest ELA quartile in districts	-0.324***	-0.377***	-0.447***	-0.436***	-0.309***	-0.359***	-0.427***	-0.425***
Highest ELA quartile in districts	0.516***	0.567***	0.550***	0.596***	0.462***	0.512***	0.518***	0.558***
Lowest Math quartile in districts	-0.299***	-0.403***	-0.460***	-0.458***	-0.286***	-0.384***	-0.438***	-0.451***
Highest Math quartile in districts	0.482***	0.487***	0.518***	0.559***	0.432***	0.445***	0.493***	0.531***
Lowest ELA quartile in school	-0.306***	-0.359***	-0.438***	-0.436***	-0.298***	-0.361***	-0.432***	-0.430***
Highest ELA quartile in school	0.410***	0.450***	0.466***	0.487***	0.413***	0.443***	0.467***	0.483***
Lowest Math quartile in school	-0.297***	-0.355***	-0.443***	-0.450***	-0.300***	-0.354***	-0.431***	-0.442***
Highest Math quartile in school	0.371***	0.415***	0.444***	0.454***	0.367***	0.410***	0.456***	0.461***

Notes: Table presents growth mindset differences in year 2016 (2015 gaps have similar patterns). Differences presented correspond to a t-test between both groups, with and without school-grade fixed effects. Growth mindset scores are standardized per grade level. †Comparison groups correspond to students for whom the corresponding variable is equal to 0. (ie, non-FRPL, non-ELL, Male), Latinx in the case of race/ethnicity subgroups and middle performing students ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A3: Effect of Each Growth Mindset Item on Achievement

	(1)	(2)	(3)	(4)
	My intelligence is something that I can't change.	Challenging myself won't make me any smarter.	There are some things I am not capable of learning.	If I am not naturally smart in a subject, I will never do well in it.
VARIABLES	Panel A: ELA (std)			
level 2 (ref: level 1)	0.008***	0.002	0.015***	0.023***
	(0.003)	(0.004)	(0.004)	(0.005)
level 3 (ref: level 1)	0.002	0.004	0.019***	0.028***
	(0.003)	(0.004)	(0.004)	(0.005)
level 4 (ref: level 1)	0.008**	0.015***	0.031***	0.049***
	(0.003)	(0.004)	(0.004)	(0.005)
level 5 (ref: level 1)	0.041***	0.034***	0.053***	0.069***
	(0.003)	(0.003)	(0.004)	(0.004)
	Panel B: Math (std)			
level 2 (ref: level 1)	0.005	0.003	0.017***	0.019***
	(0.003)	(0.004)	(0.004)	(0.005)
level 3 (ref: level 1)	-0.004	0.005	0.029***	0.030***
	(0.003)	(0.004)	(0.004)	(0.005)
level 4 (ref: level 1)	-0.007**	0.015***	0.035***	0.037***
	(0.003)	(0.004)	(0.004)	(0.004)
level 5 (ref: level 1)	0.011***	0.023***	0.045***	0.055***
	(0.003)	(0.003)	(0.004)	(0.004)
Observations	251,620	254,088	255,097	256,983

Notes: Estimands from each column in each panel is estimated using the full model presented in Table 3, replacing growth mindset scale for the discrete version of the item described the corresponding column. Each item offers alternatives in a 5-Likert scale from "Very true" (lowest level) to "Not at all true" (highest level). Standard errors in parenthesis, clustered by student. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A4. Comparison of Mindset Effect Measured by Different Mindset Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
	4-item mindset	3-item mindset	2-item mindset	4-item mindset	3-item mindset	2-item mindset
VARIABLES		ELA			Math	
Full sample	0.024***	0.019***	0.019***	0.015***	0.010***	0.013***
N = 299,450	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Grade Level						
4th grade	0.022***	0.015***	0.018***	0.012***	0.009***	0.012***
N = 84604	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
5th grade	0.017***	0.014***	0.014***	0.011***	0.008***	0.011***
N = 78909	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
6th grade	0.029***	0.025***	0.022***	0.018***	0.015***	0.015***
N = 67934	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
7th grade	0.029***	0.024***	0.023***	0.016***	0.011***	0.015***
N = 69182	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ELA Achievement quartiles						
Lowest test Quartile	0.018***	0.011***	0.014***	0.013***	0.008***	0.011***
N = 65513	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Low middle test Quartile	0.022***	0.016***	0.017***	0.015***	0.011***	0.014***
N = 75611	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
High middle test Quartile	0.029***	0.024***	0.022***	0.017***	0.012***	0.015***
N = 79010	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Highest test Quartile	0.027***	0.023***	0.025***	0.013***	0.010***	0.014***
N = 80495	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Notes: Each cell shows the estimated effect of mindset on achievement based on the model 5 of Table 2. Each column uses a different measure of mindset based on a 4-item to 2-item instrument. Instruments included in the 4-item instrument are all the 4 items available. The 3-item instrument eliminates the fourth item, as listed in notes of Table 3, which is the most predictive item and the one that could be the most challenging in reading comprehension. The 2-item mindset instrument further eliminates the first item, which is the least predictive. Clustered standard errors in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A5: Heterogeneity of the Growth Mindset effect. Estimation per Subgroup

		Effect of Growth Mindset on Achievement				
		ELA (std)		Math (std)		
Subgroup type	Subgroup	Coeff.	(s.e)	Coeff.	(s.e.)	N†
Grade	4th	0.022***	(0.002)	0.012***	(0.002)	84,604
	5th	0.017***	(0.002)	0.011***	(0.002)	78,909
	6th	0.029***	(0.002)	0.018***	(0.002)	67,934
	7th	0.029***	(0.002)	0.016***	(0.002)	69,182
Characteristics	non-ELL	0.026***	(0.001)	0.014***	(0.001)	141,205
	ELL ever	0.022***	(0.001)	0.015***	(0.001)	159,424
	Male	0.026***	(0.001)	0.013***	(0.001)	150,407
	Female	0.022***	(0.001)	0.016***	(0.001)	150,222
	non-SPED	0.025***	(0.001)	0.015***	(0.001)	273,338
	SPED	0.019***	(0.003)	0.006*	(0.003)	27,291
	non-FRPL	0.028***	(0.002)	0.013***	(0.002)	68,378
	FRPL	0.023***	(0.001)	0.015***	(0.001)	232,251
	Mother w/HS	0.025***	(0.001)	0.015***	(0.001)	226,554
	Mother w/o HS	0.021***	(0.002)	0.014***	(0.002)	74,075
Race/ethnicity	Whites	0.027***	(0.003)	0.017***	(0.003)	28,664
	African-American	0.031***	(0.004)	0.013***	(0.004)	11,907
	Latinx	0.023***	(0.001)	0.015***	(0.001)	197,722
	Asian	0.024***	(0.004)	0.015***	(0.003)	23,503
	Native Origin	0.024***	(0.005)	0.023***	(0.004)	17,170
Achievement quartiles w/in state cohort	Lowest	0.018***	(0.002)	0.013***	(0.002)	65,513
	Mid low	0.022***	(0.002)	0.015***	(0.002)	75,611
	Mid High	0.029***	(0.002)	0.017***	(0.002)	79,010
	Highest	0.027***	(0.002)	0.013***	(0.002)	80,495
Achievement quartiles w/in school grade	Lowest	0.018***	(0.002)	0.013***	(0.002)	76,153
	Mid low	0.023***	(0.002)	0.015***	(0.002)	65,156
	Mid High	0.028***	(0.002)	0.017***	(0.002)	86,860
	Highest	0.030***	(0.002)	0.014***	(0.002)	72,457

Notes: Each coefficient is estimated using an independent regression that corresponds to the subgroup listed in the second column and the outcome of the corresponding column, based on the full model. This is, controlling by cubic functions of math and ELA tests scores from two previous years, demographics and school-grade-year fixed effects. † Observations listed for the subgroups related to the achievement quartiles correspond to the observations counted on the ELA groups. Math groups are similar. Standard errors in parenthesis, clustered by student. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A6: Demographics Effects on Achievement

	(1)	(2)	(3)	(4)	(5)	(6)
	Individual controls					
VARIABLES	**Panel A: Effect on ELA**					
Female	0.111***					
	(0.002)					
Mother with no Highschool		-0.020***				
		(0.002)				
FRPL			-0.022***			
			(0.003)			
ELL this year				0.011***		
				(0.002)		
SPED					-0.097***	
					(0.003)	
Black						-0.074***
						(0.005)
Latinx						-0.035***
						(0.004)
Asian						0.044***
						(0.004)
	Panel B: Effect on Math					
Female	-0.004**					
	(0.002)					
Mother with no Highschool		-0.015***				
		(0.002)				
FRPL			-0.017***			
			(0.002)			
ELL this year				0.024***		
				(0.002)		
SPED					-0.050***	
					(0.003)	
Black						-0.088***
						(0.004)
Latinx						-0.044***
						(0.003)
Asian						0.074***
						(0.004)
Other race/ethn. controlled						yes
Test scores twice lagged	yes	yes	yes	yes	yes	yes
Quadratic and cubic tests	yes	yes	yes	yes	yes	yes
School-Grade-Year FE	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes
Observations	300,629	300,629	300,629	300,629	300,629	300,629

Notes: Standard errors in parentheses. Sample restricted to students with all demographic information.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A7: Growth Mindset Effect Compared with Other SEL Dimensions Included in CORE Survey

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	ELA					Math				
Growth Mindset	0.024***				0.022***	0.015***				0.011***
	(0.001)				(0.001)	(0.001)				(0.001)
Self-efficacy		0.018***			-0.001		0.025***			0.016***
		(0.001)			(0.001)		(0.001)			(0.001)
Social Awareness			0.018***		-0.004***			0.012***		-0.011***
			(0.001)		(0.001)			(0.001)		(0.001)
Self-Management				0.042***	0.043***				0.033***	0.031***
				(0.001)	(0.001)				(0.001)	(0.001)
Demographics	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Test scores twice lagged	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Quadratic and cubic tests	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
School-Grade-Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	300,629	300,629	300,629	300,629	300,629	300,629	300,629	300,629	300,629	300,629

Note: All SEL measures are standardized within grade. Standard errors in parenthesis. Sample is described in Table 1. *** $p < 0.01$