Changing Mindsets to Raise Achievement:
Evidence from the Stanford University Project for Education Research That Scales
—Executive Summary—

What are academic mindsets?

To be academically successful, students must choose to learn and to persist in learning even when schoolwork is challenging. Research shows that students' *academic mindsets*—their beliefs about learning and about school—affect these choices. Studies show that students seize more learning opportunities and earn higher grades when they believe their schoolwork is relevant to their lives [1,2,3], when they believe they can grow their abilities to meet academic challenges [4,5], and when they feel like they belong in school [6,7]. Furthermore, a growing body of research shows that these highly influential beliefs can be changed with brief, low-cost *mindset interventions*.

What are mindset interventions?

Mindset interventions are psychologically powerful activities that draw on decades of behavioral research to change they way students think about learning and school in targeted ways. They typically consist of short readings and reflective writing exercises designed to dispel specific beliefs that hinder learning, beliefs like: "I'm just not smart enough;" "People like me don't belong in this school;" and "What I'm learning in school doesn't relate to my life." When mindset interventions successfully change students' keystone beliefs about learning, they can raise their academic performance over periods of months or years [8,9,10,11].

Mindset interventions can raise achievement on a large scale and at a low cost

The Stanford University Project for Education Research That Scales (PERTS) creates and evaluates mindset interventions that have the potential to raise academic achievement on a massive scale. It uses the Internet as a delivery vehicle to ensure that students across the nation can have access to effective mindset interventions at a low cost. Its randomized controlled studies suggest that even brief activities, delivered entirely over the Internet at virtually no cost, can meaningfully affect achievement:

- In an experiment with over 1,500 high school students, a 30-minute online mindset intervention increased the rate at which underperforming students (those in the bottom 33% by pre-study grade point average) earned satisfactory grades (As, Bs, Cs) in core academic classes. Over the entire semester, treated students earned satisfactory grades at a 14% higher rate relative to control group students.
- In an experiment with 886 community college students, a 30-minute online mindset intervention increased the rate at which students earned satisfactory grades (As, Bs, and Cs) in a semester-long math course by 12% relative to the control condition.
- In an experiment with over 250,000 students learning math on the Khan Academy website, growth mindset messages presented above math problems (e.g., "When you learn a new kind of math problem, you grow your math brain!") increased the number of concepts students mastered by 3%. Messages of encouragement that emphasized effort but did not convey the idea that students were growing their abilities had no effect (e.g., "Some of these problems are hard, just do your best").

PERTS continues to study how to make scalable mindset interventions effective and how to disseminate them to more students across the United States.

About PERTS

PERTS is directed by Drs. Dave Paunesku and Carissa Romero, and its specific research projects are led by Professors Carol Dweck, Greg Walton, and James Gross at the Stanford University Department of Psychology; by Assistant Professor David Yeager at the University of Texas at Austin; and by Professor Jo Boaler at the Stanford University Graduate School of Education.

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Appendix

The following pages provide further information about each of the studies described in the executive summary on the previous page. For more information about PERTS or about the studies presented in this summary, contact Dave Paunesku at paunesku@stanford.edu.

Appendix: High School Study

Researchers
Dave Paunesku, Carissa Romero, David Yeager, Greg Walton, Carol Dweck

Procedure
Thirteen high schools from around the United States enrolled students in a study of mindset interventions and provided PERTS with the academic transcripts of participating students n=1594 (525 Latino, 277 Asian, 371 White, 174 Black, and 247 other/mixed ethnicity students in grades 9-12). Each school was asked to name a study coordinator who would recruit teachers to participate and follow-up if classrooms lagged behind. The coordinator asked teachers to create accounts on the study website (perts.net) and schedule two 45-minute sessions[12] two weeks apart. Both sessions were administered in each school's computer lab during the spring semester of 2012. In the course of the online registration process, teachers agreed to introduce the activities as a part of an ongoing Stanford University study about why and how students learn. Upon signing into the study website from the school computer lab, each student was randomly assigned to a control condition or to one of three intervention conditions: a growth-mindset intervention, a sense-of-purpose intervention, or a combined intervention condition.

In the growth-mindset intervention, students read an article describing the brain's ability to grow and reorganize itself. The article focused on the implications of neuroscience findings for students' potential to become more intelligent and academically successful through study and practice. This message was reinforced through several writing exercises. In one, students summarized the scientific findings in their own words. In the second, they read about a hypothetical student who was becoming discouraged and beginning to think of himself as "not smart enough" to do well in school. The writing exercise asked participant students to advise this student based on what they had read. In the control condition, students read and completed superficial similar materials; however, these focused on functional localization, not neural plasticity. They thus lacked the key psychological message that intelligence is malleable.

The sense-of-purpose intervention was designed to help students articulate how schoolwork could help them accomplish meaningful, beyond-the-self life goals. The intervention first asked students how they wished the world could be a better place. It then went on to say that many students work hard in school because they want to grow up to be empowered individuals who "make a positive impact on the world," "make their families proud," or "are a good example for other people." Students were asked to think about their own goals and how learning and working hard in school could help them achieve these goals. In the control condition, students completed either of two similarly formatted web modules that did not differ from each other in their impact, $T<1$, and are combined in analyses. One asked students to describe how their lives were different in high school than before high school. The other was identical to the sense-of-purpose treatment but put forward economic self-interest rather that prosocial contribution as a reason to work hard in school, a motivation that was *not* associated with higher achievement in prior work[13].

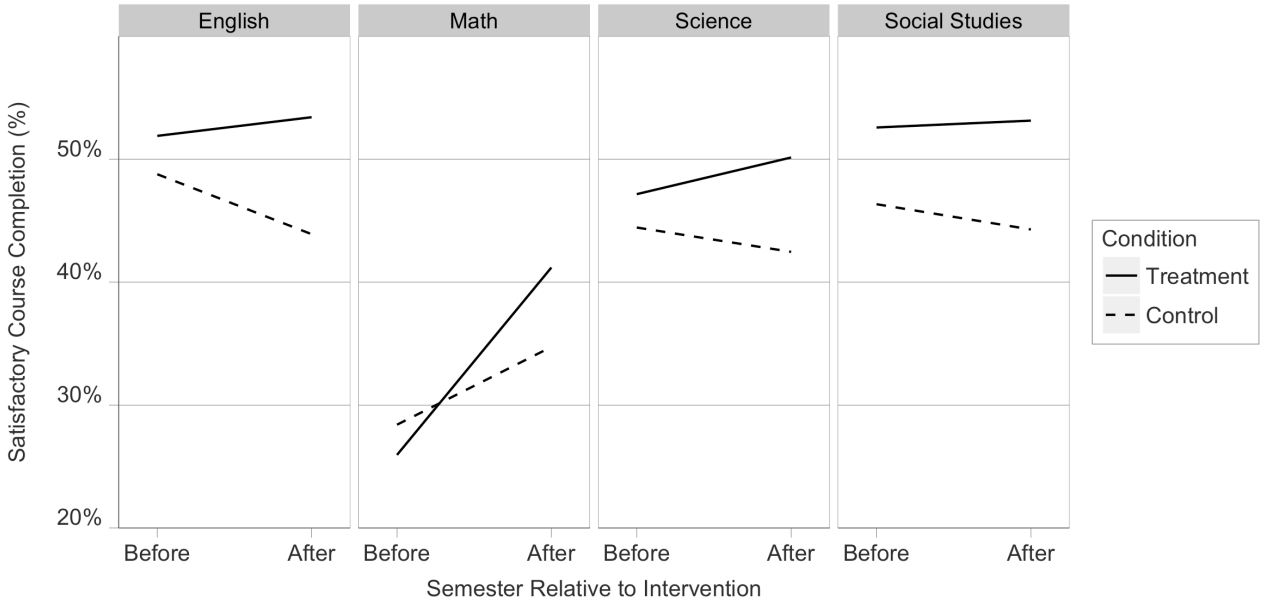
Using criteria developed by the Consortium on Chicago School Research (CCSR)[14] and recommended by the National High School Center[15], we identified as at-risk all students who earned baseline first semester GPAs of 2.0 or less and those who earned failing grades in any

core academic course. Analyses focus on these 519 at-risk students, who comprised the bottom third of the sample by pre-study academic achievement.

Results

Satisfactory grades (e.g., "A","B", "C") denote minimal acceptable proficiency in a subject and often gate entry into higher-level courses. To assess the effects of the interventions on getting at-risk students over this key academic threshold, we used a logistic mixed-effect model because it enabled us assess the effect of treatment on students' likelihood of satisfactory performance while controlling for students' grades in pre-intervention courses and other students' grades in the same courses[16]. As the outcome, we specified satisfactory completion (earning an A, B, C, P, or CR vs. D, F, NC, W, or I) in each core course before and after treatment; as fixed effects, we specified treatment (dummy-coded), time (0 pre-treatment, 1=post-treatment), and their interaction; as random intercepts we specified each student, course, and school. The regression revealed a significant time x treatment interaction, such that treatment group students earned significantly more satisfactory grades after the intervention than before the intervention compared to control group students, OR=1.48, z=2.239, p=.03. In the treatment group, students exhibited a 14% rise in the satisfactory completion rate, while no rise was observed in the control group.

The mindset interventions increased the rate at which students earned satisfactory grades in core academic courses.



Appendix: Community College Study

Researchers
Dave Paunesku, Carissa Romero, David Yeager, Greg Walton, Carol Dweck

Procedures
Two community colleges agreed to participate in this study and provide academic outcomes for participating students. One of these community colleges was located in Southern California, and the other was located in the Midwest. Between these two colleges, 886 participating students were enrolled in a math course during the semester of the intervention. These students were enrolled in 29 different math courses. The sample was diverse, including 413 White, 176 Latino, 78 Asian, 76 Black, and 143 other ethnicity or unknown ethnicity students. Of the 884 participants, 58% (517) were new students and 391 were returning students, for whom prior grades were available.

The study consisted of two 45-minute sessions[17] spaced approximately two and a half weeks apart (mean 18 days). Both sessions were administered either in each school's computer lab (n = 239) or as homework (n = 647) during the fall semester, between September and November of 2012. When students first signed into the intervention, they were individually randomly assigned to a control condition or to one of three intervention conditions — a growth-mindset intervention, a sense-of-purpose intervention, or a combined intervention condition. Students who were assigned to receive only one treatment always completed that treatment during the first session. In the second session, they completed the control condition associated with the other treatment, e.g., a student assigned to the sense-of-purpose only condition completed the sense-of-purpose treatment during session 1 and the growth mindset control condition during session 2. Students assigned to the combined treatment completed the growth mindset intervention during session 1 and the purpose intervention during session 2, and students assigned to the control condition completed the growth mindset control activity during session 1 and the sense of purpose control activity during session 2.

In the growth mindset intervention, students read an article describing the brain's ability to restructure itself as a consequence of effortful practice. The article focused on the implications of these neuroscience findings for students' potential to become more intelligent through study and practice. This message was reinforced through several writing exercises. In one, students summarized the scientific findings in their own words. In the second, they read about a hypothetical student who was becoming discouraged and starting to think of himself as not smart enough to do well in school. The writing exercise asked participants to advise this hypothetical student based on what they had just read. In the growth mindset control condition, students read a similarly formatted web module about the brain. However, it focused on functional localization instead of neural plasticity. It was thus devoid of the key psychological message that intelligence is malleable.

The sense-of-purpose intervention was designed to motivate students by helping them to see the value of trying hard in school for their ability to have a personally meaningful life as an adult. Specifically, students were led to focus on personally meaningful, prosocial reasons to try their best in school. The intervention started by asking students how they wish the world could be a better place; it then went on to describe some of the reasons other students report trying hard in

school, e.g., to "make a positive impact on the world," "have a career that they enjoy," or "make their families proud or be a good example for other people." Students were then asked to think about their own goals and how learning and trying hard in school could help them achieve those goals. Students not assigned to the sense-of-purpose intervention were assigned to a similarly formatted web module that asked them to describe how their lives are different now that they are in college.

Results

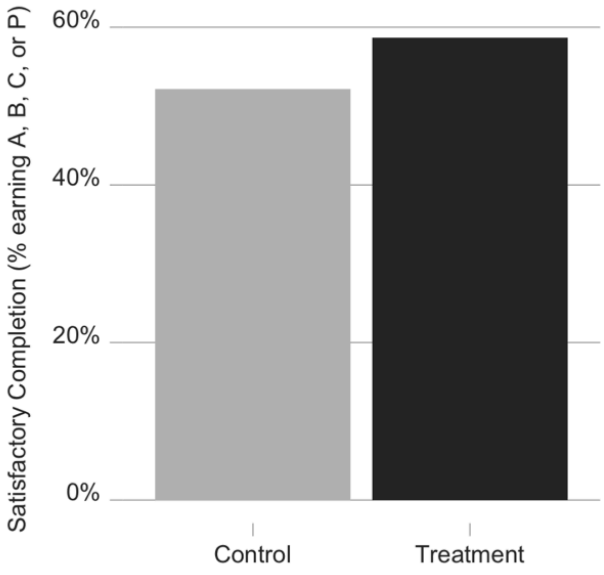
We examined the effects of the treatments on students' rate of successful math course completion. Grades A, B, C, and P were coded as "satisfactory" and D, F, and W as "unsatisfactory." At participating colleges, only satisfactory grades permit a student to receive transfer credit, to count the course as a prerequisite for more advanced courses, or to count the course towards their general education requirements.

Students in the treatment groups (growth mindset=56.0%, sense-of-purpose=60.3%, combined=59.6%) were more likely than students in the control group (52.2%) to earn a satisfactory grade in math. A mixed effect logistic regression model revealed that the effect of treatment on satisfactory grade completion was statistically significant, OR = 1.46, logit = .38, z = 2.365, p = .02, see table and figure below. Treatment increased satisfactory completion by 12% relative to the control group[18].

A regression table and graph, showing the effects of the mindset treatments on satisfactory math course completion in a sample of 886 community college students.

Intercept	-0.11
	(0.41)
Treatment	0.38*
	(0.16)
B Prior-GPA	-0.08
	(0.28)
C Prior-GPA	-0.75**
	(0.29)
D & F Prior-GPA	-1.66***
	(0.44)
New Student	-0.10
	(0.24)
AIC	1217.99
Log Likelihood	-600.00
Num. Observations	908
Num. Students	886
Num. Courses	29
Num. Programs	2
Variance: Student	0.00
Variance: Course	0.15
Variance: Program	0.20
Variance: Residual	

***p < 0.001, **p < 0.01, *p < 0.05, ˙p < 0.1



Appendix: Khan Academy Study

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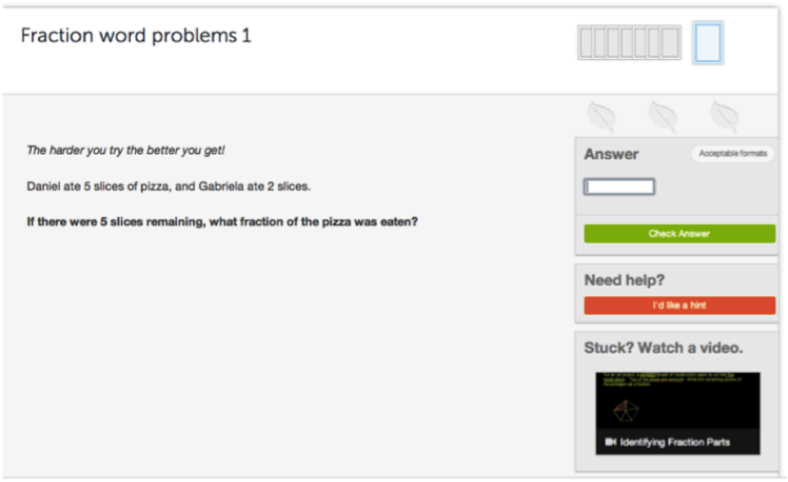

Procedure
We modified all fractions exercises on Khan Academy (khanacademy.org) to randomly present users with one of five sets of header messages immediately above each math problem (see figure). Once assigned to a header condition, users were randomly exposed to within-condition header messages on all subsequent fractions exercises.

The conditions included a no-header control group in which users did not see a header; this is the default on Khan Academy. Some students were assigned to see growth mindset headers intended to convey the idea that intelligence is malleable and that students can increase them by working hard, e.g., "Remember, the more you practice the smarter you become!" and "If you make a mistake, it's an opportunity to get smarter!" There were also two control statements groups: standard encouragement, e.g., "Some of these problems are hard. Just do your best," and science statements, e.g., "Did you know: An elephant brains weighs 7/2 as much as a human brain." These were intended to control for effort-based encouragement and scientific novelty, respectively. Reported results include all data collected from 265,082 participants over the first 37 days of the experiment.

Outcome
Khan Academy deems students proficient at a particular concept when they correctly answer enough problems that there is an above 94% probability that they will answer the next problem targeting that specific concept correctly. We calculated the total number of proficiencies students earned after assignment to condition and used a negative binomial regression to determine statistical significance because proficiencies are a count outcome overdispersed relative to a Poisson distribution[19], standard deviation/mean = 2.57.

Effect of conditions on proficiencies earned.

	Negative binomial	
Parameter	Estimate	z-Value
Intercept	1.708	359.259^{***}
Standard Encouragement	0.000	0.001
Science Statements	0.013	1.074
Mindset Statements	0.029	3.212^{**}

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

The results of a negative binomial regression model are displayed in the table above. Relative to the no headers group, the growth mindset encouragement group earned proficiencies at rate that was 2.9% higher, z = 3.212, p < .01. Neither of the control statement types influenced the rate at which students earned proficiencies, z < 1.

Footnotes & References

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[12] Note that the 45-minute sessions also included survey questions that were not part of the intervention. Each of two interventions lasted less than 30 minutes, and a single intervention was as effective as both interventions together.

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[17] Note that the 45-minute sessions also include survey questions that are not part of the intervention. Each of two interventions lasted less than 30 minutes, and a single intervention was as effective as both interventions together.

[18] Treatment rate 59% / Control group rate 52% = 12% relative increase.

[19] See Cameron, A. C., & Trivedi, P. K. (1998). Regression analysis of count data. New York, NY: Cambridge University Press.