To What Extent and Under Which Circumstances Are Growth Mind-Sets Important to Academic Achievement? Two Meta-Analyses

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Abstract

Mind-sets (aka implicit theories) are beliefs about the nature of human attributes (e.g., intelligence). The theory holds that individuals with *growth* mind-sets (beliefs that attributes are malleable with effort) enjoy many positive outcomes—including higher academic achievement—while their peers who have *fixed* mind-sets experience negative outcomes. Given this relationship, interventions designed to increase students' growth mind-sets—thereby increasing their academic achievement—have been implemented in schools around the world. In our first meta-analysis (k = 273, N = 365,915), we examined the strength of the relationship between mind-set and academic achievement and potential moderating factors. In our second meta-analysis (k = 43, N = 57,155), we examined the effectiveness of mind- set interventions on academic achievement and potential moderating factors. Overall effects were weak for both meta- analyses. However, some results supported specific tenets of the theory, namely, that students with low socioeconomic status or who are academically at risk might benefit from mind-set interventions.

According to mind-set theory (aka implicit theories; Dweck, 2006; Dweck, Chiu, & Hong, 1995), individuals vary in their beliefs about whether human attributes (e.g., intelligence) are stable or malleable. Individuals who believe attributes are stable have fixed mind-sets (aka entity theories), whereas those who believe attributes are malleable have growth mind-sets (aka incremental theories). According to mind-set theory, holding a fixed mind-set is detrimental for a variety of real-world outcomes, whereas holding a growth mind-set leads to a variety of positive outcomes, including weight loss (Burnette & Finkel, 2012), reaching international acclaim (Dweck, 2006), and achieving peace in the Middle East (Dweck, 2012, 2016).

Most frequently, mind-sets are researched in educational contexts. Mind-set theory suggests that students with higher growth mind-sets have more adaptive psychological traits and behaviors (e.g., positive response to failure), which lead to greater academic achievement (e.g., Dweck, 2000). The theory also suggests that interventions designed to increase students' growth mind- sets will lead to greater academic achievement because there is a "powerful impact of growth mindset messages upon students' attainment" (Boaler, 2013, p. 143). These ideas have led to the establishment of nonprofit organizations (e.g., Project for Education Research That Scales [PERTS]), for-profit entities (e.g., Mindset Works, Inc.), schools purchasing mind-set intervention programs (e.g., Brainology), and millions of dollars in funding to individual researchers, nonprofit organizations, and for- profit companies (e.g Bill and Melinda Gates Foundation,Institute of Educational Sciences).

Given mind-set theory's impact on education, we sought to ask the following questions:

1. What is the magnitude of the relationship between mind-sets and academic achievement, and under which circumstances does the relationship strengthen or weaken?
2. Do mind-set interventions positively impact academic achievement, and under which circumstances does the impact increase or decrease?

To answer these questions, we conducted two meta- analyses to (a) estimate the sizes of these effects and whether they are consistent across studies, (b) examine potential moderating factors, and (c) empirically evaluate the theory.

Meta-Analysis 1: The Relationship Between Mind-Sets and Academic Achievement

Mind-set theory suggests that mind-sets play critical roles in academic achievement (Rattan, Savani, Chugh, & Dweck, 2015). For example, Dweck (2008) stated, "what students believe about their brains — whether they see their intelligence as something that's fixed or something that can grow and change — has profound effects on their motivation, learning, and school achievement". In the first meta-analysis, we examined the magnitude of the relationship between mind-sets and academic achievement.

Next, we investigated potential moderators. We examined *academic risk status* because the theory holds that having a growth mind-set is especially important for at-risk students and students facing situational challenges such as school transitions. According to the theory, students with growth mindsets will interpret struggles as learning opportunities, while students with fixed mind-sets will be "devastated by setbacks" (Dweck, 2008). Similarly, although the theory is not linked to a particular age, some researchers suggest that mind-sets are particularly influential during the tumultuous period of adolescence when students face new challenges. To assess the importance of this moderator, we examined *student developmental stage*. Additionally, we examined *socio- economic status* (SES) because some research (e.g. Claro, Paunesku, & Dweck, 2016) has suggested that holding a growth mind-set is especially beneficial for low-SES students' academic success.

We examined the *type of academic achievement measure* because the effect might differ, for example, between course grades and standardized tests. Additionally, we investigated the possibility that if students with growth mind-sets are taking more challenging courses (see Romero, Master, Paunesku, Dweck, & Gross, 2014), then the relationship could be suppressed when the measure of achievement also reflects students' course selection.

Finally, we tested whether publication bias is problematic within the mind-set-in-education literature. Publication bias occurs when some results are systematically less likely to be published than others (e.g., studies that find small or null effects; Rosenthal, 1979).

Method

We designed the meta-analysis and report the results in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.

Inclusion criteria, literature search, and coding. We searched for studies for both meta-analyses in a single search. The criteria for including a study in Meta-Analysis 1 were as follows:

• A measure of a belief about one or more human attributes (e.g., intelligence) as fixed or malleable—henceforth *mind-set*—was collected.

• A mind-set measure was collected prior to or without a mind-set intervention.

• A measure of academic achievement—course exam (e.g., midterm exam), course grade, average of course grades (e.g., grade point average, or GPA), or standardized test performance—was collected prior to or without a mind-set intervention.

• A bivariate correlation coefficient reflecting the relationship between mind-set and academic achievement was reported, or enough information was provided to compute this effect size.

• The methods and results were in English.

Mind-set is typically measured using participants' responses to statements such as, "No matter who you are, you can significantly change your intelligence level" and "You have a certain amount of intelligence, and you can't really do much to change it" (reverse scored) using a Likert scale (e.g., Dweck, 2006). The more students agree with statements about the malleability of an attribute, the more of a growth mind-set they hold. Measures of beliefs about the importance of effort without corresponding beliefs about the malleability of one or more human attributes were not included. Likewise, mind-set of willpower was not included because (a) willpower refers to exerted control rather than an attribute, and (b) mind-set of willpower focuses on beliefs about whether willpower is limited or not limited rather than whether an attribute is stable or changes with effort.

To identify studies meeting these criteria and the criteria set forth for Meta-Analysis 2, we systematically searched for relevant published and unpublished articles in psychology, education, and other disciplines through October 28, 2016. We also e-mailed authors of articles on mind-set (N = 137) and asked that they forward the e-mail to colleagues who might have conducted relevant studies. Further, we contacted organizations dedicated to intervention- in-education research (e.g., PERTS) to request information relevant to our meta-analysis that was not accessible (e.g., unpublished data), and we posted requests for unpublished data on a Society for Personality and Social Psychology forum. We accepted new data from these calls through January 11, 2017. Following our search stop date, we evaluated studies for eligibility and coded each study and the measures collected in it for reference information, student characteristics, methodological

characteristics, and results. We included updates to our existing records until February 1, 2017.

Our search included 15,867 novel records. After examining these records and discarding obviously irrelevant ones (e.g., literature reviews, commentaries), we identified 129 studies that met all the inclusion criteria for Meta-Analysis 1. These studies included 162 independent samples, with 273 effect sizes and a total sample size of 365,915 students. In cases where authors reported effects associated with multiple measures of mind-set (e.g., a fixed mind-set scale and a growth mind-set scale) or multiple measures of academic achievement (e.g., GPA and performance on a standardized test), we adjusted for dependent samples by using a method based on that of Cheung and Chan (2004, 2008). This method statistically adjusts (lowers) the associated sample size because of dependent effects being partially redundant, which reduces the weight of these effect sizes in the meta-analysis so as not to overly contribute to the model. For additional characteristics of Meta-Analysis 1, see Table 1.

Effect sizes. To measure the magnitude of the relationship, we used the correlation as the measure of effect size. For most studies, the authors reported a Pearson's correlation coefficient; for studies in which the authors reported group-level comparisons (e.g., students holding a growth mind-set vs. a fixed mind-set), we converted standardized mean differences (Cohen's *d*s) to biserial correlations. There was not a significant difference in effect sizes between studies that reported group-level comparisons and those that used continuous variables, $p = .463$. Most studies' authors coded higher scores on the mind-set measure as reflecting more of a growth mind-set. When authors used a mind-set measure where higher scores reflected more of a fixed mind-set, we reversed the sign of the correlation before analyzing the data. We also reversed the sign of the correlation in the rare cases where lower scores on a measure of academic achievement reflected better performance. For instance, in Germany, lower grades reflect better performance. Thus, all effect sizes were coded such that a positive correlation reflected a positive relationship between growth mind- set and academic achievement.

Moderator variables

Developmental stage. There were three levels of developmental stage: children (primary school students), adolescents (middle school, junior high school, and high school students), and adults (e.g., postsecondary students). Studies that included students in multiple categories were not included in this moderator analysis.

Academic risk status. There were three levels of academic risk status: high (at risk of failing; e.g., students who previously failed courses), moderate (facing a situational challenge; e.g., transitioning to a new school, a member of a stereotyped group under a stereotype threat manipulation), and low (no indicators that students were at risk). Each sample was categorized on the basis of the majority (> 50%) of the students in the sample. If we could obtain separate effect sizes for each subsample in a study based on risk level (e.g., an effect was available for the high-risk students as well as the remaining low-risk students), we did so and entered those effects as independent samples. If effects were available only for the entire sample and a high-risk subgroup, we replaced the entire sample with the high-risk subgroup when examining this moderator.

We did not code minority students or female students as academically at-risk samples unless they were under a relevant stereotype threat manipulation. The effect of student ethnicity and gender on the relationship between growth mind-set and academic achievement is an important research question. However, we did not have the level of detail that would allow us to conduct a meaningful moderator analysis on ethnicity or gender as risk factors.

Socioeconomic status. There were two levels of SES: low SES (e.g., students qualified for reduced-price lunch) and not low SES (i.e., middle class or higher). Each study was categorized on the basis of the majority (> 50%) of the students in the sample. Studies not reporting student- level SES were not included in the SES moderator analysis.

Type of academic achievement measure. There were four levels of academic achievement measure: standardized test (e.g., Iowa Test of Basic Skills, SAT), and three pertaining to course performance—course exam (e.g., final exam score), course grade (e.g., math course grade), and cumulative or current GPA. When studies included multiple standardized test scores (e.g., verbal SAT, quantitative SAT, total SAT), we used the combined score when available. When studies included multiple course performance measures, we used the measure that provided the most comprehensive measure of academic achievement. That is, we used GPA when available because this provides the most information about a students' course performance. Likewise, we used course grades over course exams.

Some studies included measures of academic achievement administered by a researcher (e.g., practice questions on the GRE, a researcher-designed course-relevant test) as a proxy for academic achievement. We did not include researcher-designed tests as course exams if they were irrelevant to students' course- work (e.g., trivia quizzes, reading comprehension of the mind-set stimulus, worksheets on topics described as outside students' curricula). We present the results with and without laboratory measures because performance on these measures does not contribute to students' academic records.

Developmental stage as a moderator of mind-set on GPA. If students with a growth mind-set select more challenging courses or schools, it is possible that their GPAs would not be significantly higher than fixed mind-set students taking easier classes, leading to the relationship between mind-set and GPA being suppressed, especially for older students who have more opportunities for course selection. This suppression would affect only GPA, which reflects students' course selections. It would not suppress the effect on course exams or course grades because all students in the sample are in the same course. It would not suppress the effect on standardized tests because, if anything, students taking more challenging courses will be better prepared for standardized tests than students not exposed to higher-level material. We therefore also examine the interaction between mind-set and developmental stage on GPA.

Table 1: Descriptive Characteristics for Meta-Analysis 1

Study Characteristics	Number of Effect Sizes (k=273)	Number of participants (N=365,915)
Developmental Stage		
Children	50	8,118
Adolescents	126	332,240
Adults	89	21,673
Academic Risk Status		
Low	208	346,043
Moderate	55	19,215
High	6	218
Socioeconomic Status		
Low	33	173,614
Not low	62	27,160
Mind-set type		
Intelligence	167	335,560
Other attribute (eg math ability)	106	30,355
Academic achievement measure		
Course exam	15	9,318
Course grade	51	11,384
Average grades (ie grade point average)	82	46,986
Standardised test	125	298,227
Laboratory measures	24	2,121
Publication status		
Published	116	323,040
Unpublished	157	42,875

Results

The model consists of 273 effect sizes.

The meta-analytic average correlation (i.e., the average of various population effects) between growth mind-set and academic achievement is $r = .10$, 95% confidence interval (CI), $p < .001$.

We did not correct individual effect sizes for the attenuating effect of measurement error (i.e., measurement unreliability), because very few studies in the meta-analysis reported a reliability estimate for mind-set. However, measures of mind-set have typically been found to have acceptable reliability greater than .80 (see, e.g., Dweck et al., 1995). If we assume reliability of .80, the meta- analytic average correlation between mind-set and academic achievement is $r = .12$, 95% CI = [.09, .14].

Our results show that 157 of the 273 effect sizes (58%) are not significantly different from zero. Another 16 effect sizes (6%) are significantly different from zero but negative, indicating that growth mind-sets were associated with worse academic achievement. The remaining 100 effect sizes (37%) are significantly different from zero and positive, indicating that growth mind-sets were positively associated with academic achievement.

As can be seen, the effect sizes are not consistent across studies. The I^2 statistic specifies the percentage of the between-studies variability in effect sizes that is due to heterogeneity rather than random error. We investigated the source of this heterogeneity through the moderator analyses reported next.

Moderator analyses

Student factors. The developmental stage of the students **was** a statistically significant moderator. The average correlation between mind-set and academic achievement was r = .19, 95% CI = [.16, .23] for children; r = .15, 95% CI = [.12, .18]; for adolescents; r = .02, 95% CI = [−.005, .05]; for adults. Adults differed significantly from both adolescents and children. Adolescents and children did not differ significantly from each other.

Academic risk status **was not** a significant moderator. The average correlation between mind-set and academic achievement was r = .11 for low-risk students; r = .11 for moderately at-risk students; and r = .08 for highly at-risk students.

r measures what?

In statistics, the correlation coefficient r measures the strength and relationship between two variables. The value of r is always between +1 and -1. Most statisticians like to see correlations of at least +0.5 or -0.5 before surmising a strong relationship.

CI is the confidence interval

Socioeconomic status **was not** a significant moderator. Ninety-five effect sizes associated with reported student-level SES were included in this analysis. The average correlation between mind-set and academic achievement was r = .17, 95% CI = [.10, .23] for low-SES students; and r = .12, 95% CI = [.09, .16], p < .001, for middle-class and higher students.

Academic achievement measure. The measure of academic achievement used was **not** a statistically significant moderator. The average correlation between mind-set and academic achievement was r = .08 for studies that used a course exam; r = .13 for studies that used a course grade; r = .08 for studies that used GPA; and r = .12 for studies that used a standardized test.

Twenty-four effect sizes reflected the relationship between mind-set and a measure of academic achievement that was laboratory based. These included researcher-designed tests supposed to reflect comprehension of course-specific content (coded as a course exam) and standardized tests and portions of standardized tests administered by researchers in a laboratory setting (coded as standardized tests). Excluding the 24 effect sizes where the measure of academic achievement was a laboratory-based measure did not change the overall results.

Developmental stage as a moderator of mind-set on GPA. If students with growth mind-sets select more challenging courses, we would expect two patterns of results. First, the relationship between mind-set and academic achievement would not be suppressed for children who typically have little control over their course selection, somewhat suppressed for adolescents who have more course selection opportunities, and most suppressed for adults who have the most opportunities for course selection. The other pattern of results we would expect if students with growth mind-sets are selecting more challenging courses is that the relationship between mind-set and academic achievement will be suppressed when the measure of academic achievement is GPA, because GPA reflects performance in the students' selected courses. The relationship should not be suppressed for this reason when the measure is course grade or course exam because, in these cases, all students are taking the same courses. The relationship should also not be suppressed for this reason when the measure is standardized test performance because, if anything, students exposed to higher-level material should perform better than students taking less challenging courses.

Publication bias analyses. Publication bias threatens the validity of published research by masking small and null effects. We tested this via Egger's regression. We tested whether published studies, on average, report larger effect sizes than studies that remain unpublished. Unpublished studies included manuscripts in preparation to submit, manuscripts submitted but not yet accepted, conference papers and posters, and studies and manuscripts that have remained unpublished. Studies may remain unpublished for multiple reasons. A moderator analysis revealed that the 157 correlations between mind-set and academic achievement from unpublished studies (median study sample size = 122) were **not** significantly different from the 116 correlations from published studies.

p-*curve analysis*. We tested whether the source of published significant effects was due to *p*-hacking; that is, selective reporting of results (e.g., when authors conduct multiple analyses on the same data set but report only significant effects) or collecting data until a non-significant effect becomes significant. These results suggest that the *p*-curve is significantly right-skewed, indicating evidential value.

Discussion

The meta-analytic average correlation between growth mind-set and academic achievement was very weak— $r = .10$. This result is almost identical to the meta- analytic average correlation found between mind-set and achievement across achievement domains: $r = .095$. However, the overall effect is overshadowed by the high degree of heterogeneity.

Moderators were limited in accounting for this variance. Academic risk status and SES did not affect the relationship. Developmental stage moderated the relationship, though the effect remained weak for all sub-groups and non-significant for adults. This pattern held when examining only Grade Point Average as the outcome, and GPA did not differ from other measures of academic achievement. Thus, there is limited evidence for a suppression effect due to students with growth mind-sets potentially selecting more challenging courses.

Growth-mind-set interventions in education are predicated on the relationship between mind-sets and academic achievement. However, it is possible that despite generally weak relationships between students' naturally held mind-sets and academic achievement, interventions promoting growth mind-sets might still be effective, especially for certain subgroups. We examined the effectiveness of growth-mind-set interventions on academic achievement next.

Meta-Analysis 2: The Effect of Growth-Mind-Set Interventions on Academic Achievement

Growth-mind-set interventions have been suggested as a way for students to earn higher grades and score higher on standardized tests (mindsetscholarsnet work.org/learning-mindsets/growth-mindset/). To examine the effectiveness of these interventions, we estimated the standardized mean differences in academic achievement between students who received a growth-mind-set intervention and students who did not.

To investigate potential moderators, we tested the same three student-related factors as in Meta-Analysis 1: developmental stage, academic risk status, and SES as well as control- and intervention-related methodological factors. We examined the type of control group (active control, passive control, fixed mind-set). If studies using passive control groups have the largest effects, this suggests that exposure to treatments might drive the effect rather than growth-mind-set interventions per se. Alternatively, if growth mind-sets are beneficial for academic achievement and fixed mind-sets are detrimental, we should see the largest effect when the comparison group is a fixed-mind-set condition.

We examined the type of intervention to test whether interactive (e.g., saying-is-believing) interventions are more effective than passive interventions. The number of intervention sessions was examined as a continuous variable to test whether there is a linear additive effect of intervention exposure. We included mode of intervention (computerized, in person, reading materials, combination) to test whether certain modalities are more effective than others. For interventions at least partially administered in person, we further classified whether administers were teachers, researchers, or both. We include intervention context (integrated in the classroom, outside regular classroom activities) because some researchers have suggested that mind-set interventions might be context dependent (Yeager & Walton, 2011).

We examined whether studies included a manipulation check and whether the manipulation check was successful. We included these measures because if mind-set interventions are a scalable treatment, we should expect most manipulation checks to be successful, and if mind-set interventions are generally effective, we would expect null results only when manipulation checks are unsuccessful.

We also investigated factors related to the measure of academic achievement: intervention-achievement measure interval and type of academic achievement measure. If mind-set interventions are susceptible to the fadeout effect, we should expect stronger effects the shorter the intervention-achievement measure interval. In contrast, if mind-set interventions interact with recursive processes the effects should be sustained (or enhanced) with additional time. Finally, we tested whether publication bias is problematic within the mind-set intervention literature.

Method

As with Meta-Analysis 1, we designed the meta-analysis in accordance with the PRISMA statement.

Inclusion criteria, literature search, and coding. The criteria for including a study in Meta-Analysis 2 were as follows:

- A growth mind-set treatment, henceforth *intervention*, where the primary goal was to increase students' belief that one or more human attributes (e.g., intelligence) can improve with effort was administered

directly to students.

- A control group (active, passive, or fixed-mind- set condition) was included.
- A measure of academic achievement—course exam (e.g., midterm exam), course grade, average of course grades (e.g., GPA), or standardized test performance—was collected.
- An effect size reflecting the difference between the mind-set intervention group and the control group on one or more measures of academic achievement after the intervention was reported, or enough information was provided to compute this effect size.
- The methods and results were in English.

We identified 29 studies that met all the inclusion criteria. We coded each study and the measures collected in it for reference information, student characteristics, methodological characteristics, and results. These studies included 38 independent samples, with 43 effect sizes and a total sample size of 57,155 students.

Effect sizes. To measure the magnitude of the effectiveness of the intervention, we used Cohen's *d* as the measure of effect size. Ideally, we would have estimated the difference in gain scores between the treatment and control groups. However, only a third of the studies provided enough information to calculate this difference. Therefore, except when a study reported a significant pretest difference, we use the standardized mean difference post-treatment scores, which could cause a bias in the effect sizes. Positive Cohen's *d*s indicated that the group receiving a growth-mind-set intervention performed higher on a measure of academic achievement than students in the control group.

What is Cohen's d?

Cohen's d is an effect size used to indicate the difference between two means. It is defined as the difference between two means divided by a standard deviation of the data. Cohen suggested that 0.2 be considered a small effect size; 0.5 represents a medium effect size; and 0.8 a large effect size.

Potential moderators

Student factors. As with Meta-Analysis 1, there were three levels of developmental stage: children (primary school students), adolescents (middle school, junior high school, and high school students), and adults (e.g., postsecondary students). There were three levels of academic risk status: high (at risk of failing; e.g., students who previously failed courses), moderate (facing a situational challenge; e.g., transitioning to a new school, a member of a stereotyped group under a stereotype threat manipulation), and low (no indicators that students were at risk). We did not code ethnic minorities or women as at risk unless they were under a stereotype threat manipulation.

As with Meta-Analysis 1, there were two levels of SES: low SES (e.g., students qualified for reduced-price lunch) and not low SES (i.e., middle-class or higher). Each study was categorized on the basis of the majority (> 50%) of the students in the sample.

Control and intervention method factors. There were three levels of control group type: active control (i.e., placebo control), passive control (e.g., no contact control), and fixed-mind-set condition (i.e., students in the comparison group were given a fixed-mind-set intervention). Students in active (placebo) control groups engaged in similar activities and amounts of contact with administrators but without the content of a hypothesized effective treatment. Active controls did not consist of other treatments designed to be effective in improving academic achievement.

Intervention type has three levels: passive (students read a document or watch a video on how human attributes are malleable), feedback (students are given feedback on their performance in terms of growth mind-set), and interactive (e.g., participants read materials and then write an essay about how intelligence can be developed or participate in an in-class discussion). If passive and feedback interventions are as effective as interactive interventions, this suggests that effective interventions can be implemented with few resources and with a light touch (see Yeager, Walton, & Cohen, 2013, for a discussion of stealthily implementing interventions).

Intervention length was a continuous variable based on the number of intervention sessions. If intervention effectiveness increases with the number of intervention sessions, then this suggests a positive dose-response relationship. In contrast, if intervention effectiveness decreases with the number of intervention sessions, this could be due to students perceiving the repetition as a message that they need help, undermining the credibility of the growth-mind-set intervention (see Yeager et al., 2013).

Table 2: Descriptive Characteristics for Meta-Analysis 2

Study Characteristic	No. of Effect Sizes (k=43)	No. of participants (N=57,155)		Study Characteristic	No. of Effect Sizes (k=43)	No. of participants (N=57,155)
Developmental Stage				**Intervention context**		
Children	2	181		Integrated in class activities	5	2,057
Adolescents	27	48,991		Outside regular class activities	38	55,098
Adults	13	7,871		**Intervention-measure interval level**		
Academic Risk Status				Immediate (same session)	5	533
Low	17	3,801		Short interval	32	56,180
Moderate	18	8,664		Long interval	4	292
High	5	1,960		**Mindset type**		
Socio-economic status				Intelligence	33	54,002
Low	7	577		Other attribute (eg math ability)	10	3,153
Not low	8	4,596		**Academic achievement measure**		
Control Group				Course exam	3	628
Active	26	11,365		Course grade	4	2,083
Passive	11	45,267		Average of course grades	15	10,564
Fixed-mindset condition	6	523		Standardised test	21	43,880
Intervention type				Laboratory measures	12	899
Passive	13	1,355		**Publication status**		
Feedback	1	1,589		Published	25	6,180
Interactive	29	54,211		Unpublished	18	50,975
Mode of Intervention						
Computerized training	16	11,581				
Reading material	8	1,441				
In-person training:						
- by teachers	7	43,141				
- by researchers	5	649				
- both teachers & researchers	5	162				

Results

The results show that 37 of the 43 effect sizes (86%) are not significantly different from zero. One effect size is significantly different from zero but negative, indicating that students receiving a growth-mind-set intervention had significantly worse academic achievement than students in the control conditions. The remaining 5 effect sizes (12%) are significantly different from zero and positive, indicating that students receiving a growth-mind-set intervention had significantly greater academic achievement than students in the control groups.

The meta-analytic average standardized mean difference (i.e., the average of various population effects) in academic achievement between students receiving a growth-mind-set intervention and students in control groups is $d = 0.08$.

As illustrated by the I^2 statistic, which specifies the percentage of the between-studies variability in effect sizes that is due to heterogeneity rather than random error, there was a medium amount of heterogeneity in the effect sizes, $I^2 = 43.15$, indicating that the true effect of a given study could be somewhat lower or higher than the meta-analytic average. We investigated the source of this heterogeneity through the moderator analyses.

Moderator analyses.

Student factors. The developmental stage of the students was **not** a significant moderator. Only two effect sizes associated with children were available. For one effect size, sample age information was unavailable. These three effect sizes were not included in this analysis. Growth-mind-set intervention did not significantly improve academic achievement relative to controls either for adolescents, $d = 0.08$, or for adults, $d = 0.08$.

Academic at-risk status was **not** a significant moderator. Growth-mind-set intervention did not significantly improve academic achievement relative to controls for low-risk students, $d = 0.06$; for moderately at-risk students, $d = 0.08$; or for highly at-risk students, $d = 0.17$.

SES **was** a significant moderator. Student-level growth-mind-set intervention did **not** improve middle-class and upper-class students' academic achievement, $d = 0.03$. However, for those from low-SES households (7 effect sizes), academic achievement was significantly higher for students who received growth-mind-set interventions relative to controls, $d = 0.34$.

Control and intervention-related factors. Control-group type was **not** a significant moderator. Academic achievement was similar between students who received a growth-mind-set intervention and students who received a fixed-mind-set condition, $d = 0.27$. There was also no effect when the control group was passive, $d = 0.02$. A borderline significant difference was observed when the control group was an active control (i.e., placebo control), $d = 0.08$.

Intervention type was **not** a significant moderator. Only one effect size used feedback (weekly growth mind-set feedback with students' quiz grades) as the manipulation, and thus this effect size was removed from this moderator analysis. The effectiveness of a growth-mind-set intervention on academic achievement was not significant when the intervention was passive (e.g., reading about growth mind-set without writing a reflection), $d = 0.02$, but demonstrated effectiveness when the intervention was interactive (e.g., reading about growth mind-set and then writing a reflection), $d = 0.09$.

Intervention length was **not** a significant moderator. The number of sessions ranged from 1 to 10. Increasing the number of growth-mind-set-intervention sessions neither increased nor decreased the impact on academic achievement.

Mode of intervention **was** a significant moderator. Growth-mind-set interventions were not effective when administered via computer programs, $d = 0.03$; in person, $d = 0.06$; or via a combination of modes, $d = 0.27$. The intervention **was** effective when students read growth-mind-set materials, $d = 0.20$. Follow-up tests revealed that mind-set interventions administered via reading materials were significantly more effective than when administered via computer programs.

When interventions were administered in person (solely or as part of a combination), growth-mind-set interventions remained **ineffective** regardless of whether the intervention was administered by a teacher, $d = -0.01$; a researcher, $d = 0.34$;or both,$d = 0.27$.

The context in which the intervention was implemented was **not** a significant moderator. Growth-mind-set interventions were not effective when the intervention was integrated into regular classroom activities, $d = -0.14$. However, when the interventions were administered **outside regular classroom activities**, the effect was significant, $d = 0.09$ 95% CI = [0.03, 0.16].

Fifteen of the 43 effect sizes (35%) were associated with studies that did not report pre- and post-intervention measures of mind-set to test whether the growth-mind- set intervention effectively increased growth mind-set (i.e., no manipulation checks). Interestingly, the effect of a growth-mind-set intervention was significant when no manipulation check was administered, but not significant for studies that employed a manipulation check.

Factors related to academic achievement measures. When using effect sizes associated with the greatest amount of time between the intervention and measure of academic achievement within the same semester, if available, the interval between the growth-mind-set intervention and the measure of academic achievement

was **not** a significant moderator. The effectiveness of growth-mind-set interventions was not significant regardless of whether academic achievement was measured within the same session, d = 0.35, or within 4 months of the intervention.

The type of academic achievement measure was **not** a significant moderator. Growth-mindset interventions **were borderline significant** when the measure of academic achievement was GPA, d = 0.07, 95% CI = [0.002, 0.14]. Growth-mind-set interventions were **not** significant when the measure of academic achievement was performance on a standardized test, d = 0.09, 95% CI = [–0.07, 0.24].

Publication bias analyses. We conducted the same three types of publication bias analyses as in Meta-Analysis 1. *Moderator analysis*. The median sample size associated with unpublished studies was 270 (compared with 66 for published studies). A moderator analysis revealed that the 18 effect sizes associated with unpublished studies were **not** significantly different from the 25 effect sizes associated with published studies. p-*curve analysis*. Only four statistically significant results were available to be included in the primary analysis (*p*-curve excludes unpublished results and non-significant results). The estimated power of the *p*-curve analysis to detect right-skew on the basis of this simulation was 18.2%. Therefore, the results of the *p*-curve analyses are inconclusive.

Discussion

Some researchers have claimed that mind-set interventions can "lead to large gains in student achievement" and have "striking effects on educational achievement". Overall, our results do not support these claims. Mind- set interventions on academic achievement were non-significant for adolescents, typical students, and students facing situational challenges (transitioning to a new school, experiencing stereotype threat). However, our results support claims that academically high- risk students and economically disadvantaged students may benefit from growth-mind-set interventions, although these results should be interpreted with caution because (a) few effect sizes contributed to these results, (b) high-risk students did not differ significantly from non-high-risk students, and (c) relatively small sample sizes contributed to the low-SES group.

The results do not support the claim that mind-set interventions benefit both high- and low-achieving students. Mind-set interventions are relatively low cost and take little time, so there may be a net benefit for students' academic achievement. However, there may be a detriment relative to fixed-mind-set conditions when students are confident in their abilities. Regardless, those seeking more than modest effects or effects for all students are unlikely to find them. To this end, policies and resources targeting all students might not be prudent.

Regarding methodological moderators, interactive interventions produced a significant effect in line with mind-set theory. However, other results were confusing. For example, there was no significant difference between students in growth-mind-set versus fixed-mind-set conditions or when the treatment group was passive—the effect was significant only when com-pared with active controls. As another example, the effect was significant for studies that did not report manipulation checks while non-significant for studies with manipulation checks. Further, of studies that reported manipulation checks, almost half failed, suggesting that the interventions had no impact on students' mind-sets. Most surprising, the effect was significant when the manipulation checks failed but null when the manipulation checks succeeded. This suggests that "successful" interventions may not be attributable to students' mind-sets. Manipulation checks are critical for establishing causal inferences.

General Discussion

Mind-sets and their implications for academic achievement have received substantial attention from the media, funding agencies, educators, and government institutions. For example, in 2013, the White House convened a special meeting entitled "Excellence in Education: The Importance of Academic Mindsets." Boaler (2013) summarized the impact as the "mindset revolution that is reshaping education."

Part of the reshaping effort has been to make funding mind-set research a "national education priority" because mind-sets have "profound effects" on school achievement (Dweck, 2008, para.2). Our meta-analyses do not support this claim. Effect sizes were inconsistent across studies, but most analyses yielded small (or null) effects. Overall, the first meta-analysis demonstrated only a very weak relationship between mind-sets and academic achievement. Similarly, the second meta-analysis demonstrated only a very small overall effect of mind-set interventions on academic achievement.

However, not all mind-set research makes broad claims. Some research focuses on specific tenets of the theory regarding how mind-sets affect individuals facing challenges, hypothesizing effects only for specific groups of students. Some subgroup results from the present meta-analyses supported these hypotheses, such as the significant effects for academically high-risk students and low-SES students. Other subgroup results did not support these hypotheses, such as null results for students facing situational challenges and adolescents. Still other subgroup results suggest that standards are needed for implementing intervention studies and interpreting the results.

Moving forward, researchers interested in mind-sets' effects on academic achievement should institute manipulation checks to ensure that mind-set interventions are influencing students' mind-sets. If mind-set manipulations are not demonstrating an influence on students' mind-sets (as was found in nearly half the studies including manipulation checks), then the mechanism affecting any observed change in achievement is either due to chance or due to mediating variables.

Additionally, while the results that supported mind-set theory were not strong, it is possible that unmeasured factors are suppressing effects or that imperfect control of the intervention in the classroom buffers the effects. Alternatively, mind-set interventions might need to be combined with other interventions to increase effectiveness. From a theoretical perspective, further investigations into potential mediators and moderators might yield important discoveries about the nature of human beliefs, the role of educational interventions, or both.

However, from a practical perspective, resources might be better allocated elsewhere than mind-set interventions. Across a range of treatment types, Hattie, Biggs, and Purdie (1996) found that the meta-analytic average effect size for a typical educational intervention on academic performance is 0.57. All meta-analytic effects of mind-set interventions on academic performance were < 0.35, and most were null. The evidence suggests that the "mindset revolution" might not be the best avenue to reshape our education system.