False growth mindsets negatively impact student beliefs and performance

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Abstract

What does it mean to hold a “growth mindset?” Is it enough to simply think that anyone can grow their abilities as long as they try, or is there more to it? Are using appropriate strategies and being willing to ask for help important, or irrelevant? And what does it matter if you’re wrong? Using a large nationally-representative sample of 9th graders in public high-school math classes and their teachers, we find, in a preregistered analysis, that a so-called “false growth mindset” - believing that anyone can succeed with hard work alone - is surprisingly common among teachers, and has real-world impacts on their students. In a multi-level non-parametric latent profile analysis, we find that 38% of teachers surveyed can be classified as having a false-growth mindset (characterized by an unreserved belief that everyone has the ability to succeed, but with a tendency towards praising success and imposing strategies on students instead of working with them to figure out what strategies would work best for them), and that students in these classrooms are more likely than students in the classrooms of teachers with a true growth mindset (~39% of teachers surveyed, characterized by a belief that most students can improve their abilities paired with strategy-supportive practices) to view their teachers as having fixed ability beliefs, are more likely to hold entity theories about their own abilities, and that students’ beliefs about their own ability significantly mediates a relationship between teacher mindset and lower end-of-year student grades.

Keywords: growth mindset, teacher practice, high-school, latent profile analysis, structural equation modeling

False Growth Mindsets Negatively Impact Student Beliefs and Performance

‘Growth mindsets,’ or the belief that one’s abilities are malleable have been shown to be a powerful determinant of students’ academic success (e.g. Dweck 1999; 2006). Students with a growth mindset tend to believe that intellectual improvement is possible if they work for it (e.g. Dweck & Leggett, 1988), and are able to reframe potential setbacks, such as academic failure experiences as opportunities for improvement (e.g. Mueller & Dweck, 1998). These beliefs stand in relief against the beliefs of students with a fixed mindset, who believe that their talents are what they are, and that failure is simply an indication that they don’t have what it takes to succeed. Mindset beliefs are surprisingly easy to change however, and interventions which teach students to change their orientation from an entity-theory/fixed mindset to an incremental theory/growth mindset has been shown to have real consequences for their motivation and academic performance, even at scale (e.g. Blackwell, Trzesniewski, & Dweck, 2007; Yeager, Walton, et al., 2016; Yeager et al., 2019; Yeager et al., 2019; but see Sisk et al., 2018). By learning that one can improve with the right combination of effort, study strategies, and willingness to ask for help, students, especially those who may worry about their inherent academic worthiness, seem better equipped to handle the ups-and-downs of academic experience, and gain a resilience which helps them to ultimately outperform those who believe in the power of talent alone (e.g. Yeager & Dweck, 2012).

Teacher Mindsets Matter

Mindsets aren’t just an intrapsychic phenomenon – the expectations that others have for us affects our own outcomes. Most profoundly, of course, this can be seen in the literature on

self-fulfilling prophecies (e.g. Rosenthal & Jacobson, 1968; reviewed in Madon, Willard, Guyll, & Scherr, 2011; but see also Jussim & Harber, 2005). Perceiver expectations for target outcomes can shape targets' own expectations, as when teacher expectations for success leads students to believe that they are able to succeed. Beliefs in how one can succeed may be similarly transmissible – the mindsets of parents, for example, powerfully shapes the mindsets of their children (Haimovitz & Dweck, 2016), the generally accepted beliefs of an organization can shape the mindsets of those who wish to become a member (Murphy & Dweck, 2010), and teachers may be able to intentionally instill growth mindsets in their students (Ferguson, Phillips, Rowley, Friedlander, 2015).

People can accurately infer the mindsets held by important people in their life, such as teachers or significant others, and an inference that one's evaluator has a fixed mindset can lead to self-doubt in academic settings (Reich & Arkin, 2006). This set of inferences can seriously impact student performance – in a large-scale study of STEM professors, for example, classes taught by professors with fixed mindsets had twice as large of a racial achievement gap as classes taught by professors with growth mindsets (Canning, Muenks, Green, & Murphy, 2019).

On the one hand, it may be that teachers with more of a fixed mindset shape their classroom in line with these beliefs, which affects student performance directly. One longitudinal study, for example, demonstrated that teachers who more strongly held entity theories of intelligence were more likely to emphasize performance-oriented educational practices (such as doing well on tests, regardless of strategies), which led to an increase in student entity theorizing throughout the semester (Park, Gunderson, Tsukayama, Levine, & Beilock, 2016; see also Leroy, Bressoux, Sarrazin, & Trouilloud, 2007).

Teachers with different mindsets may also treat students differently. There is evidence, for example, that the implicit biases of teachers can leak out into the expectations they have for their students, with concomitant effects on student grades (van den Bergh, Denessen, Hornstra, Voeten, & Holland, 2010). Teacher attributions for success and failure shapes the emotions they feel towards the failing student and the behaviors they take in turn. If a teacher interprets a student's failure as coming from a lack of ability, they may be driven to pity, while if they interpret the failure as coming from a lack of effort, they may be driven to anger, and the less a teacher feels that their student's outcomes are something that the teacher can control, the less help they're willing to give (Butler, 1994; Georgiou, Christou, Stavarinides, & Panaoura, 2002). Teachers may provide more support and instruction to students who they believe have a high potential for success, while providing fewer resources for those who they feel have less potential (Fuchs, Fuchs, & Phillips, 1994). Teachers with a fixed mindset, therefore, may focus more on students who they think have the talent to succeed in their class, writing off those who they feel cannot improve.

On the student side, it can be incredibly demotivating as a student to think that your teacher doesn't believe in you. Teacher practice can change student's attitudes as deeply as students' content knowledge (reviewed in Blazar & Kraft, 2017), and, for example, students taught by professors who they believe to have a fixed mindset feel higher degrees of impostor-syndrome and increased worries that they might not belong in their STEM classes. These beliefs can lead to less engagement with their classes, including lower rates of attending class, higher rates of class dropout, and lower end-of-year grades (Muenks, Canning, Green, Zirkel, Garcia, & Murphy, under review; see similar findings in Rattan, Savani, Komarraju, Morrison, Boggs, & Ambady, 2018).

False Growth Mindsets

But what happens when your teacher has a misunderstanding of what a growth mindset actually entails? In the canonical form of the growth mindset, people should be learning that they can improve their performance as long as they try hard, use the proper strategies, and are unafraid to ask for help (Dweck, 2008). The traditional approach to teaching growth mindsets (e.g. Yeager, Romero, et al., 2016), however, stresses the power of hard work for improvement above and beyond other factors. With its stress on “growing the brain,” it is entirely possible that people may come to believe that effort alone is the key to improvement, and that, simply, if you try hard, you’ll do well. This so-called “false growth mindset” (Dweck, 2015; 2016a, 2016b) may not carry the same motivational benefits as the “true growth mindset,” and may even hinder one’s performance (e.g. Wormington et al, under review).

Those who truly believe that effort is the only thing that matters for one’s outcomes may see the failures of others as an indication of unwillingness to try hard enough to succeed, and a misunderstood growth mindset may lead to victim-blaming (e.g. Hoyt & Burnette, 2020; Ryzanov & Christenfeld, 2018). This line of thinking may be especially problematic in educational settings, where teachers who hold such a mindset may be less likely to help struggling students, and may be communicating to students, either intentionally or unintentionally, through their messages or their practices, that failure indicates that students are lacking innate ability and are unlikely to improve. After all, since all that’s required for success is trying hard, and since anyone can try hard, it must mean that failure is an indicator that there’s something wrong with the student themselves.

There is some evidence that students can pick up on this misunderstanding in their teachers, and that they do not respond well to it. Students whose teachers mainly praise their effort, without praising their strategies have been shown to interpret that praise as demeaning, indicating that their teacher doesn't believe that they have the ability to succeed in the class and that the teacher is just praising their effort as a sort of 'consolation prize.' Students who make this attribution are then more likely to internalize the message that they're hearing, leading them to question their abilities and ironically shading them towards an entity theory of their own intelligence (see Amemiya & Wang, 2018 for a review).

The Present Study

How commonly-held are these false growth mindsets, and do they actually matter for student beliefs and performance in school? While anecdotal evidence suggests that misunderstandings of growth mindsets may be more widely-held than education researchers are comfortable with (e.g. Sorhagen, personal communication), we know of no systematic effort to quantify their prevalence or consequences. In the present study, we provide an early step in this process, through a preregistered analysis of data collected in the National Study of Learning Mindsets (NSLM). The NSLM is a large nationally-representative study of a growth-mindset intervention conducted with over 12,000 9th graders in 65 public schools across the United States. In addition to randomly-assigning students to either a growth-mindset or control intervention, the NSLM surveyed students at two timepoints about their classroom experiences, including their perceptions of their teacher's beliefs about ability and effort; and surveyed their math teachers about their attitudes and beliefs towards education, including how they would hypothetically respond to students portrayed as struggling in their class versus thriving. The

NSLM is the largest randomized-controlled-trial of growth-mindset interventions to date in a US K-12 setting, and its careful sampling provides an unmatched window into processes surrounding growth mindsets (see Yeager et al., 2019 for more about the NSLM, and see Gopalan & Tipton, 2018 and Tipton, Yeager, Iachan, & Schneider, 2019 for more about the sampling and national representation).

Linking up the teacher and student surveys allows us to first categorize teachers according to a rich range of their beliefs and self-reported practices - how much they believe that math is the sort of thing that you need special talent for, but also how they set up their classroom, their focus on effort in their feedback versus their focus on outcomes or strategy-use, and their beliefs about whether teaching itself is something that a person can get better at.

After categorizing teachers, we then turn to their students. One month or so into the semester, how do students perceive their teacher's beliefs about effort and ability? Do they think that their teacher believes that anyone can succeed at math or that only certain talented people can? And what about students' own mindsets? Do they think that they too can grow their intelligence, or do they think that their abilities are fixed?

Finally, we turn to the consequences of these beliefs, looking at end-of-year student grades to determine whether having a teacher with a false growth mindset predicts lower grades than one with a true growth mindset, and whether that difference can be explained through differences in self-reported student psychology.

We predicted that teacher mindset would matter, and that having a teacher with a false growth mindset (compared to a true growth mindset) would lead, among their students, to an increase in entity theorizing, increased perceptions that the teacher cares about effort, and an increase, ironically, in perceptions that their teacher has a fixed mindset about ability. These

increases, we predicted, would be borne out in end-of-year GPA, such that these student beliefs would mediate the relationship between teacher mindset and end-of-year GPA. We additionally predicted that these relationships would be stronger for students that came into the year in a more precarious place, grade-wise, as students with lower GPAs in previous semesters would be the most likely to struggle, and therefore the most likely to be victim-blamed by teachers with a false growth mindset.

Method

Disclosures

Preregistration. All models were refined on an initial 10% of the data, randomly selected, that was made available as an exploratory set for this purpose. After models were finalized, the remaining 90% of the data were made available for the confirmatory tests reported below. The preregistration for this project can be found at https://osf.io/vfxds?view_only=87d1b260a5994cd4bc863b2ef2680d36

Data & Materials. All data and codebooks for the National Study of Learning Mindsets are available at <https://doi.org/10.3886/ICPSR37353.v1>. Analysis scripts for this project can be found at https://osf.io/qz4g9/?view_only=87d1b260a5994cd4bc863b2ef2680d36, and model outputs can be found at https://osf.io/edj64/?view_only=87d1b260a5994cd4bc863b2ef2680d36. The Online Supplement can be found at https://osf.io/h7s6v/?view_only=87d1b260a5994cd4bc863b2ef2680d36.

Reporting. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Ethical Approval. The underlying data analyzed in this paper were collected under approval from the Institutional Review Board at Stanford University (30387), ICF (FWA00000845), and the University of Texas at Austin (#2016-03-0042).

Participants

Data come from the National Study of Learning Mindsets (NSLM), a study which recruited 12,490 9th-graders and 354 of their math teachers from a stratified random sample of 65 U.S. public high schools in the 2015-2016 academic year. At the beginning of the semester, students completed a short online session, in which they either learned about a growth mindset, or received a control intervention. 1-4 weeks later, all students completed a set of follow-up measures. Teachers, blind to the condition that their students were randomized into, were simply surveyed at the beginning of the semester. For further details about the NSLM, see Yeager et al., 2019.

The subsample of data analyzed here come from the pairing of students and teachers where the student filled out the full complement of measures below, where the student and teacher could be uniquely matched (i.e. the student only had one teacher who filled out survey measures in the dataset), and where end-of-year grades for the student were provided by the school. Depending on the precise specification, the data comprise between 3,835-5,453 students nested within 305 teachers in 61 schools.

Materials

Teacher Survey. To assess teachers' beliefs about the importance of effort, ability, strategies, and their attitude towards more and less successful students, we selected the following questions from the beginning-of-the-semester Teacher Survey:

Teachers were given a set of videos of classrooms, and were asked “Based on your professional judgment, what percent of the math students in the last three videos probably had the intellectual potential to excel at the highest levels of high school math, like Calculus?”

They were then told to “Imagine that one of your 9th grade math students was very discouraged in math class. The student kept getting low grades on assignments. The student didn’t always try, but when he or she did try hard, the student would still get things wrong, even after practicing.” They were given a space to freely respond with the sorts of feedback that they would provide, and were asked (on a scale from 1 = extremely likely to 5 = not at all likely) how likely they would be to say the following statements: “Don’t worry—it’s okay to not be a math person;” “Please come get tutoring after class/school;” “Keep working hard and you’ll get it;” “Let’s look at what went wrong in your process and see what happens when we fix it;” and “Let’s see what you don’t understand and I’ll explain it differently.”

Next, teachers were told to “Imagine one of your math students was doing very well in math class. The student is getting really high grades on assignments, often without trying or putting in much time. The student doesn’t ask questions because he or she isn’t confused by very much.” They were given a space to freely respond with the sorts of feedback that they would provide, and were asked (on a scale from 1 = extremely likely to 5 = not at all likely) how likely they would be to say the following statements: “Let’s find something to challenge and confuse you, so you can learn more;” “When it’s easy, that’s when it’s time to try something harder;” “Great job, you must be working hard;” “It’s great that it’s so easy for you;” and “You’re lucky that you’re a math person.”

Teachers were then asked about their general practices in 9th grade math (on a scale from 1 = extremely true to 5 = not at all true): “I tell my 9th grade students it is important to work hard

in math class;” “I try to put my slower/remedial 9th grade students together for group work;” “I allow my 9th grade students to revise and resubmit work when they did not get a good enough score initially;” and “It slows my class down to encourage lower achievers to ask questions.”

Finally, teachers were asked about their beliefs about ability more generally and their attitudes about teaching more specifically (on a scale from 1 = strongly disagree to 6 = strongly agree, with no neutral midpoint): “People have a certain amount of intelligence, and they really can’t do much to change it;” “Being a top math student requires a special talent that just can’t be taught;” “If you want to succeed in math, hard work alone just won’t cut it; you need to have a natural gift or talent;” “Some people are just born great teachers; if you’re not, there’s not much you can do to become a really great teacher;” and “If I really try hard, I can get even the most difficult or unmotivated student to learn.”

We additionally made use of the free-responses to both the struggling and excelling students, using coding generated by Alex Browman and his team (Browman, Miele, O’Dwer, & May, under review). The authors had two independent coders rate the teachers across three dimensions (on a three point bipolar scale with a midpoint indicating neither of the two options): the degree to which the teacher was autonomy-supportive versus controlling (e.g. “Acknowledges or prompts a dialogue/discussion about their rationale or the unique way in which they have chosen to think about or approach their work” versus “Proposes to make the student do the work in the teacher’s own/preferred way”; ICC for struggling student response = .78; ICC for excelling student response = .72); the degree to which the teacher was mastery-oriented versus performance-oriented (e.g., “Emphasizes the importance of understanding course material” versus “Emphasizes the importance of getting the right answer or of not making mistakes on course work”; ICC for struggling student response = .77; ICC for excelling student

response = .83); and the degree to which the teacher expressed positivity versus negativity (e.g., “Expresses warmth, approval, encouragement, or gave positive feedback to the student” versus “Expresses frustration, annoyance, or hostility or gave negative feedback to the student”; ICC for struggling student response = .80; ICC for excelling student response = .86). See Browman et al. (under review) for more details.

Student Survey. We used three sets of variables from the Student Surveys, which we each collapsed into a score when used in analyses. Scores were based on the average of non-missing data for the scale in question. All values, unless otherwise noted, come from surveys taken roughly 1-4 weeks after the Teacher Surveys. In the pre-registration exploratory dataset, we conducted an exploratory factor analysis, using parallel analysis to determine the number of factors to extract, and found that our items measuring student perceptions about their teacher’s beliefs formed two factors.¹ In the confirmatory dataset, we found the same pattern of results.

Student Mindset

This construct was generated from three questions (all on a scale from 1 = strongly disagree to 6 = strongly agree with no neutral midpoint): “You have a certain amount of intelligence, and you really can’t do much to change it;” “Your intelligence is something about you that you can’t change very much;” and “Being a ‘math person’ or not is something that you really can’t change. Some people are good at math and other people aren’t.” Scale alpha = .80 [.79, .80].

Student Perceptions of Teacher Beliefs About Ability

This construct was generated from five questions (all on a scale from 1 = extremely true to 5 = not at all true): “My math teacher seems to believe that only a few students will

¹ In both the exploratory dataset and the confirmatory dataset, an additional item, “My math teacher thinks failure is bad and should be avoided.” did not load onto either factor, and was therefore dropped

understand the hardest problems;” “My math teacher seems to like you better if you are good at math;” “My math teacher calls you “smart” if you are good at math;” “My math teacher seems to believe that students can't really change how smart they are;” and “My math teacher thinks that some kids are smart and others are not.” Scale alpha = .74 [.73, .75].

Student Perceptions of Teacher Beliefs About Effort

This construct was generated from four questions (all on a scale from 1 = not at all true to 5 = extremely true): “My math teacher believes that everybody in my class can be very good at math;” “My math teacher thinks failure helps us learn and grow;” “My math teacher accepts nothing less than our full effort;” and “My math teacher asks questions to be sure we are following along when s/he is teaching.” Scale alpha = .69 [.68, .70].

Student Grades. Our primary DV was end of year student grade point average (standardized to a 0-4.3 scale). For those students who took the intervention in the fall semester, we used an average of their fall and spring semester GPAs, while for those students who took the intervention in the spring semester, we just used their spring-semester GPA.

Analysis Strategy

Analysis was conducted in two phases. We first categorized teachers, entering the answers from their questions into a multi-level non-parametric latent profile analysis (LPA), with teachers nested within schools (Finch & French, 2014; Henry & Muthen, 2010). This analysis allows researchers to interpret patterns in self-report data as being generated by distinct underlying latent variables, while allowing these latent variables to express themselves differently across schools. As LPA is an inherently exploratory framework where models are chosen that best fit the data, we fit multiple potential models and registered a decision rule. To

select the number of profiles to model, we first fit a series of flat LPAs (ones with no nesting) that varied in their number of profiles. Based on the fit of the flat models, we then fit multilevel non-parametric LPAs that varied in their number of profiles both at Level 1 (the teacher level) and at Level 2 (the school level). To identify the best-fitting model, we selected the model with the lowest adjusted BIC (Bayesian Information Criterion), as long as each profile contained at least 10% of the sample. If the model with the lowest aBIC did not generate profiles that each contained at least 10% of the sample, we selected the model with the next highest aBIC, etc.

After identifying the best-fitting model, we then interpreted the profiles, classifying them as true growth mindset theorists, false growth mindset theorists, or entity theorists, based on their patterns of results. We created a dummy variable for teacher mindset, with 1 = false growth mindset and 0 = true growth mindset (those teachers with an entity theory were excluded from the dummy).

Once profiles had been categorized, we collapsed students across their intervention condition, first fitting a multilevel regression predicting students' final grades from the teacher mindset dummy described above, with a random intercept for math classroom, to determine whether students in classes where their teacher had a false growth mindset ended up with worse end-of-semester grades than those students in classes where their teachers had a true growth mindset.

We then followed-up by testing whether the impact of teacher false growth mindset was stronger on students with lower grades in the previous semester, by fitting a multilevel regression predicting students' final grades from the teacher mindset dummy interacted with students' prior-semester grades, with a random intercept for math classroom.

Finally, to look at psychological process, we fit a 2-(1, 1, 1)-1 multilevel structural equation model with random slopes (Stride, Gardner, Catley, & Thomas, 2015; Preacher, Zhang, & Zyphur, 2011; Preacher, Zyphur, & Zhang, 2010). We modeled a level-2 (classroom) manifest independent variable (the teacher mindset dummy) predicting three level-1 (student-level) mediating manifest variables: students' time-2 beliefs about their teacher's growth mindset; students' time-2 beliefs about their teacher's theory of effort; and student's own time-2 mindset. Both the IV and the mediators then predicted a manifest level-1 DV: students' end of semester grades. For all the paths from the level-1 mediators, we fit both random slopes and random intercepts. Code for the model can be found at https://osf.io/8tvc5/?view_only=87d1b260a5994cd4bc863b2ef2680d36. We additionally tried to fit a matching 2-(1, 1, 1)-1 model with moderation by prior-semester grades, but the model would not converge. All LPA and SEM models were run in MPlus 8, while all data cleaning and regression models were run using R 3.6.0. All multilevel models were conducted using the *lme4* and *lmerTest* packages, with *p*-values calculated using Satterthwaite-approximated degrees of freedom (Kuznetsova, Brockhoff, & Christensen, 2017).

Results

Confirmatory Analyses

Profile Analysis. Using the full complement of teacher measures and data from 305 teachers within 61 schools, we initially fit flat (un-nested) models that ranged from 2 profiles all the way to 8 profiles. Based on the fit statistics of the flat models, we then fit a set of multilevel nonparametric models with 2 to 5 Level-1 (teacher) profiles and 1 to 5 Level-2 (school) profiles. Based on the aBIC and coverage of the profiles, we settled on a solution with three Level-1

profiles and one Level-2 profile. See Table 1 for profile fit solutions, and see Figure 1 for a graphical representation of the final profile solution.

Figure 1. Final profiles from non-parametric multi-level latent profile analysis.

Teachers belonging to Profile 1 (most likely containing 117 teachers, or 38% of the sample) *strongly* agreed with the statement that people could grow their ability, and that any student had the intellectual potential to do well at the highest level of college mathematics. This group was more likely to praise the efforts of successful students while, at the same time, being less likely to push them to try harder challenges. Coding of the teachers' free responses about what they would say to the struggling and successful students suggested that these teachers were also more likely to respond in more authoritarian fashion to struggling students: demanding that they do things the way that the teacher wanted and being less likely to acknowledge the student's way of seeing the world or approaching the class problems; while tending towards strong positivity in their messages to the succeeding students. In other words, these teachers showed

some variant of a false growth mindset: believing that students can grow their ability and that anyone had the potential to succeed, but focusing more on students' effort, and less on helping students find strategies that work for them.

Teachers belonging to Profile 2 (most likely containing 120 teachers, or 39% of the sample) were more measured in their growth mindset beliefs, agreeing that people could grow their abilities, but not unreservedly. These teachers were less likely to praise the effort of succeeding students, and provided feedback that was more empathetic and more supportive of each student's individual needs and worldviews. These teachers, in other words, planned on providing the necessary behavioral support for success, not just slogans or good intentions.

Teachers belonging to Profile 3 (most likely containing 68 teachers, or 22% of the sample) tended to believe that one's intelligence is fixed, that being a top math student is the sort of thing that cannot be taught, and that success in math requires talent, not just hard work. These teachers were also more likely to believe that teaching itself is something that requires talent, and that really great teachers are born, not made. In short, these teachers reported beliefs that ability is fixed both for students and for themselves and their fellow teachers. These teachers also provided a wide range of free responses to both the struggling and succeeding students, underlining the heterogeneity that can underly the fixed mindset.

Perhaps interestingly, teachers did not differ across profiles in their self-reported classroom practices. Teachers from all three profiles appeared to be equally likely to allow students to resubmit work, or to agree that it slowed down their class to let lower achievers ask questions. We return to this point in our Discussion.

Therefore, based on the pattern of results, we classified those teachers belonging to Profile 1 as possessing false growth mindset theories; those teachers belonging to Profile 2 as

possessing true growth mindset theories; and those teachers belonging to Profile 3 as possessing entity theories.

We additionally ran sets of models with a more restricted number of self-report items, using just questions referring to hypothetical students, and to just questions referring to hypothetical failing students, but we found that the best-fitting models for those specifications were harder to theoretically interpret. See the Online Supplement for those fit statistics and profile solutions.

Regressions. After settling on a profile solution, we put those profiles to predictive work. Using data from 5453 students nested within 139 teachers (those student and teacher pairs for which we were able to uniquely match classrooms, and for whom we had student grade data available), we did not find evidence that students with teachers holding false growth mindsets had lower end-of-year grades than those students with teachers holding true growth mindsets, False $M = 2.46$ [2.31, 2.62]; True $M = 2.56$ [2.41, 2.72], $b = -.10$ [-.31, .12], $t(128.55) = -0.91$, $p = .37$, $d = -0.079$ [-0.13, 0.24]. We additionally (using data from 1403 students nested within 30 teachers - the difference in sample size comes as a function of missing administrative data for prior-year grades) found no evidence that the effect of teacher mindset on student grades was different based on students' prior-semester grades, interaction $b = 0.0002$ [-0.06, .06], $t(1399) = 0.009$, $p = .99$.

Structural Equation Models. Using data from 4905 students nested within 138 teachers, we found that a teacher holding a false growth mindset predicted an increase in time-2 student entity-theory beliefs (a path), $b = 0.21$ [0.056, 0.36], $p = .007$; and an increase in student entity-theory beliefs predicted a decrease in end-of-year grades (b path), combined Level-1 & mean Level-2 $b = -1.73$ [-2.94, -0.52], $p = .005$; overall indirect effect = -0.36 [-0.70, -0.014], $p =$

.041. While we did find that students with teachers that had a false growth mindset were less likely to think that their teacher had a growth mindset about ability, $b = -0.12 [-0.24, -.002]$, $p = .046$, we did not find evidence for mediation of teacher false growth mindset to end-of-year student grades through student beliefs about their teacher's theories of ability, indirect effect = $0.18 [-0.14, 0.51]$, $p = .27$; nor through student beliefs about their teacher's theories of effort, indirect effect = $0.70 [-0.24, 0.10]$, $p = .41$. See Figure 2 for a simplified path diagram, and see https://osf.io/edj64/?view_only=87d1b260a5994cd4bc863b2ef2680d36 for the full model output.

Figure 2. Simplified output for 2-(1,1,1) Structural Equation Model.

Italics indicate combined Level-1 and Level-2 effects. Brackets contain 95% confidence intervals; * $p < .05$, ** $p < .01$.

Exploratory Analyses

Alternate tests of mediation. To further check the results of the multilevel SEM, we ran an additional set of mediational models outside of an SEM framework, testing whether changes in student entity theories mediated the effect of teacher false growth mindset on end-of-year student grades without taking student beliefs about their teacher's theories of effort and intelligence into account. Using the *mediation* package in R (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014), we fit a mediational model with random intercepts for classroom (excluding the random slopes because the package cannot yet handle models of that type) on data from 4,914 students nested within 138 teachers (the sample differs from the SEM models due to missingness in the beliefs about teacher effort and ability theories), and found evidence that student entity theories did still mediate the relationship: teacher false growth mindset predicted student entity theory (*a* path): $b = 0.19 [0.043, .34]$, $t(123.48) = 2.53$, $p = .013$; and, controlling for teacher mindset, student entity theory predicted end-of-year grades (*b* path): $b = -0.14 [-0.17, -.012]$, $t(4875.41) = -10.65$, $p < .001$; average causal mediation effect = $-0.026 [-0.050, -0.010]$, $p = .01$.

Finally, as an attempt to suss out the causal direction of the effect - whether teachers with a false growth mindset changed the mindsets of their students, or whether classrooms full of students with entity theories led to teachers adopting false growth mindsets of their own, we fit a model predicting student's time-2 entity theories from their time-1 entity theories (measured at the beginning of the semester, 1-4 weeks before the time-2 survey) and the teacher mindset dummy.

Using data from 4,880 students nested within 138 classrooms, controlling for students' time-1 mindsets and with a random intercept for classroom, teacher false growth mindset marginally predicted students' time-2 mindsets (*a* path): $b = 0.075 [-0.010, .16]$, $t(117.70) = 1.73$, $p = .087$. Controlling for time-1 student and teacher mindsets, however, time-2 student

mindsets still predicted end-of-year grades (*b* path): $b = -0.13 [-0.16, -0.093]$, $t(4795.85) = -7.71$, $p < .001$. The effect of time-1 student mindsets on end-of-year grades, controlling for teacher mindset and time-2 student mindsets was far weaker: $b = -0.035 [-0.069, -0.0011]$, $t(4798.46) = -2.02$, $p = .044$). The overall indirect effect for the mediation of teacher mindset predicting end-of-year grades through time-2 student mindset, controlling for time-1 student mindset, was marginally significant: average causal mediation effect = $-0.0094 [-0.021, 0.00]$, $p = .062$.

Alternate grade specifications. We then re-ran these models looking just at students' end-of-year math GPA (calculated in the same way as our end-of-year measure above). Our results were largely consistent. As with total end-of-year GPA, we found no direct effect of teacher mindset on student grades (5542 students nested within 140 teachers): $b = -0.091 [-.31, .13]$, $t(128.02) = -0.82$, $p = .41$; and no moderation by prior GPA (1423 students nested within 32 teachers): $b = -0.0024 [-0.059, 0.063]$, $t(1418.08) = 0.077$, $p = .94$. In our SEM models (4592 students nested within 139 teachers), we again found evidence for a significant indirect effect for teacher mindset predicting student grades through student entity theorizing: $-0.32 [-0.64, -0.054]$, $p = .048$, while finding no significant evidence for an indirect effect through either measure of student perceptions of their teachers. Finally, in a causal mediation framework, we again found evidence for the mediating effects of student entity theorizing on the relationship between teacher mindset and end-of-year math grades (5002 students nested within 139 teachers): average causal mediation effect = $-0.025 [-0.048, 0.00]$, $p = .028$.

Full details are reported in the Online Supplement, as are two additional sets of analyses that use alternate end-of-year grade specifications: one set of models that uses just total spring GPA for all students, and another set that used total spring GPA where it was available, imputing in the mixed spring/fall total GPA from the main analysis where it was not. Our point estimates

and p -values change somewhat, mainly as a function of fluctuating sample size (the two alternate grade measures correlate with the original measure at $r(5689) = .968$ [.965, .969], $p < .001$ for just the spring GPA; and $r(6781) = .973$ [.972, .975], $p < .001$ for the spring/imputed GPA), but the conclusions we take away largely do not.

Comparison of true growth mindset theorists with entity theorists. As a robustness-check for the profile analysis, we ran an additional set of models comparing teachers classified as true growth mindset theorists with teachers classified as entity theorists. While we found no main effect of teacher mindset on end-of-year student grades ($b = 0.069$ [-0.22, 0.36], $t(96.21) = 0.47$, $p = .64$, using 3950 students nested within 101 teachers), we found results consistent with theory (using 3605 students nested within 103 teachers), where teachers with true growth mindsets were directionally less likely to endorse entity theories at time-2 (a path): $b = -0.19$ [-0.39, 0.0081], $t(82.30) = -1.88$, $p = .064$; and students with stronger entity theories (controlling for teacher mindset) had lower end-of-year GPA (b path): $b = -0.15$ [-0.18, -0.12], $t(3577.13) = -9.26$, $p < .001$; with an overall indirect effect of teacher true growth mindset predicting end-of-year GPA mediated through student mindset that was marginally significant: average causal mediation effect = 0.028 [-0.00078, 0.06], $p = .056$. See Online Supplement for full results, including SEM models.

Comparing student mindsets across teacher profiles. Finally, we compared student entity theories at time-2 across the three profiles. Using 6,133 students nested within 170 teachers, we ran a one-way ANOVA with a random intercept for classroom, and found that students nested within the three teacher mindset profiles differed significantly: $F(2, 141.79) = 3.48$, $p = .034$. Follow-up uncorrected pairwise tests (Maxwell & Delaney, 2004) showed that students in classrooms where their teacher had a true growth mindset ($M = 2.58$, $SD = 1.18$)

endorsed entity beliefs significantly less than students in classrooms where their teacher had a false growth mindset ($M = 2.78$, $SD = 1.22$): $b = -0.19$ $[-0.38, -0.0081]$, $z = -2.44$, $p = .015$; and students where their teacher had a true growth mindset endorsed entity beliefs marginally less than students in classrooms where their teacher had an entity theory ($M = 2.73$, $SD = 1.16$): $b = -0.19$ $[-0.42, 0.046]$, $z = -1.88$, $p = .060$. There was no difference between students in classrooms where their teachers held false growth mindsets versus those where their teachers held entity theories: $b = 0.0046$ $[-0.23, 0.24]$, $z = 0.046$, $p = .96$. See Figure 3.

Figure 3. Student endorsement of entity theories of intelligence by the mindset profile of their teacher. Error bars indicate 95% confidence intervals.

Discussion

In a set of preregistered analyses, using data from a large nationally-representative sample of public-school 9th grade mathematics classes, we find that misunderstandings about growth mindsets are surprisingly common among teachers, and that these misunderstandings have consequences for student beliefs and outcomes. Growth mindset interventions teach that people can improve their abilities through hard work, the use of good strategies, and a willingness to ask for help. A casual misunderstanding of the message, however, may omit the last two elements, leaving holders of such a “false growth mindset” with a sort of bumper-sticker version - that anyone can improve anything, as long as they simply try hard enough (and that, therefore, if someone isn’t getting better, they’re simply not trying hard enough).

We identified three profiles of belief among teachers (the content of which did not differ across schools), with 22% subscribing to entity theories (characterized by a belief that intelligence and ability is fixed), 39% subscribing to a true growth mindset (characterized by a belief that most students can improve their abilities paired with strategy-supportive practices), and 38% subscribing to a false growth mindset (characterized by an unreserved belief that everyone has the ability to succeed, but with a tendency towards praising success and imposing strategies on students instead of working with them to figure out what strategies would work best for them).

Student experiences differed based on the beliefs of their teachers. Compared to students with teachers holding true growth mindsets, those students in a classroom with a teacher holding a false growth mindset were more likely, a month or so into the semester, to identify that teacher as having entity theories of ability, and were more likely to hold an entity theory of their own abilities. These beliefs about their own abilities predicted lower end-of-year grades, mediating the link between teacher beliefs and student outcomes. In exploratory follow-up analyses, we

found that the endorsement of entity theories among students with teachers holding false growth mindsets was essentially equivalent to those among students with teachers holding entity theories.

If anything, these findings may under-represent the psychological effect that teacher mindsets may have on their students (as with the lack of mediation through perceived teacher ability beliefs). Student beliefs were measured fairly early in the semester, usually within the first month or so, and therefore there was only a limited amount of time for teacher beliefs and practices to have an impact at that point.

We did not find support for all of our hypotheses, however. We had predicted that our effects would be stronger for students who had a worse academic record in the prior semester, as teachers with a false growth mindset would be more likely to blame them for their failures to improve. Unexpectedly, however, we were missing a large proportion of prior-semester grades in our sample (roughly $\frac{3}{4}$ of the students in our sample did not have prior-semester grades reported), and those that did have prior-semester grades reported did differ significantly from those that did not, as end-of-semester grades were significantly higher among those who did have prior-semester grades reported than those who did not: $t(3249.1) = 5.45, p < .001, d = 0.15$ [0.09, 0.20]. These compositional differences, plus the radically-reduced sample-size (only 30 teachers) may have prevented us from identifying effects.

We also did not find evidence for main-effects of teacher mindset on student outcomes. This, excitingly, suggests that there may be additional benefits for teachers holding false growth mindsets that we were unable to capture with our chosen measures. It may be that emphasizing effort actually helps some students out, providing motivation that was otherwise lacking, or that

the effects of a false growth mindset are moderated by context (e.g. Walton & Yeager, in press). Further probing this suppressor effect is a clear future direction for this line of work.

Finally, while we did find that students with teachers holding a false growth mindset were more likely to think that the teacher had fixed beliefs about abilities than students with teachers holding a true growth mindset, we did not find any differences in our effort variable. Students may have trouble accessing their teachers' beliefs directly, and may instead be inferring those beliefs from their teachers' actions (e.g. Park et al., 2016), actions that they may not have had all that much experience with, given the earliness in the semester when they were surveyed.

Beyond these limitations of our analyses, we note one primary, unavoidable issue: that we were unable to directly measure a false growth mindset, relying instead on an inferred proxy. The profiles that we identified do differ from each other in meaningful ways, but as with factor analysis, for example, it is we, the researchers, who are post-hoc interpreting the psychological roots of these differences. While we identified and labeled the profiles prior to the regression and SEM phase of our analyses, and while our profiles do largely act in a predictable way (with teachers classified as possessing a true growth mindset inculcating a stronger growth mindset in their students than those teachers classified as entity theorists, for example), they are nevertheless dependent on the set of questions selected for analysis, and may not represent true sets of beliefs in the broader population. Looking more deeply at teacher false-mindset beliefs, with a psychometrically-validated tool designed for the purpose, therefore, is a clear need (see Buttrick, Silverman, & Wormington, in prep, for such a scale).

We expected, for example, that our mindset profiles would differ in their reported practices. However, these did not appear to be delineating variables, with all teachers endorsing similar approaches in their teaching, and there was similarly relatively little difference across our

profiles in how teachers reported that they would address a student struggling in their classroom. In both cases, we may be dealing with an issue of “cheap talk,” where teachers find it easier to think about their teaching-self in the abstract, without having to deal with the concrete everyday, where they may not be able to live up to their ideals (e.g. Thompson, 1984). It is costless to tell researchers about the more-intensive teaching practices one would like to do, but it may be far harder to put them into practice, with all the real-world tradeoffs that inevitably ensue. It may be instructive, then, that we appeared to see greater differentiation in the coding of the free-responses to the students, where the teacher had to generate responses themselves, without experimenter-cued answers to fall back upon.

The distinction between talk and action highlights an area for further research. Recent studies suggest that the transmission of mindsets from authority figures to learners may be more complicated than originally theorized, and that the mindsets of authorities don’t always predict the mindsets of learners (e.g. Park et al., 2016; see Haimowitz & Dweck, 2017 for a review). It may be that what a teacher personally believes and the actions that they take in the classroom don’t always line up; that they fail to connect abstract beliefs with motivational practices. In one qualitative study, for example, it was shown that four teachers, who all equally endorsed growth-mindset beliefs, had practices which often diverged from their self-reported beliefs, and that their students, therefore, were receiving very mixed messages (Sun, 2019). This discrepancy between what one professes and what one does may be explained through a more holistic approach to understanding growth mindset beliefs, and that those with a false growth mindset, focusing on effort, may be setting up classrooms differently from those with a true growth mindset, focusing more on strategy use. While we found no such differences in this study, a properly observational approach, looking at what teachers *do*, rather than what they *say*, may prove useful.

This issue marks the importance for mindset educators to focus on intervention fidelity (e.g. Hulleman & Cordray, 2009; Murrah, Kosovich, & Hulleman, 2017; O'Donnell, 2008). The vast majority of teachers in this study would certainly self-identify as having a growth mindset, but as the analyses show, precisely how that mindset is comprised and instantiated has very different repercussions for students. Those teachers classified as holding a false growth mindset have students who look very similar to those teachers endorsing an entity theory, and look very different from those holding a true growth mindset. In a set of related findings, researchers have shown that what one takes away from a growth mindset intervention alters its effects: those who interpret a growth mindset as involving effort alone showing no improvement in end-of-year grades relative to a control while those who interpret a growth mindset as involving flexible strategy use and a willingness to ask for help do show improvement (Wormington, under review); and that those who get a traditional growth mindset intervention are more likely to victim-blame than controls while those who get a revised intervention, that focuses more on strategy use, are not (Buttrick et al, in prep). Now that “growth mindsets” are part of the common educational conversation, it is more important than ever that they are understood in their full nuance, and not in simplified ways that elide their power.

Because, ultimately, the present work leads to some troubling conclusions. Based on these results, there appear to be a large proportion of teachers who, while believing that all students can grow their abilities, are nevertheless reinforcing entity theories in their students, with potentially deleterious consequences.

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Table 1.
Fit statistics for non-parametric multi-level latent profile analyses

# of Level 1 Profiles	# of Level 2 Profiles	Parameters	LL	AIC	BIC	aBIC	Entropy	Smallest Profile Proportion
2	1	79	-9823.17	19804.33	20098.24	19847.69	0.96	0.38
2	2	81	-9823.17	19808.33	20109.68	19852.79	0.82	0
2	3	83	-9823.17	19812.33	20121.12	19857.88	0.59	0
2	4	85	-9823.17	19816.33	20132.56	19862.98	0.55	0
2	5	87	-9823.17	19820.33	20144.00	19868.08	0.68	0
3	1	106	-9698.11	19608.21	20002.57	19666.39	0.89	0.22
3	2	109	-9698.11	19614.21	20019.73	19674.03	0.55	0
3	3	112	-9698.11	19620.21	20036.89	19681.68	0.47	0
3	4	115	-9698.11	19626.21	20054.05	19689.32	0.41	0
3	5	118	-9698.11	19632.21	20071.21	19696.97	0.38	0
4	1	133	-9603.78	19473.57	19968.37	19546.56	0.92	0.079
4	2	137	-9603.78	19481.57	19991.25	19556.75	0.66	0
4	3	141	-9603.78	19489.57	20014.13	19566.95	0.92	0
4	4	145	-9603.78	19497.57	20037.01	19577.14	0.48	0
4	5	149	-9603.78	19505.57	20059.89	19587.34	0.83	0
5	1	160	-9523.52	19367.03	19962.28	19454.84	0.93	0.033
5	2	165	-9549.07	19428.15	20042.00	19518.70	0.73	0
5	3	170	-9523.52	19387.03	20019.49	19480.33	0.70	0
5	4	175	-9549.07	19448.15	20099.20	19544.19	0.68	0
5	5	180	-9549.07	19458.15	20127.80	19556.93	0.86	0

Note: LL = Log-likelihood, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, aBIC = Adjusted Bayesian Information Criterion