Journal of Educational Psychology

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Online First Publication, September 3, 2020. http://dx.doi.org/10.1037/edu0000620

AMERICAN PSYCHOLOGICAL ASSOCIATION

Journal of Educational Psychology

ISSN: 0022-0663

http://dx.doi.org/10.1037/edu0000620

The Role of STEM Professors' Mindset Beliefs on Students' Anticipated Psychological Experiences and Course Interest

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Two decades of research consistently demonstrates that students' beliefs about the malleability of intelligence (also known as "mindsets") influence their motivation and academic outcomes. The current work provides a novel extension to this literature by examining how STEM *professors'* mindset beliefs can influence students'—and particularly female students'— anticipated psychological experiences and interest in those professors' courses. In 3 experiments, college students evaluated STEM courses taught by professors who espoused either fixed or growth mindset beliefs. Students' anticipated psychological experiences (i.e., fair treatment concerns, sense of belonging, evaluation concerns), anticipated course performance, and ultimately, course interest were assessed. Results revealed that, regardless of gender, students anticipated more negative psychological experiences, lower performance, and lower course interest when courses were taught by STEM professors who endorsed more fixed (vs. growth) mindset beliefs. However, consistent with an identity threat framework, the effects of STEM professors' mindset beliefs (in all studies and across all outcomes) were much larger among female students. Results suggest that professors' perceived mindset beliefs may deter students from taking the STEM courses students need in order to major in STEM.

Educational Impact and Implications Statement

Many colleges and universities aim to address the STEM pipeline by focusing on introductory STEM gateway courses—with the objective of making them more attractive and stoking students' interest in enrolling in these courses. However, students' anticipated experiences with professors in these courses may prevent students from becoming interested in these courses in the first place. In the current research, three experiments examined how STEM professors' fixed (vs. growth) mindset beliefs (i.e., beliefs that intelligence is fixed and unchangeable vs. malleable and developed) shape students' anticipated psychological experiences in these courses (i.e., their expectations for fair treatment, sense of belonging, evaluation concerns), their anticipated course performance, and ultimately, their interest in taking the STEM professors' courses. Results reveal that students anticipate more negative psychological experiences, lower performance, and report less interest in enrolling in STEM courses taught by professors who endorse fixed (vs. growth) mindset beliefs; however, these effects were moderated by student gender such that the effects of faculty mindset across all studies and outcomes were 22–74% larger among female students. Results suggest that professors' growth mindsets may serve as a productive lever for increasing interest in STEM courses among college students—and especially among women.

Keywords: STEM interest, mindsets, lay theories, identity threat, professor mindsets

Supplemental materials: http://dx.doi.org/10.1037/edu0000620.supp

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This research was supported by an NSF Grant (HRD-1661004) awarded to Mary C. Murphy, Julie A. Garcia, and Sabrina Zirkel; NSF Grants (DRL-1450755 and HRD-1661004) awarded to Mary C. Murphy; and a Russell Sage Foundation Grant (87-15-02) awarded to Sabrina Zirkel, Julie A. Garcia, and Mary C. Murphy. A subset of our findings were disseminated as part of a poster presented at the Group Processes and Intergroup Relations Preconference at the 20th Annual Society for Personality and Social Psychology Convention in Portland, Oregon. It was titled: *Perceptions of Instructors' Intelligence Mindsets Elicit Identity Threat or Safety among Women in STEM*.

Data and syntax for studies reported can be found here: https://osf.io/7mkj6/.

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According to the U.S. Bureau of Labor Statistics (2018), many science, technology, engineering, and math (STEM) occupations are projected to grow at a faster rate than others. For example, from 2016 to 2026 the average rate of growth for all types of occupations is 7% on average. However, job growth in biochemistry (11%), technology (13%), and mathematics (28%) is projected to grow much faster (U.S. Bureau of Labor Statistics, 2018). Moreover, workers in these occupations are expected to earn significantly higher incomes compared to workers in non-STEM occupations. Therefore, it is more important than ever to encourage STEM interest and persistence among all students. It is particularly important to encourage women to pursue and complete degrees in STEM fields in order to build a more diverse, globally competitive, workforce (Woetzel et al., 2015). Unfortunately, the current state of gender equity in STEM occupations suggests that we have a long way to go to bridge this gap in the United States. Recent governmental studies indicate women remain significantly underrepresented in postsecondary STEM majors (McFarland et al., 2017) and less than 42% of women choose to work in science and engineering occupations upon receiving their bachelor's degree (National Center for Science and Engineering Statistics, 2019).

The current research explores one factor that might contribute to undergraduate women's early STEM interest: their perceptions of STEM faculty's beliefs about intelligence. Specifically, we examine whether *STEM faculty's beliefs* that intelligence is either (a) fixed and unchangeable (i.e., *fixed mindset beliefs*); or (b) malleable and developed with effort and good strategies (i.e., *growth mindset beliefs*; Dweck, 1999, 2006)[1] impacts women's anticipated psychological experiences (i.e., fair treatment concerns, sense of belonging, and evaluative concerns) in the course, their anticipated performance in the course, and ultimately, their interest in taking the course.

The Influence of Faculty Beliefs and Expectations on Students' Academic Experiences

Numerous studies have demonstrated the critical role that instructors play in shaping students' psychological experiences of school at all levels of education (e.g., Hughes & Kwok, 2006; Roorda, Koomen, Spilt, & Oort, 2011; Wentzel, 1998, 2009). In particular, instructors' expectations for students impact the way students think about themselves, as well as their anticipated and actual course performance (e.g., Babad, 2009; Rubie-Davies, 2010; Timmermans, van der Werf, & Rubie-Davies, 2019). For instance, research indicates that when professors judge students' academic abilities to be lacking—and thus have low expectations for students—these beliefs and expectations often lead to a self-fulfilling prophecy in which those students perceived to be lacking ability actually end up performing poorly even if their objective abilities are not weak (i.e., pygmalion effects; Raudenbush, 1984; Rosenthal & Jacobson, 1968). In the context of STEM, students who perceive that their STEM professors believe in their abilities are much more likely to choose STEM majors during their first year of college (Lee, Min, & Mamerow, 2015).

Relevant to the current work, instructors' expectations for students can differ from instructor to instructor and are often based on instructors' personal beliefs about their students' abilities to perform well in their class, as well as students' personal characteristics (e.g., gender, race, or social class; Raudenbush, 1984; Rosenthal & Jacobson, 1968; Rubie-Davies, 2010; Weinstein, 2002). For example, teacher expectation effects tend to be stronger for women in STEM contexts than men in those same contexts (Betz & Sekaquaptewa, 2012). Combined with research indicating that people who endorse fixed mindsets have a higher tendency to stereotype others (Levy, Stroessner, & Dweck, 1998), this suggest that instructors who are perceived to endorse fixed (vs. growth) mindsets may negatively impact the psychological experiences of women in STEM more so than men in STEM—a point to which we later return.

The Role of Others' Mindset Beliefs

How might college faculty's mindset beliefs influence students' outcomes? A large literature reveals that when students personally endorse fixed mindset beliefs, these beliefs negatively impact their motivation and performance (for a review, see Dweck, 2006). However, in order to be successful in school, students also attend to what their teachers and instructors say and do in class (e.g., Cornelius-White, 2007; Davis, 2003; Ryan & Patrick, 2001; Sakiz, Pape, & Hoy, 2012). When faculty communicate fixed mindset beliefs, they communicate that they believe intelligence is fixed and students either have ability or they do not. These kinds of beliefs about intelligence may be threatening and demotivating to all students who wish to be viewed positively and perform well in college. On the other hand, perceiving faculty to endorse more growth mindset beliefs may motivate all students to learn and develop because these beliefs communicate that there are pathways to success—that all students, regardless of ability level, can grow their ability through effort, persistence, adopting good learning strategies, and seeking help.

Correlational research on faculty's *self-reported* mindset beliefs indicates that these beliefs are associated with students' academic motivation and performance (Canning, Muenks, Green, & Murphy, 2019; De Kraker-Pauw, Van Wesel, Krabbendam, & Van Atteveldt, 2017; Leslie, Cimpian, Meyer, & Freeland, 2015; Rattan, Good, & Dweck, 2012). For example, instructors who self-report more fixed (vs. growth) mindset beliefs are more likely to use demotivating teaching strategies that reduced students' classroom engagement (Rattan et al., 2012) and are less likely to emphasize individual improvement when grading (De Kraker-Pauw et al., 2017). Similarly, in a university-wide longitudinal study, Canning, Muenks, Green, and Murphy (2019) found that students reported being less motivated to do their best work, performed worse, and were less likely to recommend STEM professors who self-reported more fixed mindset beliefs. It is also worth noting that, in addition to faculty's self-reported fixed-growth beliefs, students' perceptions of professors' other lay theories also affect their experiences in academic contexts. In a series of experimental studies, Rattan, Good, and Dweck (2012) found that STEM students reported lower belonging in courses taught by

[1] It is worth noting that historically, many terms have been used to refer to people's beliefs about the fixedness or malleability of intelligence, including "implicit theories of intelligence" (Dweck, Hong, & Chiu, 1993), "lay theories of intelligence" (Dweck & Master, 2009), and "fixed and growth mindsets of intelligence" (Dweck, 2006). In the present work, we use the term "fixed and growth mindsets of intelligence" to be consistent with Dweck (2006) and to precisely refer to people's beliefs about the fixedness or malleability of intelligence.

faculty who endorsed the belief that *only a few* can reach the highest levels of success in STEM (termed a nonuniversal metatheory) compared with courses taught by faculty who endorsed the belief that *everyone* can reach the highest levels of success in STEM (termed a universal metatheory).

Taken together, this research indicates that the self-reported mindset beliefs of faculty can impact their current students' motivation and academic achievement, with fixed beliefs associated with more negative student outcomes. Missing from this body of work is a direct examination of the psychological effects of STEM faculty's fixed-growth mindset beliefs among students who are not yet majoring in or pursuing advanced degrees in STEM. That is no research to our knowledge has examined how faculty mindset beliefs shape students' anticipated psychological experiences and course interest—and whether these effects are larger for female (vs. male) students.

Fixed Faculty Mindsets as a Cue to Threat Among Women in STEM

Although the aforementioned research suggests that faculty's fixed mindset beliefs can be associated with negative psychological experiences and academic outcomes among all students, there is reason to believe that faculty's fixed mindset beliefs may be particularly threatening for *women* in STEM (e.g., Canning et al., 2019; Emerson & Murphy, 2015; Good, Rattan, & Dweck, 2012; Leslie et al., 2015; Rattan et al., 2018). For example, Emerson and Murphy (2015) found that businesses whose management endorsed more fixed (vs. growth) mindset beliefs engendered greater mistrust and disengagement among women than men. Consistent with these gender findings, Good and colleagues (2012) found that when students believed that their math classmates endorsed more fixed (vs. growth) mindset beliefs, it reduced women's sense of belonging in math (but not men's), which in turn reduced women's interest in taking future math courses. Moreover, a correlational field study by Leslie, Cimpian, Meyer, and Freeland (2015) found that when faculty, postdocs, and graduate students in an academic discipline reported that brilliance was required for success in their field, fewer female doctoral-level students were enrolled in their graduate programs.

Our research draws on social identity threat theory and the cues hypothesis (Murphy, Steele, & Gross, 2007; Murphy & Taylor, 2011; Steele, Spencer, & Aronson, 2002) to theorize and empirically examine why faculty mindset beliefs may serve as a threatening situational cue for women who are prospectively evaluating different STEM courses. Social identity threat theory contends that stigmatized individuals (e.g., women and racial minority students) are vigilant for situational cues in the environment that signal that their identity could be a source of stigma or unfair treatment (Fogliati & Bussey, 2013; Nussbaum & Steele, 2007; Steele & Aronson, 1995; Steele et al., 2002). According to the cues hypothesis (Murphy et al., 2007; Murphy & Taylor, 2011), when environments contain identity threatening cues, these cues engender psychological concerns among stigmatized individuals regarding how they will be perceived and treated in a setting; these psychological concerns in turn interfere with motivation, interest, and performance (Emerson & Murphy, 2014; Murphy et al., 2007; Sekaquaptewa & Thompson, 2002, 2003).

We theorize that professors' fixed mindset beliefs may act as a situational cue to threat for women in STEM because widely held cultural stereotypes impugn women's natural talent and ability in STEM (e.g., Nosek, Banaji, & Greenwald, 2002). If a professor believes that STEM ability is *fixed*—some students naturally "have" this ability while others do not—American cultural stereotypes suggest that it is men (not women) who are more naturally gifted in STEM. Thus, we expected that fixed faculty mindsets would more negatively impact women's anticipated psychological experiences and interest in STEM courses compared with men's.

Consequences of Threat

This research focused on three outcomes theorized to follow from professors' fixed (vs. growth) mindset beliefs. Specifically, we examined students' (a) anticipated psychological experiences in the professor's class, (b) their anticipated performance in the class, and ultimately (c) their interest in taking the course. When identifying which psychological experiences to assess, we chose to focus on students' expectations about being treated fairly, their anticipated sense of belonging, and their concerns about being evaluated because these psychological experiences have all been linked in previous research to students' anticipated course performance and their interest in taking particular courses (e.g., Hausmann, Schofield, & Woods, 2007; O'Keefe, 2013; Patrick, Ryan, & Kaplan, 2007; Rodabaugh & Kravitz, 1994). For example, regardless of gender, when students believe they will not be treated fairly by their professor they exhibit less motivation to learn course material and they perform worse than students who expect fair treatment (Rodabaugh & Kravitz, 1994; Walsh & Maffei, 1994; Young, Horan, & Frisby, 2013). In addition, when students experience evaluative concerns, they are more likely to engage in avoidance behaviors (for reviews see O'Keefe, 2013; Zeidner & Matthews, 2005). Finally, sense of belonging is associated with higher levels of academic engagement, motivation, and persistence for all students regardless of their group membership (Battistich, Solomon, Watson, & Schaps, 1997; Hausmann et al., 2007; Patrick et al., 2007; Sánchez, Colón, & Esparza, 2005).

Central to our identity threat hypotheses, these specific psychological constructs are also negatively affected by identity threatening situational cues among women in various STEM settings (Cheryan, Plaut, Davies, & Steele, 2009; Emerson & Murphy, 2015; Murphy et al., 2007; Rice, Montfort, Ray, Davis, & DeBlaere, 2019; Steele & Ambady, 2006). For example, female STEM faculty at research-focused universities report being treated less fairly than their non-STEM peers (Blackwell, Snyder, & Mavriplis, 2009). Moreover, in the organizational mindset research mentioned above, fixed (vs. growth) mindset organizations engendered greater evaluative concerns among women compared with men (Emerson & Murphy, 2015). Indeed, women's concerns about being viewed as less competent in STEM negatively impact their STEM interest and performance (e.g., Sekaquaptewa & Thompson, 2003; Spencer, Steele, & Quinn, 1999). Similarly, women in STEM environments that contain other identity threatening cues (e.g., environments that are dominated by men, hostile toward women, or stereotypically male) report lower sense of belonging, which in turn dampens women's STEM interest and performance (Cheryan, Meltzoff, & Kim, 2011; Cheryan et al., 2009; Good et

al., 2012; LaCosse, Sekaquaptewa, & Bennett, 2016; McPherson, Banchefsky, & Park, 2018).

The Current Work

Taken together, extant research suggests that all students—regardless of their gender—might anticipate more negative psychological experiences and lower interest in courses taught by STEM faculty who endorse fixed (vs. growth) mindset beliefs. However, the identity threat literature (e.g., Cheryan et al., 2011; LaCosse et al., 2016; Murphy et al., 2007; Smith, Lewis, Hawthorne, & Hodges, 2013) and previous research on professors' and organizations' fixed (vs. growth) mindsets and other kinds of metalay theories (Canning et al., 2019; Emerson & Murphy, 2015; Good et al., 2012; Rattan et al., 2018) suggests that in STEM settings, women might experience more negative psychological consequences of professors' mindset beliefs relative to men. To test these questions, three studies manipulated STEM professors' mindset beliefs and examined the effects of these beliefs on students' fair treatment concerns, their sense of belonging, their evaluative concerns, their anticipated course performance, and ultimately, their interest in taking these professors' courses at all.

Finally, across all studies, we test our hypotheses among a broad swath of college students—not just those already majoring in STEM—in order to examine the idea that fixed faculty mindsets may deter students from STEM courses that could help them develop greater interest in STEM and send them along STEM pathways in college. Specifically, we focus on the early stages of the "leaky pipeline" for students in STEM—particularly for women in STEM—that is, we focus on people's anticipated psychological experiences when they are initially appraising different STEM courses (Study 1) and deciding whether they would likely stay in them after the first day (Studies 2 and 3). Participants in all three studies were currently enrolled or previously enrolled college students and were thus familiar with the process of choosing courses, as well as what to expect on the first day of class. We did not require students to currently be enrolled in STEM majors or courses because we were interested in the *recruitment* of students to STEM rather than the *retention* of students in STEM. That is to say, we were interested the psychological processes that stoke or deter students' motivation and interest in STEM, which can often be different from those related to retaining students in STEM and encouraging them to continue in STEM following graduation (Drury, Siy, & Cheryan, 2011; Mattern, Radnusel, & Westrick, 2015; Valian, 2004).

We chose to focus on the domain of STEM and the role of STEM faculty's mindset beliefs on students' anticipated psychological experiences in STEM courses because most college students must take at least some STEM courses to complete their degree, regardless of their intended major (Malcom & Feder, 2016; Mattern et al., 2015; Melega, 2020; Rajan, 2020). Moreover, once students decide to major in STEM must take many more STEM courses to graduate with a STEM degree (Malcom & Feder, 2016). Therefore, examining how students initially appraise STEM professors and courses offers valuable insight into the potential recruitment or repulsion of students into (or away from) STEM college settings. Examining students' early appraisal processes and their impact on STEM interest is valuable because it may help explain why women may decide not to pursue STEM majors or courses early on in their academic careers. Therefore, the present work extends past theory and research by examining a novel and early potential source of the leaky pipeline (Oakes, 1990; Riley, Cortines, & Forgione, 1997) as men and women forecast their psychological experiences and gauge their initial interest in STEM courses taught by fixed (vs. growth) mindset faculty.

We hypothesized that in the context of faculty's fixed (vs. growth) mindset beliefs, both men and women would report greater fair treatment concerns, lower sense of belonging, and greater evaluative concerns as they worry that they could be perceived and judged as someone who simply does not have the innate ability that fixed mindset professors prize. That is, fixed faculty mindset beliefs were hypothesized to pose a threat to college students' goals to be seen as smart, capable, and competent by their professors. We also predicted that students' anticipated psychological experiences would mediate the effect of professors' mindsets on students' anticipated course performance and their actual interest in taking the course. Finally, consistent with social identity threat theory and the cues hypothesis, we predicted that both the direct and indirect effects of fixed (vs. growth) faculty mindset beliefs would be significantly larger among female students compared to male students.

Overall, this research makes several novel contributions to the lay theories and identity threat literatures. First, we examine how faculty's fixed-growth mindset beliefs shape students' anticipated psychological experiences and interest in STEM classes (rather than examining the effects of faculty's self-reported mindset beliefs on their current students' in-class experiences). Second, we experimentally investigate multiple psychological processes through which faculty mindset beliefs may shape students' course outcomes. Third, we examine whether fixed faculty mindsets might serve as a cue to identity threat among women who are considering different STEM courses. Specifically, we test whether the effects of faculty's fixed (vs. growth) mindset beliefs are moderated by student gender and are larger for women relative to men. To our knowledge, this is the first research to directly test this theoretical proposition in this context.

Study 1

Study 1 was designed as an initial pilot study that examined the role of faculty mindset in the context of STEM professor rating systems. Specifically, we examined our faculty mindset hypotheses among students prospectively evaluating their anticipated psychological experiences and interest in STEM courses. College students read brief course reviews modeled from popular publicly available professor rating websites. We chose to use professor reviews because students frequently base their course choices on such reviews (Diaz, 2018; Grabarek, 2019; Hum, 2019; Wingate, 2019). Moreover, students judge information obtained on professor rating websites to be just as reliable as information from their friends and family, demonstrating how much stock students put into the information provided in such reviews (Hayes & Prus, 2014). Overall, this suggests that information about professors conveyed in student reviews seems to inform students' perceptions of the professor and the classes they teach, which impacts students' course choices. Given how early STEM course taking is critical to the STEM pipeline (Sass, 2015), examining students' perceptions of professors based on student reviews is both ecologically valid and practically important. We predicted that both male and female students would report greater fair treatment concerns, lower sense of belonging, greater evaluative concerns, lower

anticipated performance in STEM classes taught by the fixed (vs. growth) mindset professor, and less interest in taking those courses. However, because women's abilities in STEM are impugned by negative cultural stereotypes (Eccles, Jacobs, & Harold, 1990; Jacobs & Eccles, 1985; Nosek et al., 2002; Swim, 1994), we predicted that these effects would be moderated by student gender, such that the threat elicited by the fixed (vs. growth) mindset professor would be significantly greater among college women (vs. men).

Method

Participants. One-hundred and seventy-two college undergraduates participated in this study in exchange for course credit. Sample size was determined before analyses by recruiting as many students as possible from an introductory psychology study pool during one academic semester. Fourteen students (seven men, four women, three unreported gender) failed a multiple-choice an attention check item at the end of the study that asked students "Thank you for completing our survey to the best of your ability. This is an attention check. Please select the option 'online instructors' from those listed below" (see Oppenheimer, Meyvis, & Davidenko, 2009 for a discussion about why such attention checks improve statistical power and precision within experiments) and one student reported their gender as "other"; these students were removed from all analyses. No other exclusions were made. Thus, the final sample included 157 students (88 men, 69 women) who self-identified as White (77.1%), African American (7.6%), Asian/Pacific Islander (5.1%), Latino (2.5%), Mixed Race (3.2%), "other" (3.8%; six students did not report their race/ethnicity) and whose average age was 19.54 years (SD = 1.20). To ensure that we had adequate power to detect effects, we performed a sensitivity analysis using G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007) to obtain an estimate of the smallest detectable effect size given our sample size with a power of .95, alpha of .05, four groups, three covariates, and numerator degrees of freedom of 1. Results indicated that we were adequately powered to detect effect sizes as small as d = .58. This study was approved by the Institutional Review Board at Indiana University.

Design and procedure. Study 1 employed a 2 (faculty mindset: fixed vs. growth) × 2 (participant gender: men vs. women) factorial design. Students were invited to participate in an online study that ostensibly examined how students choose professors when signing up for classes. Upon consent, students were randomly assigned to read a brief review of a Chemistry professor who had ostensibly been rated by other students. Students were provided with a photo of the professor, a list of his courses, and an average professor rating that were all held constant across conditions. Three student quotes (described below and included in the online supplemental material) served as the professor mindset manipulation. After reading the reviews, students reported their perceptions of the professor's mindset beliefs (manipulation check), their anticipated fair treatment concerns, sense of belonging, evaluative concerns, anticipated course performance, and interest in taking the course. We also measured and controlled for students' personal mindset beliefs and their math and science identification because previous research shows these beliefs influence students' metacognitive judgments, performance, and interest in STEM settings (e.g., Degol, Wang, Zhang, & Allerton, 2018; Jones, Ruff, & Osborne, 2015; Miele, Son, & Metcalfe, 2013; Spencer et al., 1999; van Aalderen-Smeets & Walma van der Molen, 2018). By controlling for these factors, we more precisely estimate the effects of professors' mindset beliefs on students' anticipated psychological experiences, performance, and course interest. Finally, to ensure that students' perceptions of their professors' mindset beliefs were not confounded with more general "positive" or "negative" perceptions of the professor we asked students to indicate the extent to which they thought the professor would be warm, likable, positive, and approachable and included these perceptions as covariates in our analyses so that we could examine whether faculty mindset continued to have an effect on students' outcomes above and beyond simply being perceived more or less positively by students.

Manipulation and measures. Across all studies, the full text of all manipulations and measures can be found in this article's online supplemental material.

Professor reviews. Held constant across the professor reviews were: a photo of the STEM professor (an older White male), a list his courses (Chemistry I, Chemistry II, and Intro to Physics), student characterizations of the professor as a "good" professor, and the average rating of the professor (4.37 out of 5). The professor's mindset was manipulated through three student quotes. These quotes were sourced from a focus group conducted with a different set of college undergraduates who described past experiences with STEM professors whom they perceived to endorse fixed or growth mindset beliefs and behaviors. For example, in the fixed mindset condition a student wrote that "*Professor Hall was a good instructor and knew that some people were going to understand and get the information and that other people were not. He never wasted time dumbing things down for people, so I was never bored.*" In the growth mindset condition a student wrote that, "*Professor Hall was a good instructor and knew that all students can improve their math and science skills, no matter who they are. He always encouraged students to ask questions and attend office hours so that they could get better during the semester.*"

Faculty mindset manipulation check. Following the professor review, students responded to four items on a six-point scale ranging from 1 (*strongly agree*) to 6 (*strongly disagree*) that assessed their perceptions of the professor's mindset beliefs adapted from Dweck's Implicit Theory of Intelligence Scale (Dweck, 1999; "Professor Hall seems to believe that people have a certain amount of intelligence, and they can't really do much to change it"). Items were averaged to create a perceived faculty mindset composite (α = .96); higher scores indicate that students perceived the professor to endorse more fixed mindset beliefs.

Positive impressions of the professor. Four items assessed students' more general impressions about the professor (α = .95). Items were rated on seven-point scales ranging from (*cold*) to (*warm*), (*unlikeable*) to (*likable*), (*negative*) to (*positive*), and (*standoffish*) to (*approachable*). Higher scores indicate more positive impressions.

Fair treatment concerns. Two items assessed students' fair treatment concerns (e.g., "I think I would be treated fairly by the professor" and "I think I would trust the professor to treat me fairly."). Items were rated on a scale ranging from 1 (*strongly disagree*) to 8 (*strongly agree*) and averaged to create a fair treatment concerns composite (r = .90); higher scores indicate greater fair treatment concerns.

Sense of belonging. Four items assessed the extent to which students anticipated sense of belonging in the professor's class, adapted from Murphy, Steele, and Gross (2007; e.g., "How accepted would you feel during this class?"). Items were rated on a scale ranging from 1 (*not at all*) to 7 (*very much*) and averaged to create an anticipated belonging composite ($\alpha = .92$); higher scores indicate greater anticipated belonging.

Evaluative concerns. Five items assessed the extent to which students anticipated evaluative concerns in the professor's course (e.g., "How much would you worry that the professor might think that you are a slow learner?"). Items were rated on a scale ranging from 1 (*not at all*) to 7 (*very much*) and were averaged to create an evaluative concerns composite ($\alpha = .90$); higher scores indicate greater evaluative concerns.

Anticipated course performance. Anticipated course performance was assessed by asking students to respond to the item "How well do you think you would perform in a class taught by Professor Hall?" rated on a scale ranging from 1 (*worst*) to 9 (*best*); higher scores indicate greater anticipated performance.

Course interest. Three items assessed students' interest in taking a course taught by the professor (e.g., "How interested would you be in taking a class taught by Professor Hall?"). Items were rated on a scale ranging from 1 (*not at all*) to 6 (*extremely*) and averaged to create a course interest composite ($\alpha = .96$); higher scores indicate greater course interest.

Students' personal mindset (covariate). Students' personal mindset beliefs were assessed with four items adapted from Dweck (1999; e.g., "In general, I believe that people have a certain amount of intelligence, and they can't really do much to change it"). Items were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*) and averaged to create a personal mindset composite ($\alpha = .88$); higher scores indicate greater fixed mindset beliefs. We planned to control for students' personal mindset beliefs to observe the effect of faculty mindset above and beyond students' personal beliefs about ability.

Math and science identification (covariate). Because this was a STEM class context and math ability is related to STEM competency beliefs, particularly among women (Vincent-Ruz, Binning, Schunn, & Grabowski, 2018), we assessed math and science identification with two items used in past research to measure domain identification among women in STEM (Lesko & Corpus, 2006; Murphy et al., 2007; Spencer et al., 1999). Items were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*) and averaged to create a math and science identification composite (i.e., "I am good at math [science] tasks" and "It is important for me to do well on math [science] tasks"); higher scores indicate greater identification ($\alpha = .71$). We planned to control for identification to observe the effect of faculty mindset above and beyond students' level of math and science identification.[2]

Results

Analytic strategy. An independent samples *t* test evaluated the faculty mindset manipulation check. For the rest of the analyses, we employed analysis of covariance (ANCOVA) with faculty mindset and students' gender as predictors and students' personal mindset beliefs, domain identification, and positive impressions of the professor as covariates. Table 1 includes descriptive statistics and correlations among all variables; Table 2 includes a summary of ANCOVA results; and Figure 1 depicts condition by gender estimated means for all dependent measures.[3] Finally, although the results remain the same, Table S1 in the online supplemental material provides model results without covariates for interested readers.

Faculty mindset manipulation check. Results revealed that the faculty mindset manipulation was perceived as intended. A *t* test revealed a significant effect of faulty mindset, $t(155) = 21.80$, $p < .001$, $d = .80$, such that the fixed mindset professor ($M = 4.65$, $SD = .88$) was perceived to endorse more fixed mindset beliefs than the growth mindset professor ($M = 1.85$, $SD = .72$).

Fair treatment concerns. ANCOVA revealed a significant main effect of faculty mindset, such that students expected that they would have significantly more concerns about being treated fairly when the course was taught by a fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.62$, $SE_{\text{Fixed}} = .19$ vs. $M_{\text{Growth}} = 3.05$, $SE_{\text{Growth}} = .18$), $F(1, 149) = 3.36$, $p = .069$, $d = .30$. The main effect of student gender was not significant ($M_{\text{Males}} = 3.21$, $SE_{\text{Males}} = .13$; $M_{\text{Females}} = 3.45$, $SE_{\text{Females}} = .15$), $F(1, 149) = 1.37$, $p = .243$, $d = .19$, and the interaction between the professor's mindset and gender was not significant, $F(1, 149) = 1.78$, $p = .184$, $d = .22$. However, women had significantly more concerns about being treated fairly when the course was taught by the fixed (vs. growth) mindset professor; this difference was not significant among men ($M_{\text{Females-Fixed}} = 3.87$, $SE_{\text{Females-Fixed}} = .26$, $M_{\text{Females-Growth}} = 3.03$, $SE_{\text{Females-Growth}} = .24$), $F(1, 149) = 4.78$, $p = .030$, $d = .36$, versus ($M_{\text{Males-Fixed}} = 3.36$, $SE_{\text{Males-Fixed}} = .22$, $M_{\text{Males-Growth}} = 3.07$, $SE_{\text{Males-Growth}} = .23$), $F(1, 149) = .67$, $p = .416$, $d = .13$.

Sense of belonging. ANCOVA revealed that students did not reliably differ in sense of belonging in the fixed (vs. growth) mindset professor's course ($M_{\text{Fixed}} = 3.89$, $SE_{\text{Fixed}} = .16$ vs. $M_{\text{Growth}} = 4.41$, $SE_{\text{Growth}} = .16$), $F(1, 149) = 4.00$, $p = .047$, $d = .33$). Although men reported significantly more belonging in the class than did women ($M_{\text{Males}} = 4.46$, $SE_{\text{Males}} = .11$; $M_{\text{Females}} = 3.83$, $SE_{\text{Females}} = .13$), $F(1, 149) = 13.48$, $p < .001$, $d = .60$, the interaction between professor mindset and student gender was not significant, $F(1, 149 = .08$ $p = .777$, $d = .06$, suggesting that effect of professor mindset on students' anticipated belonging was

[2] As an initial pilot study, we included additional measures for exploratory purposes. Specifically, we asked students to indicate other more general perceptions of the professor by responding to a series of characteristics (e.g., smart, arrogant, etc.), how positively or negatively they thought the professor would think of them, and their perceptions of the professor's attributional style (dependent variables). We also assessed students' general self-reported achievement goals in STEM classes, students' estimates of their ability in different types of classes (e.g., chemistry, music, English), and the number of math and science versus social science and humanities course they took during and after high school (as exploratory covariates and correlates). Across all of these measures, the interaction between faculty mindset condition and student gender was not significant and there was only a main effect of professor mindset on two of these measures (professor's perceived positive and negative impressions). Because they were exploratory, these measures were not assessed in Studies 2–3. All other measures and manipulations are reported.

[3] Given the number of analyses performed in each study, we replicated all analyses with Bonferroni corrections. Statistical significance and effect sizes remained the same in the Bonferroni-corrected analyses as those reported in the main text.

Table 1
Study 1 Correlations Among Measures

Measure	*M* (*SD*)	1	2	3	4	5	6	7	8
1. Perceived professor fixed mindset	3.26 (1.61)	—							
2. Fair treatment concerns	3.31 (1.83)	.72***	—						
3. Sense of belonging	4.18 (1.47)	−.64***	−.71***	—					
4. Evaluative concerns	3.62 (1.53)	.55***	.57***	−.75***	—				
5. Anticipated course performance	6.21 (1.78)	−.56***	−.60***	.63***	−.55***	—			
6. Course interest	3.49 (1.49)	−.73***	−.70***	.66***	−.54***	.67***	—		
7. Students' personal fixed mindset covariate	3.15 (1.05)	.12	−.02	−.10	.04	−.01	.04	—	
8. Math and science identification covariate	4.19 (.88)	−.01	−.03	.15	−.10	.19*	.05	−.19*	—
9. Positive impression of instructor covariate	4.83 (1.65)	−.81***	−.73***	.65***	−.55***	.55***	.75***	<.01	.02

* $p < .05$. *** $p < .001$.

similar in magnitude among men and women ($M_{\text{Males-Fixed}} = 4.18$, $SE_{\text{Males-Fixed}} = .19$, $M_{\text{Males-Growth}} = 4.75$, $SE_{\text{Males-Growth}} = .19$), $F(1, 149) = 3.58$, $p = .060$, $d = -.31$, versus ($M_{\text{Females-Fixed}} = 3.59$, $SE_{\text{Females-Fixed}} = .22$, $M_{\text{Females-Growth}} = 4.07$, $SE_{\text{Females-Growth}} = .20$), $F(1, 149) = 2.11$, $p = .148$, $d = -.24$.

Evaluative concerns. ANCOVA revealed that students anticipated significantly more evaluative concerns in courses taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.15$, $SE_{\text{Fixed}} = .17$ vs. $M_{\text{Growth}} = 3.20$, $SE_{\text{Growth}} = .17$), $F(1, 149) = 10.87$, $p = .001$, $d = .54$. In addition, men reported significantly fewer evaluative concerns than did women ($M_{\text{Males}} = 3.23$, $SE_{\text{Males}} = .13$; $M_{\text{Females}} = 4.12$, $SE_{\text{Females}} = .14$), $F(1, 149) = 21.83$, $p < .001$; $d = .77$. The interaction between the professor's mindset beliefs and student gender was also significant, $F(1, 149) = 5.22$, $p = .024$, $d = .38$. Women anticipated significantly more evaluative concerns when the course was taught by the fixed (vs. growth) mindset professor; however, this difference was not significant among men ($M_{\text{Females-Fixed}} = 4.82$, $SE_{\text{Females-Fixed}} = .24$, $M_{\text{Females-Growth}} = 3.42$, $SE_{\text{Females-Growth}} = .22$), $F(1, 149) = 14.98$, $p < .001$, $d = .63$, versus ($M_{\text{Males-Fixed}} = 3.49$, $SE_{\text{Males-Fixed}} = .20$, $M_{\text{Males-Growth}} = 2.98$, $SE_{\text{Males-Growth}} = .21$), $F(1, 149) = 2.36$, $p = .127$, $d = .26$.

Anticipated course performance. ANCOVA revealed that students anticipated performing significantly worse in the fixed (vs. growth) mindset professor's course ($M_{\text{Fixed}} = 5.62$, $SE_{\text{Fixed}} = .21$ vs. $M_{\text{Growth}} = 6.70$, $SE_{\text{Growth}} = .21$), $F(1, 145) = 9.58$, $p = .002$, $d = .51$. In addition, men expected to perform significantly better in the course than did women ($M_{\text{Males}} = 6.51$, $SE_{\text{Males}} = .15$ vs. $M_{\text{Females}} = 5.82$, $SE_{\text{Females}} = .17$), $F(1, 145) = 9.09$, $p = .003$, $d = .50$. There was also a significant interaction between the professor's mindset beliefs and student gender, $F(1, 149) = 5.91$, $p = .016$, $d = .40$, such that women expected to perform significantly worse in the fixed (vs. growth) mindset professor's course; however, this difference was not significant among men ($M_{\text{Females-Fixed}} = 5.00$, $SE_{\text{Females-Fixed}} = .29$, $M_{\text{Females-Growth}} = 6.64$, $SE_{\text{Females-Growth}} = .26$), $F(1, 145 = 14.48, p < .001, d = -.63$, versus $M_{\text{Males-Fixed}} = 6.25, SE_{\text{Males-Fixed}} = .24, M_{\text{Males-Growth}} = 6.77$, $SE_{\text{Males-Growth}} = .26$), $F(1, 145) = 1.65$, $p = .201$, $d = -.21$.

Course interest. ANCOVA revealed that students reported significantly less interest in taking a course taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.04$, $SE_{\text{Fixed}} = .14$ vs. $M_{\text{Growth}} = 3.91$, $SE_{\text{Growth}} = .14$), $F(1, 149) = 13.61$, $p < .001$, $d = .61$. There was no main effect of student gender, $F(1, 149) = .29$, $p = .593$, $d = .09$, ($M_{\text{Males}} = 3.52$, $SE_{\text{Males}} = .10$; $M_{\text{Females}} = 3.43$, $SE_{\text{Females}} = .12$). However, the interaction between professor mindset and student gender was significant, $F(1, 149) = 9.28$, $p = .003$; $d = .50$. Women were significantly less interested in taking the fixed (vs. growth) mindset professor's course; however, this difference was not significant among men ($M_{\text{Females-Fixed}} = 2.76$, $SE_{\text{Females-Fixed}} = .19$, $M_{\text{Females-Growth}} = 4.10$, $SE_{\text{Females-Growth}} = .18$), $F(1, 149) = 21.09$, $p < .001$, $d = -.75$, versus ($M_{\text{Males-Fixed}} = 3.32$, $SE_{\text{Males-Fixed}} = .17$, $M_{\text{Males-Growth}} = 3.71$, $SE_{\text{Males-Growth}} = .17$), $F(1, 149) = 2.06$, $p = .153$, $d = -.24$.

Discussion

Study 1 provides initial support for the prediction that STEM faculty's mindset beliefs can shape students' anticipated psychological experiences, performance, and course interest. As evidenced by consistent main effects of faculty mindset; students expected to be treated less fairly and anticipated more evaluative concerns in courses taught by the fixed (vs. growth) mindset professor. Finally, students anticipated performing significantly worse in the fixed (vs. growth) mindset professor's course and reported less interest in taking such a course. These novel findings suggest that when students anticipate that faculty believe intelligence is fixed and unchangeable it may engender threat and sap their interest in taking that professor's class, whereas when students anticipate that faculty believe intelligence is malleable and can be developed, these psychological and motivational effects are mitigated. These initial findings are important because they suggest that faculty mindset beliefs, as communicated by other students in a common and externally valid way (via online course reviews), may directly lower students' interest in taking STEM courses—a serious consequence if we want to encourage more students to consider and begin STEM coursework and college majors.

Study 1 also supported the identity threat prediction that women may be particularly vulnerable to the threat engendered by STEM faculty's fixed mindset beliefs. Although we found main effects of faculty mindset, these effects were qualified by student gender, such that women, but not men, reliably anticipated more negative psychological experiences, lower performance, and were less interested in taking the professor's course. The only exceptions were fair treatment concerns and sense of belonging. For fair treatment concerns, the interaction between gender and condition was not significant; however, women (but not men) reported significantly more concerns about being treated fairly by the fixed (vs. growth) mindset professor. The

Table 2
Study 1 Summary of ANCOVA Analyses

Dependent variable	Main effect of condition (fixed vs. growth mindset professor)			Main effect of gender			Condition × Gender interaction			Personal mindset beliefs covariate			Math identification covariate			General, positive impressions of the professor covariate		
	F	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*
Fair treatment concerns	3.36	.069	.30	1.37	.243	−.19	1.78	.184	.22	.12	.725	.06	.42	.516	.11	55.98	<.001	1.23
Sense of belonging	4.00	.047	−.33	13.48	<.001	.60	.08	.777	.06	1.74	.189	.22	3.85	.052	.32	34.56	<.001	.96
Evaluative concerns	10.87	.001	.54	21.83	<.001	−.77	5.22	.024	.38	.62	.432	.13	1.49	.224	.20	12.06	.001	.57
Course performance	9.58	.002	−.51	9.09	.003	.50	5.91	.016	.40	.03	.853	<.01	7.75	.006	.46	11.61	.001	.57
Course interest	13.61	<.001	−.61	.29	.593	.09	9.28	.003	.50	.71	.400	.14	1.63	.204	.21	48.01	<.001	1.14

Note. Fixed faculty mindset condition $n = 78$. Growth faculty mindset condition $n = 78$.

lack of gender differences by condition for sense of belonging is somewhat surprising given that women often experience more concerns about belonging in STEM relative to men (Murphy & Taylor, 2011; Steele et al., 2002). We speculate that this null interaction may be due to the nature of the manipulation. Information about the professor's beliefs came from male *and female* students who had ostensibly taken courses with the professor—and these reviews were relatively positive. Reading that other women students experienced the course positively, despite the professor's fixed mindset beliefs, may have abated some of the belonging concerns engendered by the professor's mindset beliefs (though women, like men, still anticipated more belonging in the course overall when it was taught by the growth—compared with the fixed—mindset professor). To address this potential issue, Study 2 conceptually replicated the faculty mindset effects using a new manipulation of faculty mindset beliefs wherein these beliefs were communicated directly to students by the professor himself.

Study 2

Study 2 had two primary goals. The first was to conceptually replicate the results of Study 1 using a different and more direct manipulation of a STEM professor's mindset beliefs wherein the professor communicated his beliefs to students directly (rather than via former students in an online course review setting). Specifically, we manipulated a STEM professor's mindset (fixed vs. growth) beliefs through a videotaped "first day of class" lecture in which the professor reviewed the course syllabus and communicated his mindset beliefs throughout. We chose this manipulation because most professors review the syllabus on the first day of class (Iannarelli, Bardsley, & Foote, 2010; Quora, 2016) and college students report wanting professors to do so (Eskine & Hammer, 2017; Perlman & McCann, 1999). Although, for external validity, it might have been ideal to have participants view a live professor reviewing their syllabus in person, it would have been almost impossible to ensure—in the context of a controlled experiment—that a professor (confederate) could convey the same information in exactly the same way for each individual participant. For this reason, and to respect the professor's limited time, we opted to use a videotaped lecture rather than a live, in person, lecture to keep all extraneous features consistent while only varying the mindset language between experimental conditions.

If we replicated Study 1's effects with this new manipulation, we planned to explore whether students' anticipated threat experiences (i.e., fair treatment concerns, sense of belonging, and evaluative concerns) mediated students' anticipated course performance and course interest. Moreover, we wanted to examine whether these processes were larger for women relative to men. Therefore, we planned to conduct moderated mediation analyses to examine these identity threat process effects.

Method

Participants. Three-hundred and forty-six college-aged Mechanical Turk workers were recruited for participation. We specified the workers' age (18–25 years old) because we wanted the study topic (evaluating college courses) to be rele-

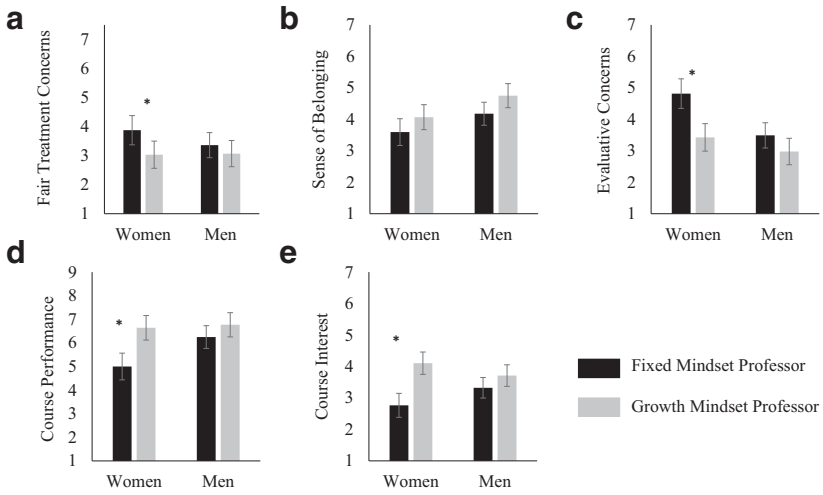

Figure 1. a–e. Study 1 faculty mindset condition comparisons by gender. Values are for students with average math and science identification ($M = 4.20$), average personal mindset endorsement ($M = 3.15$), and average positive impressions of the professor ($M = 4.84$). Error bars represent 95% confidence intervals. * $p < .05$.

vant to participants' life stage. This sample size was determined before any analyses were performed. Eighty-six participants (39 women; 47 men) were excluded from analyses because they failed the attention check question embedded in the belonging and fair treatment measures that asked "I think I am paying attention, so I'll select moderately disagree" (Oppenheimer et al., 2009). No other exclusions were made. Thus, our final sample consisted of 260 participants (102 men, 158 women) who self-identified as White (47%), African American/Black (19.4%), Hispanic (12.9%), Indian Subcontinent (12.5%), Southeast Asian (3.9%), East Asian (3.4%), Pacific Islander (0.9%), Native American (0.4%), Middle Eastern (0.4%), or Multiracial (10.8%); and who were, on average, 23.05 ($SD = 2.18$) years old. Consistent with our intentions to study a population with college course-taking experience, 96% of participants reported attending college classes in their lifetime. Eighty-six percent of the sample were currently enrolled as undergraduate or graduate students at the time of the study and 9% reported that they had already completed their undergraduate education. As in Study 1, we performed a sensitivity analysis to examine the minimal detectable effect size given the final sample size with a power of .95, alpha of .05, four groups, two covariates, and a numerator degrees of freedom of 2. Results of this analysis indicated that we were powered to detect effect sizes as small as $d = .49$. This study was approved by the Institutional Review Board at Indiana University.

Design and procedure. As in Study 1, we employed a 2 (faculty mindset: fixed vs. growth) × 2 (participant gender: men vs. women) factorial design. Participants were invited to engage in an online study evaluating college courses. They read a brief course description of a college calculus course (that was held constant across conditions) and were told that they would be watching a short video clip ostensibly filmed on the first day of class. We created these videos such that the exact same actor (an older White male) read several sections of his syllabus that communicated his fixed or growth mindset beliefs. For example, in one part of the video, the professor discussed what it takes to do well in the class. In the fixed mindset condition, the professor emphasized that, in his experience, successful students are those with fixed, innate ability ("*You either know the concepts and have the skills, or you don't*"); while in the growth mindset condition, the professor emphasized that, in his experience, successful students are those who put forth lots of effort and persist through challenges ("*With hard work, anyone can succeed in this class"*; the full course descriptions and video scripts are provided in the online supplemental material). After watching the video, participants evaluated the professor and their expectations for how they would experience the professor's course. Finally, participants completed measures of their personal mindset beliefs, their math identification (because the course was a calculus course), and their demographic characteristics.

Measures. The manipulation check measure (perceived faculty mindset beliefs; $\alpha = .90$), the dependent measures (fair treatment concerns, $r = .84$; sense of belonging, $\alpha = .89$; evaluative concerns, $\alpha = .93$; and course interest, $\alpha = .95$), and participants' personal mindset beliefs (covariate; $\alpha = .78$) were assessed with the same scales as in Study 1. We assessed anticipated course performance with three new items (e.g., "I think I would get a good grade in this class") that were less interpersonally comparative than the item used in Study 1 which had asked students to report how they thought they would perform relative to others (e.g., worst to best). These new items simply asked students to report their own anticipated performance (without comparing it with others) and were rated on a scale ranging from 1 (*strongly disagree*) to 8 (*strongly agree*). These items were averaged to create an anticipated course performance composite ($\alpha = .78$); higher scores indicate higher anticipated performance. Finally, because participants were asked to evaluate a math course (calcu-

lus), we only used the two math identification items from Study 1 (r = .63) as a covariate.[4]

Results

Analytic strategy. As in Study 1, an independent samples t test evaluated the faculty mindset manipulation check. For the remaining analyses, we employed analysis of covariance (ANCOVA) with faculty mindset and students' gender as predictors and students' personal mindset beliefs and domain identification as covariates. Table 3 includes descriptive statistics and correlations among all variables; Table 4 includes a summary of ANCOVA results; and Figure 2 depicts faculty mindset by gender estimated means for all dependent measures. For interested readers, Table S2 in the online supplemental material reports results without covariates; although the results did not differ from those reported here.

Faculty mindset manipulation check. Results revealed a significant effect of faculty mindset, $t(258) = 12.72$, $p < .001$, $d = 1.04$, such that the fixed mindset professor ($M = 3.94$, $SD = 1.06$) was perceived to endorse more fixed mindset beliefs than the growth mindset professor ($M = 2.30$, $SD = 1.02$).

Fair treatment concerns. ANCOVA revealed there was a significant main effect of faculty mindset, such that students anticipated having significantly more concerns about being treated fairly by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.90$, $SE_{\text{Fixed}} = .14$; $M_{\text{Growth}} = 2.71$, $SE_{\text{Growth}} = .14$), $F(1, 254) = 36.69$, $p < .001$, $d = .76$. Although there was no main effect of gender, $F(1, 254) = 2.06$, $p = .152$, $d = .18$, ($M_{\text{Males}} = 3.44$, $SE_{\text{Males}} = .15$; $M_{\text{Females}} = 3.16$, $SE_{\text{Females}} = .12$), the interaction was significant, $F(1, 254) = 4.08$, $p = .044$, $d = .26$ (see Figure 2a). Simple effects tests revealed that both men and women expected to have more fair treatment concerns in a course taught by the fixed (vs. growth) mindset professor; however, this effect was 47% larger among women ($M_{\text{Males-Fixed}} = 3.84$, $SE_{\text{Males-Fixed}} = .22$, $M_{\text{Males-Growth}} = 3.05$, $SE_{\text{Males-Growth}} = .21$), $F(1, 254) = 6.69$, $p = .010$, $d = .33$, versus ($M_{\text{Females-Fixed}} = 3.95$, $SE_{\text{Females-Fixed}} = .17$, $M_{\text{Females-Growth}} = 3.36$, $SE_{\text{Females-Growth}} = .18$), $F(1, 254) = 41.00$, $p < .001$, $d = .80$.

Sense of belonging. ANCOVA revealed that students anticipated significantly less belonging in the course when it was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.87$, $SE_{\text{Fixed}} = .11$; $M_{\text{Growth}} = 4.92$, $SE_{\text{Growth}} = .11$), $F(1, 254) = 46.03$, $p < .001$, $d = .85$. There was no main effect of gender, $F(1, 254) = 2.71$, $p = .101$, $d = .21$, ($M_{\text{Males}} = 4.53$, $SE_{\text{Males}} = .12$; $M_{\text{Females}} = 4.27$, $SE_{\text{Females}} = .10$); however, the interaction was significant, $F(1, 254) = 11.05$, $p = .001$, $d = .42$ (see Figure 2b). Simple effects tests revealed that both men and women anticipated less belonging when the course was taught by the fixed (vs. growth) mindset professor; however, this effect was 73% larger among women ($M_{\text{Males-Fixed}} = 4.26$, $SE_{\text{Males-Fixed}} = .18$, $M_{\text{Males-Growth}} = 4.79$, $SE_{\text{Males-Growth}} = .17$), $F(1, 254) = 4.89$, $p = .028$, $d = -.28$, versus ($M_{\text{Females-Fixed}} = 3.49$, $SE_{\text{Females-Fixed}} = .14$, $M_{\text{Females-Growth}} = 5.05$, $SE_{\text{Females-Growth}} = .14$), $F(1, 254) = 64.27$, $p < .001$, $d = -1.01$.

Evaluative concerns. ANCOVA revealed that students anticipated significantly more evaluative concerns when the course was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.56$, $SE_{\text{Fixed}} = .13$; $M_{\text{Growth}} = 3.29$, $SE_{\text{Growth}} = .12$), $F(1, 254) = 51.39$, $p < .001$, $d = .90$. Although the main effect of gender was not significant, men reported fewer evaluative concerns in the calculus class than did women overall ($M_{\text{Males}} = 3.76$, $SE_{\text{Males}} = .14$; $M_{\text{Females}} = 4.09$, $SE_{\text{Females}} = .11$), $F(1, 254) = 3.56$, $p = .060$, $d = .24$. The interaction between professor mindset and gender was also significant, $F(1, 254) = 9.02$, $p = .003$, $d = .38$ (see Figure 2c). Both men and women expected to have more evaluative concerns when the course was taught by the fixed (vs. growth) mindset professor; however, this effect was 68% larger among women ($M_{\text{Males-Fixed}} = 4.12$, $SE_{\text{Males-Fixed}} = .20$, $M_{\text{Males-Growth}} = 3.39$, $SE_{\text{Males-Growth}} = .19$), $F(1, 254) = 7.10$, $p = .008$, $d = .33$, versus ($M_{\text{Females-Fixed}} = 4.99$, $SE_{\text{Females-Fixed}} = .16$, $M_{\text{Females-Growth}} = 3.19$, $SE_{\text{Females-Growth}} = .16$), $F(1, 254) = 65.04$, $p < .001$, $d = 1.01$.

Anticipated course performance. ANCOVA revealed that students anticipated significantly worse performance when the course was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.68$, $SE_{\text{Fixed}} = .12$; $M_{\text{Growth}} = 5.99$, $SE_{\text{Growth}} = .12$), $F(1, 254) = 57.65$, $p < .001$, $d = .95$. Men and women did not significantly differ in their anticipated course performance overall ($M_{\text{Males}} = 5.39$, $SE_{\text{Males}} = .14$; $M_{\text{Females}} = 5.27$, $SE_{\text{Females}} = .11$), $F(1, 254) = .50$, $p = .480$, $d = .09$, and the interaction between student gender and the professor's mindset was significant, $F(1, 254) = 10.58$, $p = .001$, $d = .40$ (see Figure 2e). Simple effects tests revealed that both men and women expected to perform significantly worse in the calculus course when it was taught by the fixed (vs. growth) mindset professor; however, this effect was 73% larger among women ($M_{\text{Males-Fixed}} = 5.02$, $SE_{\text{Males-Fixed}} = .20$, $M_{\text{Males-Growth}} = 5.77$, $SE_{\text{Males-Growth}} = .19$), $F(1, 254) = 7.71$, $p = .006$, $d = -.35$, versus ($M_{\text{Females-Fixed}} = 4.33$, $SE_{\text{Females-Fixed}} = .15$, $M_{\text{Females-Growth}} = 6.21$, $SE_{\text{Females-Growth}} = .16$), $F(1, 254) = 73.94$, $p < .001$, $d = -1.08$.

Course interest. ANCOVA revealed that students were significantly less interested in taking the calculus course when it was taught by fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.03$, $SE_{\text{Fixed}} = .11$; $M_{\text{Growth}} = 4.25$, $SE_{\text{Growth}} = .11$), $F(1, 254) = 60.14$, $p < .001$, $d = .97$. Men and women did not significantly differ in course interest ($M_{\text{Males}} = 3.65$, $SE_{\text{Males}} = .12$; $M_{\text{Females}} = 3.63$, $SE_{\text{Females}} = .10$), $F(1, 254) = .02$, $p = .889$, $d < .01$.

[4] Participants also completed measures of science identification, verbal task identification, and perceptions that the professor endorsed racial stereotypes; however, we did not include them in analyses since they are outside the scope of the current work. No other measures or manipulations were included in this study. To examine whether the fixed and growth mindset videos may have differed on potentially confounding dimensions of person-perception (Fiske, Cuddy, & Glick, 2007), we asked an independent sample of students (N = 151) to rate the professor in the videos on the two primary person-perception dimensions of competence and warmth (Fiske et al., 2007; competence: intelligent, capable, competent; warmth: warm, friendly, likeable). We also measured the extent to which students trusted the professor and perceived him to be authentic (i.e., I would trust this professor; I think this professor was being authentic). Results revealed that none of the competence perceptions, nor trust and authenticity perceptions, $t(149) = 1.74$, $p = .083$ and $t(149) = 1.17$, $p = .243$, respectively, varied by faculty mindset condition, $t(149) < 1.18$; $p > .240$. Of the warmth perceptions, "likeable" did not differ by condition, $t(149) = 1.76$, $p = .080$; however, the other perceptions related to the dimension of warmth (i.e., "warm" and "friendly") did, $t(149) = 4.33$, $p < .001$ and $t(149) = 4.87$, $p < .001$, respectively. Given these results, it is improbable that the faculty mindset condition differences we find are driven by these alternative perceptions.

Table 3
Study 2 Correlations Among Measures

Measure	*M* (*SD*)	1	2	3	4	5	6	7
1. Perceived professor fixed mindset	3.11 (1.32)	—						
2. Fair treatment concerns	3.27 (1.72)	.53***	—					
3. Sense of belonging	4.36 (1.45)	−.41***	−.64***	—				
4. Evaluative concerns	3.97 (1.64)	.60***	.48***	−.50***	—			
5. Anticipated course performance	5.31 (1.68)	−.51***	−.66***	.73***	−.67**	—		
6. Course interest	3.63 (1.45)	−.44***	−.67***	.77***	−.42***	.66***	—	
7. Students' personal mindset beliefs covariate	2.73 (.99)	.24***	−.12†	−.02	.23**	−.11†	−.02	—
8. Math identification covariate	4.49 (1.23)	−.04	−.20**	.34***	−.20**	.39***	.25***	−.01

† $p < .10$. ** $p < .01$. *** $p < .001$.

However, the interaction was significant, $F(1, 254) = 5.69$, $p = .018$, $d = .30$ (see Figure 2d), such that both men and women were less interested in taking the course when it was taught by the fixed (vs. growth) mindset professor; but this effect was 58% larger among women ($M_{\text{Males-Fixed}} = 3.23$, $SE_{\text{Males-Fixed}} = .18$, $M_{\text{Males-Growth}} = 4.07$, $SE_{\text{Males-Growth}} = .17$), $F(1, 254) = 11.84$; $p = .001$, $d = -.43$, versus ($M_{\text{Females-Fixed}} = 2.83$, $SE_{\text{Females-Fixed}} = .14$, $M_{\text{Females-Growth}} = 4.43$, $SE_{\text{Females-Growth}} = .14$), $F(1, 254) = 64.60$; $p < .001$, $d = -1.01$.

Moderated mediation analyses. Consistent with an identity threat hypothesis, results revealed that across all outcome variables, the professor's mindset influenced the psychological experiences, interest, and anticipated performance of women more so than men. Social identity threat theory posits that experiences of threat are likely to reduce the motivation and performance of women in STEM contexts (Murphy & Taylor, 2011; Steele et al., 2002). To examine this process directly, we conducted moderated mediation analyses to determine whether each anticipated psychological experience (i.e., fair treatment concerns, sense of belonging, and/or evaluative concerns) exerted an indirect effect on course interest and anticipated course performance—and whether this process was significantly moderated by gender (i.e., larger among women vs. men). Figure 3 depicts this theoretical model.[5]

Analyses used Model 8 of the PROCESS macro developed by Hayes (2018). That is, consistent with the interaction results above, we modeled moderation by student gender on both the a-path and c-path. Condition (0 = growth mindset professor; 1 = fixed mindset professor) and student gender (1 = female; 2 = male) were dummy coded and participants' personal mindset beliefs and math identification scores were included as covariates. See Table 5 for a summary of all moderated mediation analyses, which were performed independently of one another (six total—one for each mediator and outcome variable combination). Although the results remained the same, Table S3 in the online supplemental material reports moderated mediation results without covariates for interested readers.

Anticipated course performance. First, we examined whether students' anticipated psychological experiences mediated the effect of faculty mindset on anticipated course performance, and whether each of these indirect effects were moderated by participant gender. Results revealed evidence of significant moderated mediation when fair treatment, belonging, and evaluative concerns were mediators (see Table 5). To be more specific, when each psychological experience was independently tested, each significantly predicted course performance and the interaction between participant gender and professor mindset was no longer significant (belonging and evaluative concerns) or reduced (fair treatment concerns). Moreover, although the main effect of professor's mindset on course performance remained significant among both men and women for each mediator, the overall index of moderated mediation did not contain zero for every mediator, indicating statistically significant moderated mediation. Finally, although the indirect effect of faculty mindset on performance through each mediator was statistically significant among both men and women, the indirect effect of fair treatment was 39% larger among women, the indirect effect of belonging was 69% larger among women, and the indirect effect of evaluative concerns was 57% stronger among women.

Course interest. Finally, we examined if each of the psychological experience variables were independent mediators of the effect of faculty mindset on course interest, and whether each of these indirect effects were moderated by participant gender. Results revealed that fair treatment concerns, belonging, and evaluative concerns all significantly predicted course interest and the interaction between participant gender and professor mindset was no longer significant when each mediator was included in the models. The main effect of professor's mindset on course interest remained significant among both men and women when fair treatment concerns and evaluative concerns were mediators, but it became nonsignificant when belonging was the mediator. Moreover, the overall index of moderated mediation did not contain zero regardless of which mediator was being tested, indicating statistically significant moderated mediation. Finally, while this indirect effect of faculty mindset on course interest through each mediator was statistically significant among both men and women, the effect was significantly larger among women. Specifically, the indirect effect of fair treatment concerns on course interest was 38% larger among women, the indirect effect of belonging on course interest was 72% larger among women, and the indirect

[5] To check the robustness of our moderated mediation models, we also performed reverse moderated mediation analyses for both Study 2 and Study 3 (see Tables S4 and S7 respectively in the online supplemental material). Generally, we found that evidence for significant reverse moderated mediation was mixed across outcomes and studies. However, these results should be interpreted with caution given that course performance and course interest were measured after fair treatment concerns, sense of belonging, and evaluative concerns and are conceptually considered downstream outcomes of the psychological effects (see Fiedler, Harris, & Schott, 2018 and Thoemmes, 2015 for why reverse mediation analyses should be interpreted with caution).

Table 4
Study 2 Summary of ANCOVA Analyses

Dependent variable	Main effect of condition (fixed vs. growth mindset professor)			Main effect of gender			Condition × Gender interaction			Personal fixed mindset covariate			Math identification covariate		
	F	*p*	*d*	*F*	*p*	*d*	*F*	*P*	*d*	*F*	*p*	*d*	*F*	*p*	*d*
Fair treatment concerns	36.69	<.001	.76	2.06	.152	−.18	4.08	.044	.26	1.28	.259	.14	11.46	.001	.42
Sense of belonging	46.03	<.001	−.85	2.71	.101	.21	11.05	.001	.42	.43	.511	.09	32.98	<.001	.72
Evaluative concerns	51.39	<.001	.90	3.56	.060	−.24	9.02	.003	.38	10.89	.001	.41	7.99	.005	.35
Course performance	57.65	<.001	−.95	.50	.480	−.09	10.58	.001	.41	.83	.362	.11	48.55	<.001	.87
Course interest	60.14	<.001	−.97	.02	.889	<.01	5.69	.018	.30	.52	.471	.09	16.97	<.001	.52

Note. Fixed professor mindset condition $n = 129$. Growth professor mindset condition $n = 131$.

effect of evaluative concerns on course interest was 22% larger among women.

Discussion

Taken together, Study 2 replicated and extended the findings of Study 1 and provided more support for the hypothesis that STEM faculty's mindset beliefs can shape students' anticipated psychological experiences, anticipated performance, and course interest. Moreover, consistent with an identity threat framework, women expected to have more negative psychological experiences and reported less course interest when the calculus professor endorsed more fixed (vs. growth) mindset beliefs. Indeed, the detrimental effects of fixed faculty mindset beliefs were 22–73% larger among women across outcome variables.

Interestingly, unlike Study 1, the main effect of faculty mindset on sense of belonging was significant and both belonging and fair treatment concerns were significantly moderated by student gender in Study 2, such that women reported greater fair treatment concerns and lower belonging in the fixed faculty member's course than did men (though both men and women preferred the growth mindset course overall). We speculated that when female peers in Study 1 described the professor as a relatively "good" professor (regardless of his mindset beliefs), it might have credentialed the professor to women perceivers—preserving their anticipated sense of belonging an abating concerns about being treated fairly (relative to men) in the fixed mindset professor's course. We thought that when no such credential existed—when information about the professor's mindset beliefs came directly from him, it might exert a more consistently negative effect on women's outcomes. The fact that the faculty mindset cue came directly from the professor in Study 2 may also help explain why, in Study 1, men did not significantly differ in their anticipated psychological experiences and course outcomes, but in Study 2 they did.

Study 2 also extended the results of Study 1 by shedding light on the psychological processes underlying the effects of STEM faculty mindsets. When faculty communicate that they believe that intelligence is not something that can be changed, it negatively influences students' anticipated psychological experiences in the class, which in turn influences students' course performance, and course interest. Moreover, these indirect effects were 22% to 72% larger among women.

Despite the statistical significance of our moderated mediation results, it is worth noting that it has its limitations. For example, there could be an unmeasured third variable that could be driving the differences in effect sizes between women and men (e.g., perceived communal and agentic affordances in the professor's class) or additional covariates (e.g., gender identification, premanipulation STEM interest) that may also impact the results we found. Future research would benefit from directly testing these alternative possibilities and boundary conditions.

Study 3

The goal of Study 3 was to provide a direct methodological replication of Study 2. However, unlike Study 2, which included some graduate students and nonstudents, we only recruited undergraduates currently enrolled at a single university—ensuring that the course evaluation tasks were relevant and familiar to partici-

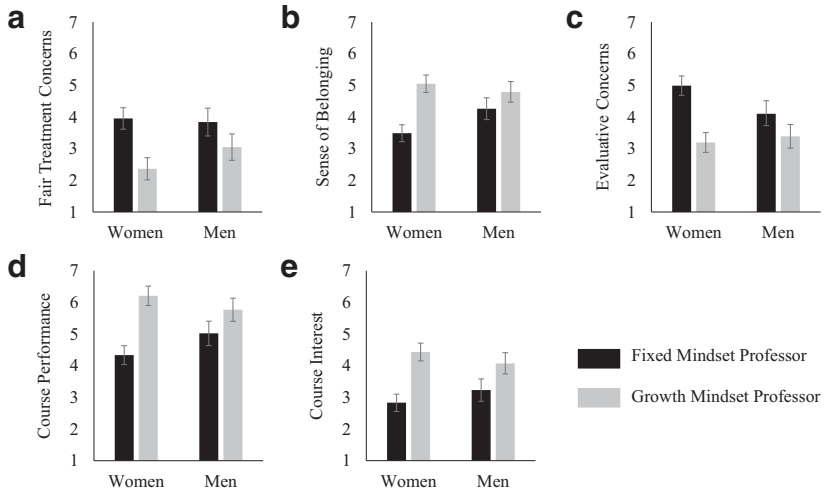

Figure 2. a–e. Study 2 faculty mindset condition comparisons by gender. Values are for students with average math identification ($M = 4.49$) and average personal mindset endorsement ($M = 2.73$). Error bars represent 95% confidence intervals. Faculty mindset condition differences for both men and women are significant at $p < .01$.

pants. Study 3's design, procedure, and measures were identical to those in Study 2.

Method

Participants. Three-hundred and forty-two undergraduates participated in exchange for course credit. Sample size was determined before performing any analyses by running as many participants as possible during a 2-week period at the end of one semester. One-hundred and thirty-four students failed the attention check—which was the same as Study 2—and one participant did not complete measures of belonging or evaluative concerns and were therefore not included in our analyses.[6] No other exclusions were made. Thus, the final sample included 206 students (109 men, 97 women) who self-identified as White (79.9%), African American (5.3%), Hispanic American (5.3%), Indian Subcontinent (1.6%), East Asian (6.3%), Southeast Asian (1.1%), or multiracial (8.3%) and whose average age was 18.17 ($SD = 4.23$) years. Using the same parameters as Study 2, we performed a sensitivity power analysis. Results indicated that we were adequately powered to detect effect sizes as small as $d = .55$. This study was approved by the Institutional Review Board at Indiana University.

Design, procedure, and measures. The study employed a 2 (faculty mindset: fixed vs. growth) × 2 (participant gender: men vs. women) factorial design. The procedure and manipulations were exactly the same as Study 2. The faculty mindset manipulation check ($\alpha = .92$), fair treatment concerns ($r = .86$), sense of belonging ($\alpha = .88$), evaluative concerns ($\alpha = .88$), anticipated course performance ($\alpha = .84$), course interest ($\alpha = .95$), students' personal mindset covariate ($\alpha = .87$), and math identification covariate ($r = .56$) measures were also identical to those in Study 2. No other measures or manipulations were used in this study.

Results

Analytic strategy. An independent samples t test evaluated the faculty mindset manipulation check. The remaining analyses employed analysis of covariance (ANCOVA) with faculty mindset and students' gender as predictors and students' personal mindset beliefs and domain identification as covariates. Table 6 includes descriptive statistics and correlations among all variables; Table 7 includes a summary of ANCOVA results; and Figure 4 depicts faculty mindset by gender estimated means for all dependent measures. Although the results remained statistically significant, interested readers can see Table S4 for a summary of results without covariates.

Faculty mindset manipulation check. Results of our manipulation check analysis revealed a significant effect of faculty mindset condition, $t(204) = 12.51$, $p < .001$, $d = 1.01$, such that the fixed mindset professor ($M = 3.98$, $SD = 1.08$) was perceived as endorsing more fixed mindset beliefs than the growth mindset professor ($M = 2.22$, $SD = .92$).

Fair treatment concerns. Consistent with Studies 1 and 2, ANCOVA revealed a significant main effect of faculty mindset beliefs on fair treatment concerns, such that students thought that they would be treated significantly less fairly by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.51$, $SE_{\text{Fixed}} = .16$; $M_{\text{Growth}} = 2.82$, $SE_{\text{Growth}} = .17$), $F(1, 200) = 50.18$, $p < .001$, $d = 1.00$). Although there was no main effect of student gender ($M_{\text{Males}} = 3.72$, $SE_{\text{Males}} = .16$; $M_{\text{Females}} = 3.62$, $SE_{\text{Females}} = .17$), $F(1, 200) = .17$, $p = .685$, $d = .06$), the interaction was significant, $F(1, 200) = 3.95$ $p = .048$, $d = .28$), (see Figure 4a). Although men and women expected to be treated less fairly by the fixed (vs. growth) mindset professor, this effect was 36% larger among women ($M_{\text{Males-Fixed}} = 4.32$, $SE_{\text{Males-Fixed}} = .22$,

[6] We suspect that our high rate of inattention is the result of the study being conducted in the last 2 weeks of the academic semester when many students are completing studies to fulfill research participation credit for their courses. Although these failure rates are not ideal, past research indicates that using an attention check increases reliability and statistical power and are particularly important to employ when attentional concerns are high (Kam & Chan, 2018; Oppenheimer et al., 2009)—such as at academic crunch times like the end of the semester.

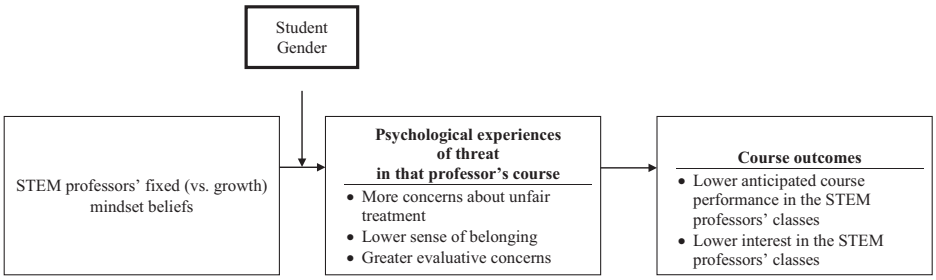

Figure 3. Theoretical model: Student gender moderates the effects of STEM professors' mindset beliefs on students' psychological experiences and course outcomes. STEM faculty who endorse more fixed (vs. growth) mindset beliefs engender threat among both male and female students, which in turn influences course outcomes; however, the amount of threat engendered by the professors' fixed versus growth mindset beliefs and its impact on students' course outcomes is theorized to be larger among women (who are negatively stereotyped in STEM) relative to men.

$M_{\text{Males-Growth}} = 3.11$, $SE_{\text{Males-Growth}} = .24$), $F(1, 200) = 13.73$, $p < .001$, $d = .52$, versus ($M_{\text{Females-Fixed}} = 4.70$, $SE_{\text{Females-Fixed}} = .24$, $M_{\text{Females-Growth}} = 2.54$, $SE_{\text{Females-Growth}} = .25$), $F(1, 200) = 38.63$, $p < .001$, $d = .88$.

Sense of belonging. ANCOVA revealed students anticipated significantly less belonging when the course was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 3.24$, $SE_{\text{Fixed}} = .11$; $M_{\text{Growth}} = 4.51$, $SE_{\text{Growth}} = .12$), $F(1, 200) = 59.12$, $p < .001$, $d = -1.09$. There was no main effect of student gender ($M_{\text{Males}} = 3.99$, $SE_{\text{Males}} = .11$; $M_{\text{Females}} = 3.77$, $SE_{\text{Females}} = .12$), $F(1, 200) = 1.77$, $p = .185$, $d = .19$; however, consistent with the Study 2 finding, the interaction was significant, $F(1, 200) = 7.78$, $p = .006$, $d = .39$ (see Figure 4b). Although both men and women anticipated lower sense of belonging when the course was taught by the fixed (vs. growth) mindset professor, this effect was 51% larger among women ($M_{\text{Males-Fixed}} = 3.58$, $SE_{\text{Males-Fixed}} = .16$, $M_{\text{Males-Growth}} = 4.39$, $SE_{\text{Males-Growth}} = .17$), $F(1, 200) = 12.66$, $p < .001$, $d = -.51$, versus ($M_{\text{Females-Fixed}} = 2.90$, $SE_{\text{Females-Fixed}} = .17$, $M_{\text{Females-Growth}} = 4.64$, $SE_{\text{Females-Growth}} = .18$), $F(1, 200) = 51.58$, $p < .001$, $d = -1.02$.

Evaluative concerns. ANCOVA revealed students anticipated significantly more evaluative concerns when the course was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.51$, $SE_{\text{Fixed}} = .13$; $M_{\text{Growth}} = 3.25$, $SE_{\text{Growth}} = .14$), $F(1, 200) = 46.24$, $p < .001$, $d = .96$. Although the main effect of gender was not significant, women anticipated more evaluative concerns in the calculus class overall than did men ($M_{\text{Females}} = 4.05$, $SE_{\text{Females}} = .14$; $M_{\text{Males}} = 3.70$, $SE_{\text{Males}} = .13$), $F(1, 200) = 3.66$, $p = .057$, $d = .27$. In addition, the interaction was significant, $F(1, 200) = 5.81$, $p = .017$, $d = .34$ (see Figure 4c). Although both men and women expected more evaluative concerns in the course taught by the fixed (vs. growth) mindset professor, this effect was 44% larger among women ($M_{\text{Males-Fixed}} = 4.10$, $SE_{\text{Males-Fixed}} = .17$, $M_{\text{Males-Growth}} = 3.29$, $SE_{\text{Males-Growth}} = .19$), $F(1, 200) = 10.16$, $p = .002$, $d = .45$, versus ($M_{\text{Females-Fixed}} = 4.91$, $SE_{\text{Females-Fixed}} = .18$, $M_{\text{Females-Growth}} = 3.20$, $SE_{\text{Females-Growth}} = .20$), $F(1, 200) = 39.85$, $p < .001$, $d = .89$.

Anticipated course performance. ANCOVA revealed that students anticipated significantly worse performance in the course when it was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 4.32$, $SE_{\text{Fixed}} = .13$; $M_{\text{Growth}} = 5.68$, $SE_{\text{Growth}} = .14$), $F(1, 200) = 49.34$, $p < .001$, $d = -.99$. There was no main effect of gender on anticipated performance overall ($M_{\text{Males}} = 5.12$, $SE_{\text{Males}} = .13$; $M_{\text{Females}} = 4.88$, $SE_{\text{Females}} = .14$), $F(1, 200) = 1.51$, $p = .220$, $d = -.18$; however, consistent with the previous studies, the interaction was significant, $F(1, 200) = 11.71$, $p = .001$, $d = .48$ (see Figure 4e). Although both men and women expected to perform more poorly when the class was taught by the fixed (vs. growth) mindset professor, this effect was 64% larger among women ($M_{\text{Males-Fixed}} = 4.77$, $SE_{\text{Males-Fixed}} = .18$, $M_{\text{Males-Growth}} = 5.47$, $SE_{\text{Males-Growth}} = .20$), $F(1, 200) = 6.81$, $p = .010$, $d = -.37$, versus ($M_{\text{Females-Fixed}} = 3.86$, $SE_{\text{Females-Fixed}} = .19$, $M_{\text{Females-Growth}} = 5.90$, $SE_{\text{Females-Growth}} = .21$), $F(1, 201) = 51.29$, $p < .001$, $d = -1.01$.

Course interest. ANCOVA revealed that students reported significantly less interest in taking the calculus course when it was taught by the fixed (vs. growth) mindset professor ($M_{\text{Fixed}} = 2.30$, $SE_{\text{Fixed}} = .11$; $M_{\text{Growth}} = 3.69$, $SE_{\text{Growth}} = .12$), $F(1, 200) = 69.02$, $p < .001$, $d = -1.18$. There was no main effect of student gender ($M_{\text{Males}} = 2.94$, $SE_{\text{Males}} = .12$; $M_{\text{Females}} = 3.05$, $SE_{\text{Females}} = .12$), $F(1, 200) = .49$, $p = .486$, $d = .09$; however, the interaction was significant, $F(1, 201) = 9.30$, $p = .003$, $d = .43$ (see Figure 4d). Although both men and women were significantly less interested in taking the course when it was taught by the fixed (vs. growth) mindset professor, this effect was 56% larger among women ($M_{\text{Males-Fixed}} = 2.50$, $SE_{\text{Males-Fixed}} = .16$, $M_{\text{Males-Growth}} = 3.38$, $SE_{\text{Males-Growth}} = .17$), $F(1, 200) = 14.58$, $p < .001$, $d = -.54$, versus ($M_{\text{Females-Fixed}} = 2.10$, $SE_{\text{Females-Fixed}} = .17$, $M_{\text{Females-Growth}} = 4.00$, $SE_{\text{Females-Growth}} = .18$), $F(1, 200) = 60.59$, $p < .001$, $d = -1.10$.

Moderated mediation analyses. Using the same specifications as Study 2, we tested for moderated mediation using Model 8 of the PROCESS macro (Hayes, 2018). Faculty mindset beliefs (0 = growth; 1 = fixed) and student gender (1 = female; 2 = male) were dummy coded, students' math identification and personal mindset beliefs were entered as covariates, and one analysis was performed for each mediator-outcome combination resulting in six independent analyses. See Table 8 for a summary of moderated mediation results and, although the results remain the same, see Table S5 for results without covariates.

Anticipated course performance. When we examined course performance as the outcome variable, we replicated Study 2's results. All three mediators significantly predicted course perfor-

Table 5
Study 2 Summary of Moderated Mediation Results

Mediator	Outcome	Relation between	Index of moderated mediation	Indirect effect	Indirect effect	Direct effect of condition with inclusion of M	Condition by gender interaction with inclusion of M	Direct effect with inclusion of M	Direct effect with inclusion of M
M	Y	M & Y		Among women	Among men			Among women	Among men
Fair treatment concerns	Course performance	$-.49^{***}$ [−.58, −.40]	$.39^{*}$ [.001, .81]	$-.78^{*}$ [−1.11, −.49]	$-.39^{*}$ [−.72, −.10]	-1.83^{***} [−2.70, −.96]	$.74^{*}$ [.16, 1.31]	-1.10^{***} [−1.48, −.71]	−.36 [−.80, .09]
Sense of belonging	Course performance	$.67^{***}$ [.56, .78]	$.69^{*}$ [.28, 1.16]	-1.04^{*} [−1.46, −.67]	$-.35^{*}$ [−.66, −.08]	-1.27^{**} [−2.13, −.41]	.44 [−.12, 1.00]	$-.83^{***}$ [−1.22, −.44]	−.35 [−.82, .04]
Evaluative concerns	Course performance	$-.54^{***}$ [−.64, −.44]	$.57^{*}$ [.20, .97]	$-.96^{*}$ [−1.32, −.65]	$-.39^{*}$ [−.69, −.12]	-1.47^{***} [−2.37, −.57]	−.56 [−.03, 1.14]	$-.91^{***}$ [−1.31, −.51]	−.35 [−.80, .10]
Fair treatment concerns	Course interest	$-.47^{***}$ [−.55, −.39]	$.38^{*}$ [.01, .74]	$-.75^{*}$ [−1.03, −.49]	$-.37^{*}$ [−.69, −.10]	-1.24^{*} [−2.02 −.46]	.38 [−.13, .89]	$-.86^{***}$ [−1.20, −.51]	$-.47^{*}$ [−.87, −.08]
Sense of belonging	Course interest	$.70^{***}$ [.60, .79]	$.72^{*}$ [.31, 1.13]	-1.09^{*} [−1.41, −.77]	$-.37^{*}$ [−.66, −.09]	−.56 [−1.28, .16]	.04 [−.43, .51]	$-.52^{**}$ [−.84, −.20]	$-.49^{**}$ [−.84, −.12]
Evaluative concerns	Course interest	$-.20^{**}$ [−.31, −.10]	$.22^{*}$ [.05, .43]	$-.37^{*}$ [−.64, −.13]	$-.15^{*}$ [−.32, −.03]	-1.78^{***} [−2.73, −.82]	.54 [−.08, 1.16]	-1.24^{***} [−1.67, −.80]	$-.70^{**}$ [−1.18, −.22]

Note. Gender was coded 1 = female, 2 = male. Faculty mindset condition was coded 0 = growth mindset professor, 1 = fixed mindset professor. Coefficients are unstandardized betas and numbers in brackets represent 95% confidence intervals. Math identification and personal mindset beliefs were included as covariates.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6
Study 3 Correlations Among Measures

Measure	*M* (*SD*)	1	2	3	4	5	6	7
1. Perceived professor fixed mindset	3.16 (1.34)	—						
2. Fair treatment concerns	3.73 (1.91)	−.67***	—					
3. Sense of belonging	3.84 (1.40)	−.63***	−.68***	—				
4. Evaluative concerns	3.91 (1.51)	.63***	.65***	−.72***	—			
5. Anticipated course performance	4.96 (1.64)	−.49***	−.57***	.70***	−.60***	—		
6. Course interest	2.95 (1.41)	−.67***	−.70***	.76***	−.63***	.66***	—	
7. Students' personal fixed mindset covariate	2.95 (1.01)	.09	−.01	−.03	.02	−.02	−.04	—
8. Math identification covariate	4.19 (1.20)	−.07	−.15*	.27***	−.22**	.30***	.19**	.02

* $p < .05$. ** $p < .01$. *** $p < .001$.

mance in their respective analyses and the direct effect of professor mindset on course performance was reduced. Moreover, for each mediator the index of moderated mediation did not include zero and although indirect effects were significant among both men and women, the indirect effect of fair treatment concerns on performance was 35% larger among women and the indirect effect of sense of belonging was 62% larger among women. Differing from Study 2, evaluative concerns significantly predicted course performance and accounted for a significant amount of variance in anticipated performance. Moreover, this effect was moderated by gender, such that the indirect effect of evaluative concerns was 43% larger among women.

Course interest. Overall, results replicated those found in Study 2. We found evidence for statistically significant moderated mediation of professor mindset on course interest through each psychological variable. As in Study 2, fair treatment concerns, sense of belonging, and evaluative concerns significantly predicted course interest and statistically mediated the effect of professor mindset on course interest among both men and women. The indirect effect of fair treatment concerns was 40% larger among women, the indirect effect of sense of belonging was 63% larger, and the indirect effect of evaluative concerns was 41% larger among women.

Discussion

The findings of Study 3 corroborated Study 2 in a sample of undergraduate college students currently enrolled in a single university setting. These findings strengthen our confidence in the reliability and generalizability of the results. When STEM faculty endorse more fixed (vs. growth) mindset beliefs, students are more concerned about being treated unfairly, they anticipate feeling like they will not belong in class, they are concerned about being negatively evaluated by the professor, and they expect to perform worse there. In addition, students are less interested in taking a course taught by fixed (vs. growth) STEM faculty.

Consistent with hypotheses, moderated mediation analyses indicated that students' anticipated psychological experiences accounted for significant variance in students' anticipated course performance and course interest. Moreover, and perhaps most importantly, Study 3 provided consistent support that the fixed mindset beliefs of STEM professors engender greater psychological threat and lower interest in STEM courses among women (relative to men). Indeed, the direct effects of fixed faculty mindset beliefs were 36–64% larger and indirect effects of mediators were 35–63% larger among women across outcome variables.

Internal Meta-Analyses

Because these three studies comprise the full set of studies performed to test these hypotheses, we conducted an internal meta-analysis ($n = 627$) to provide more comprehensive statistical analyses and obtain a more precise estimates of the effects of faculty mindset on students' anticipated psychological experiences, anticipated course performance, and course interest. Thus, across all five outcome variables, we examined (a) the average effect size of the main effects of professor's mindset, (b) the average effect size of the student gender main effects, (c) the average effect size of the interaction, (d) the average effect size of professor mindset beliefs among female participants, and (e) the average effect size of professor mindset beliefs among male participants. Analyses were performed using the metafor package (Viechtbauer, 2010) in R Version 3.5.3 (R Core Team, 2019) and Table 9 provides a summary of the results. Given the similarity between studies in terms of design and effect sizes we used a fixed-effects model as recommended by Borenstein, Hedges, Higgins, and Rothstein (2010). In discussing the magnitude of the effect sizes, we used the conventions developed by Cohen (1992).

Results revealed that the main effects of faculty mindset were consistent and reliable. Average effect sizes were large in size (average d's .71–.94). Next, we examined the average main effects of participant gender on the dependent variables. These main effects were inconsistent across studies. The meta-analysis revealed that the average effect size of gender differences in sense of belonging, evaluative concerns, and anticipated course performance were statistically reliable and small to medium in size (average d's .22–.38). However, the average main effect of participant gender on fair treatment concerns ($d = .14$) course interest was not reliable ($d = .05$). Following these analyses, we examined the average effect sizes of the interaction between professor mindset and participant gender on each of the dependent variables. Across all variables, the average interaction effect size was statistically reliable and small to medium in size (average d's = .26–.43).

The final meta-analyses examined the simple effects of professor mindset beliefs among women and among men. Results revealed reliable and large average effect sizes of faculty mindset beliefs across all dependent variables among women (average

Table 7
Study 3 Summary of ANCOVA Analyses

Dependent variable	Main effect of condition (fixed vs. growth mindset professor)			Main effect of gender			Condition × Gender interaction			Personal fixed mindset covariate			Math identification covariate		
	F	*p*	*D*	*F*	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*	*F*	*p*	*d*
Fair treatment concerns	50.18	<.001	1.00	.17	.685	.06	3.95	.048	.28	<.01	.975	<.01	3.52	.062	.26
Sense of belonging	59.12	<.001	−1.09	1.77	.185	−.19	7.78	.006	.39	.56	.456	.11	15.40	<.001	.55
Evaluative concerns	46.24	<.001	.96	3.66	.057	.27	5.81	.017	.34	.33	.566	.09	8.17	.005	.40
Course performance	49.34	<.001	−.99	1.51	.220	−.18	11.71	.001	.48	.51	.474	.11	19.39	<.001	.62
Course interest	69.02	<.001	−1.18	.49	.486	−.09	9.30	.003	.43	1.08	.299	.14	6.89	.009	.37

Note. Fixed professor mindset condition $n = 110$. Growth professor mindset condition $n = 96$.

d′s = .71–.97) and men (average *d*′s = .31–.42). It is worth highlighting that, across all dependent variables, the average faculty mindset effect sizes were much larger among women than men.

General Discussion

America continues to contend with a growing need for more people to enter the STEM workforce (U.S. Bureau of Labor Statistics, 2018). STEM occupations and salaries are projected to increase at a greater rate than non-STEM occupations and salaries, making the recruitment and retention of students in STEM valuable to both students themselves and to the economy. The recruitment and retention of women in STEM is particularly important because women remain numerically underrepresented in STEM. Obtaining gender parity in the STEM workforce could encourage innovation, positively impact the U.S. economy, and reduce gender wage gaps in earnings (Dezsö & Ross, 2012; Lorenzo & Reeves, 2018; Woetzel et al., 2015). Therefore, understanding the contextual and psychological factors that lead students—particularly female students—to pursue (or opt out of) STEM coursework is an important endeavor. The current work offers novel answers to these questions by suggesting that college women may opt out of and lose interest in STEM courses when STEM faculty endorse the belief that ability is a fixed quality that is innately determined. It also suggests that more attention should be paid to the early experiences of women as they appraise STEM settings, and how these experiences might contribute to the leaky pipeline in the recruitment of women into STEM settings.

More specifically, the present work indicates that when faculty communicate fixed mindset beliefs, these beliefs threaten students' anticipated psychological experiences in class and reduce their academic motivation and anticipated performance. Faculty who say and do things that indicate that they endorse more fixed mindset beliefs cause students to anticipate a negative learning environment in which students experience concerns about how they will be treated and evaluated by the professor, as well as doubts about feeling like they belong there. These anticipated experiences are strong enough to influence students' anticipated performance in those courses and they influence students' interest in taking courses taught by fixed mindset faculty, which could play a role in students' later STEM enrollment—an important question for future research. Taken together, these results suggest that although students' personal mindset beliefs certainly matter for student engagement (for a review, see Dweck, 2006), faculty mindset beliefs also matter and shape students' outcomes—in these studies, above and beyond the role of students' personal mindset beliefs.

Importantly, we found some evidence that STEM professors' fixed mindset beliefs may act as a situational cue to identity threat among women in STEM settings. There is a plethora of research indicating that negative stereotypes about women's STEM abilities can lead women to be vigilant to situational cues that suggest that ability stereotypes may affect the way they are treated and valued (Murphy & Taylor, 2011; Steele et al., 2002). However, the present research is among the first to specifically examine professors' fixed and growth mindset beliefs as a potential situational cue to identity threat in carefully controlled, experimental contexts. Like other cues to threat in STEM settings (e.g., numerical repre-

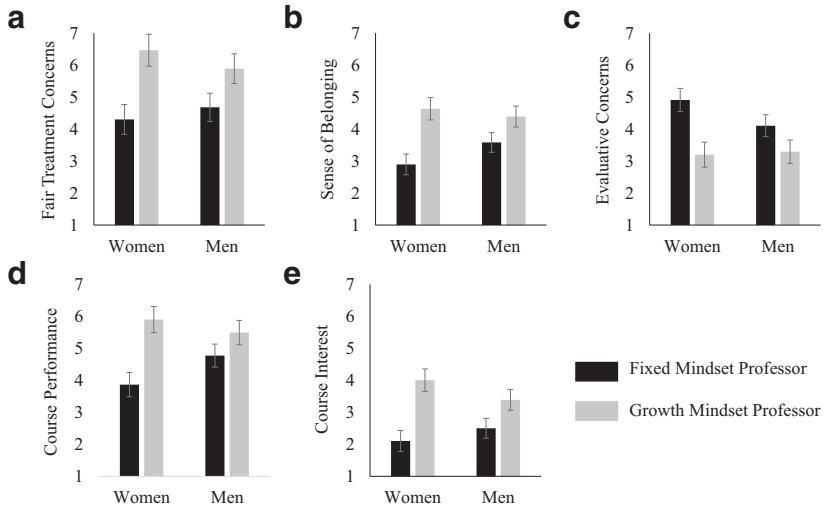

Figure 4. a–e. Study 3 faculty mindset condition comparisons by gender. Values are for students with average math identification ($M = 4.19$) and average personal mindset endorsement ($M = 2.95$). Error bars represent 95% confidence intervals. Faculty mindset condition differences for both men and women are significant at $p < .01$.

sentation; LaCosse et al., 2016; Murphy et al., 2007), faculty mindset beliefs exert a significantly larger effect on women's (vs. men's) psychological experiences (i.e., fair treatment, belonging, and evaluative concerns), anticipated performance, and ultimately their course interest. Consistently across studies, the negative effects associated with professors' fixed (vs. growth) mindset beliefs were 36–74% larger among women (or only present among women, as in Study 1). Moreover, the indirect effects of faculty mindset via psychological experiences on anticipated performance and course interest were 22–69% larger among women than men. Finally, internal meta-analyses provide more precise estimates of the average effect sizes observed and reveal that, consistent with the identity threat hypothesis, these average effects were reliably larger among women (whose identities are impugned by negative STEM ability stereotypes) than among men (who do not contend with similar group-based stereotypes).

Limitations and Future Directions

Although the current work presents novel theoretical advances and practically important findings, it is prudent to note its limitations. First, the present work relied on controlled experiments and random assignment to evaluate our hypotheses among students who may or may not intend to major in STEM. Although these methodological choices strengthen causal inference by examining how STEM professors' mindset beliefs influence students' interest in taking STEM courses, our methodology does not allow us to measure actual enrollment choices and this work provides less insight into how STEM faculty mindset beliefs may or may not impact the *retention* of students who are already enrolled or persisting in STEM settings. Future research would benefit from field studies that examine the influence of STEM faculty mindset beliefs, assess students' in vivo experiences, and examine how these experiences impact men's versus women's decisions to take more STEM classes, choose a STEM major, or persist in a STEM major through graduation.

Future research could also examine whether faculty characteristics such as faculty gender, race, or field moderate these effects. For example, will fixed (vs. growth) mindsets be more detrimental to students' outcomes when they come from professors of different gender or racial groups? Another future direction could examine the impact of professors' mindsets in STEM versus non-STEM fields; given that women are not negatively stereotyped or numerically underrepresented in many non-STEM fields (U.S. Department of Education, 2018), we might expect only main effects of faculty mindset and no moderation by student gender. Finally, it is possible that other individual differences among students could further moderate our effects. For example, women who are high (vs. low) in gender identification experience greater identity threat (Keller, 2007; Schmader, 2002). Taken together, the present work provides a basis for researchers to perform studies with larger samples to examine three-way interactions between faculty mindset, student gender, and other important faculty or student characteristics.

Conclusion

Over two decades of research indicates that students who endorse growth mindset beliefs have more positive academic experiences and outcomes compared to students who endorse fixed mindset beliefs (e.g., Blackwell, Trzesniewski, & Dweck, 2007; Burnette, Russell, Hoyt, Orvidas, & Widman, 2018; Lou, Masuda, & Li, 2017). In addition, recent research suggests that professors' *self-reported* mindset beliefs about the malleability of intelligence can have similar motivational and performance effects for students (Canning et al., 2019; De Kraker-Pauw et al., 2017; Leslie et al., 2015; Rattan et al., 2012). The current work makes a contribution to this growing body of work by *manipulating* professors' mindset beliefs and examining the causal impact these mindsets on students' anticipated academic experiences and course interest, above and beyond students' personal mindset beliefs. We found that STEM professors who believe in students' ability to grow (or not

Table 8
Study 3 Summary of Moderated Mediation Results

Mediator	Outcome	Relation between	Index of moderated mediation	Indirect effect	Indirect effect	Direct effect of condition with inclusion of M	Condition by gender interaction with inclusion of M	Direct effect with inclusion of M	Direct effect with inclusion of M
M	Y	M & Y		Among women	Among men			Among women	Among men
Fair treatment concerns	Course performance	$-.38^{***}$ [−.47, −.27]	$.35^{*}$ [.01, .74]	$-.79^{*}$ [−1.17, −.48]	$-.44^{*}$ [−.74, −.19]	-2.23^{***} [−3.38, −1.07]	$.99^{**}$ [.29, 1.69]	-1.24^{***} [−1.79, −.69]	−.25 [−.74, .24]
Sense of belonging	Course performance	$.66^{***}$ [.53, .80]	$.62^{*}$ [.17, 1.06]	-1.15^{*} [−1.56, −.76]	$-.53^{*}$ [−.88, −.23]	-1.61^{**} [−2.69, −.52]	$.72^{*}$ [.07, 1.37]	$-.88^{**}$ [−1.40, −.36]	−.16 [−.61, .29]
Evaluative concerns	Course performance	$-.48^{***}$ [−.61, −.35]	$.43^{*}$ [.08, .81]	$-.82^{*}$ [−1.20, −.50]	$-.39^{*}$ [−.71, −.14]	-2.12^{***} [−3.27, −.96]	$.91^{*}$ [.21, 1.60]	-1.21^{***} [−1.76, −.67]	−.31 [−.79, .17]
Fair treatment concerns	Course interest	$-.42^{***}$ [−.50, −.34]	$.40^{*}$ [.01, .82]	$-.91^{*}$ [−1.23, −.61]	$-.51^{*}$ [−.79, −.23]	-1.62^{***} [−2.51, −.73]	$.63^{*}$ [.09, 1.16]	$-.99^{***}$ [−1.41, −.57]	−.38 [−.74, .01]
Sense of belonging	Course interest	$.67^{***}$ [.57, .77]	$.62^{*}$ [.17, 1.11]	-1.17^{*} [−1.53, −.82]	$-.54^{*}$ [−.84, −.23]	-1.13^{**} [−1.98, −.29]	.40 [−.10, .91]	$-.73^{**}$ [−1.14, −.33]	−.33 [−.68, .02]
Evaluative concerns	Course interest	$-.46^{***}$ [−.57, −.35]	$.42^{*}$ [.07, .76]	$-.79^{*}$ [−1.10, −.50]	$-.38^{*}$ [−.66, −.13]	-1.72^{*} [−2.68, −.76]	$.61^{*}$ [.03, 1.19]	-1.11^{***} [−1.56, −.66]	$-.50^{*}$ [−.90, −.10]

Note. Gender was coded 1 = female, 2 = male. Faculty mindset condition was coded 0 = growth mindset professor, 1 = fixed mindset professor. Coefficients are unstandardized betas and numbers in brackets represent 95% confidence intervals. Math identification and personal mindset beliefs were included as covariates.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 9
Summary of Meta−Analyses Results

Dependent variable	Avg. effect size for the main effect of condition (fixed vs. growth mindset professor)		Avg. effect size for the main effect of gender		Avg. effect size for the Condition × Gender interaction		Avg. effect size for the difference between women in the fixed versus growth mindset professor condition		Avg. effect size for the difference between men in the fixed versus growth mindset professor condition	
	Avg. *d*	95% CI	Avg. *d*	95% CI	Avg. *d*	95% CI	Avg. *d*	95% CI	Avg. *d*	95% CI
Fair treatment concerns	.71***	[.55, .88]	−.14	[−.01, .30]	.26**	[.10, .41]	.71***	[.55, .87]	.34***	[.18, .50]
Sense of belonging	−.79***	[−.95, −.62]	.30*	[.14, .46]	.32***	[.16, .48]	−.82***	[−.99, −.66]	−.34***	[−.50, −.19]
Evaluative concerns	.82***	[.66, .99]	−.38***	[−.54, −.22]	.37***	[.21, .53]	.87***	[.71, 1.04]	.35***	[.19, .51]
Course performance	−.85***	[−1.04, −.68]	.22**	[.06, .38]	.43***	[.27, .59]	−.94***	[−1.10, −.77]	−.31***	[−.47, −.16]
Course interest	−.94***	[−1.11, −.77]	.05	[−.10, .21]	.39***	[.23, .55]	−.97***	[−1.14, −.80]	−.42***	[−.58, −.26]

* $p < .05$. ** $p < .01$. *** $p < .001$.

grow) their intelligence shape students' anticipated psychological experiences in the classroom, their anticipated course performance, and their interest in taking the professors' course. This was particularly true among female students who contend with negative group stereotypes that impugn their abilities in STEM. Taken together, this research suggests that one way to improve the representation of women in STEM in higher education may be to more fully consider the role that faculty mindset beliefs play in shaping men and women's expectations for those STEM environments and their interest in them.

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Received December 2, 2019
Revision received April 25, 2020
Accepted June 2, 2020 ■