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Supplementary Materials for

STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes

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Supplemental Analyses

Do faculty mindset beliefs predict the gender achievement gap?

Like URM students, women's abilities are also impugned by negative societal stereotypes. In American society, women are often stereotyped as having less innate intellectual ability in STEM relative to their male peers. Thus, we might expect faculty mindset beliefs to predict the gender achievement gap in STEM courses. However, in this university sample, women actually earned higher grades in STEM courses, compared to men, $B = .12$, $p < .001$. Thus, it was unclear whether faculty mindset beliefs would have a similar effect on women's performance as it did for URM students. A growing trend in undergraduate STEM courses, especially in more gender-balanced disciplines such as biology in which men and women are equally represented, is that women do not underperform compared to men (37, 38). Nevertheless, we examined the relationship between faculty mindset beliefs and men and women's performance. We tested the same HLM model used in previous analyses and added a faculty mindset X student gender interaction term. We also tested the intersection of student race/ethnicity and gender, but did not find any evidence of intersectional effects, thus we trimmed these higher-order interaction terms from the model. In all analyses, we controlled for the same student, course, and faculty characteristics as in all previous models reported in the main text.

Results revealed that faculty mindset beliefs did not predict differences in women and men's grades in STEM courses, $B = .02$, $p = .298$ (see table S1). Even though men received lower grades in STEM courses overall, compared to women, we wouldn't expect faculty mindset beliefs to be associated with men's grades, since men do not contend with negative stereotypes about STEM ability. Gender differences in STEM achievement and representation increase at higher levels of education (e.g., Ph.D. programs, tenure-track academic positions) (37, 38) and thus faculty mindset beliefs may exert a greater impact on women's performance and representation further along the STEM pipeline.

Are the performance effects moderated by STEM discipline?

Leslie and colleagues (21) found that some STEM disciplines have stronger cultures of "brilliance" than others—that is, there are stronger beliefs among faculty in some disciplines,

relative to others, that brilliance is required for top performance in the field—and this emphasis on brilliance is correlated with the representation of women and URM Ph.D. students in those fields. It could be that more traditional mindset beliefs—about the fixedness or malleability of ability—may have a greater association with URM underperformance in disciplines that emphasize more fixed mindset beliefs. We explored this possibility in three ways.

First, following the analysis strategy of Leslie et al. (21), we examined whether STEM disciplines predicted faculty mindset beliefs. As noted in the main text, we found that fixed mindset beliefs were endorsed equally across the 13 STEM disciplines in our sample (all *p*s > .14, Table 1). This suggests that fixed mindset beliefs—unlike brilliance beliefs—are not concentrated among, or isolated to, certain STEM disciplines. Instead, fixed mindset beliefs appear to be distributed relatively evenly among faculty across STEM disciplines.

Second, we created a discipline-level mindset variable by aggregating faculty's self-reported mindset beliefs within each STEM discipline. Then, we correlated our discipline-level mindset beliefs variable with the field ability brilliance beliefs (FAB) reported in Leslie et al. (21) and found that they were not significantly correlated, $r = .42$, $p = .177$. FAB emphasizes faculty's beliefs about the requirements of being a successful top scholar in a field (e.g., "Being a top scholar of [discipline] requires..."), whereas more traditional mindset beliefs emphasize the nature of ability—whether ability is fixed or malleable (8). Therefore, it is possible for a faculty member to believe that being a top scholar in their field requires brilliance, while also endorsing growth mindset beliefs (i.e., believing that ability is malleable and can be acquired through strategies, learning, and development). Thus, fixed ability beliefs and mindset beliefs represent distinct independent constructs.

Third, we tested whether discipline-level mindset was a significant moderator of URM students' grades. We tested the same HLM model used in the primary analysis (controlling for the same student, course, and faculty characteristics as in all other analyses); however, we substituted the individual faculty mindset beliefs variable for the discipline-level mindset variable (see table S7). We found that discipline-level mindset beliefs did not predict the racial achievement gap in STEM courses, $B = .04$, $p = .075$. This suggests that faculty mindset beliefs that are most

proximal to students (i.e., the mindset beliefs of the faculty member who is teaching the course that students are currently enrolled in) have a greater effect on students' performance in STEM courses, than the average mindset beliefs of a particular STEM discipline. It is possible that discipline-level mindset beliefs and/or FAB might have a greater effect on the performance or representation of students at higher levels of education (i.e., graduate programs or tenure-track faculty positions).

Do course evaluations mediate the performance effects?

Why are there larger racial achievement gaps in courses taught by faculty who endorse more fixed mindset beliefs? Perhaps this is explained by the pedagogical practices that fixed (vs. growth) mindset faculty employ in their classroom. To explore this possibility, we tested students' perception of their professor's usage of motivating pedagogical practices as a mediating mechanism. We combined the two course evaluation questions regarding professors' practices (e.g., "How much did the instructor motivate you to do your best work?", "How much did the instructor emphasize student learning and development?") into a composite and tested it as a mediator of student performance. However, the results are consistent when examining each item separately.

Given that the primary model examining students' course grades was particularly complex (e.g., three levels of nested data: students nested within courses, nested within faculty) and included partially crossed random effects (since students can take classes from more than one faculty in our sample), we had to simplify the model in two ways in order to be able to test for mediation within the bounds of current statistical software capabilities. First, we simplified the nested structure of the data and reduced the model to two levels: students (level 1) nested within courses (level 2). Thus, both faculty mindset beliefs and average course evaluations were analyzed at level 2. As noted in the main text, student-level course evaluations were unavailable due to confidentiality constraints. Second, we were unable to account for the partially crossed random effects in this analysis with current statistical software. Given these constraints, we consider these mediation analyses exploratory and advise caution when interpreting the results.

We conducted the mediation analyses using Mplus Version 8.1 (39) and controlled for the same student, course, and faculty characteristics as in our primary model. Results indicated that the indirect effect of fixed faculty mindset beliefs on course grades via motivating pedagogical practices was statistically significant (i.e., the confidence interval did not include zero) for URM students (.025, 95% CI [.010, .049]) and for non-URM students (.016, 95% CI [.005, .029]) (see fig. S1). The indirect effect for URM students was somewhat larger than the indirect effect for non-URM students, indicating that motivating pedagogical practices may be especially important for URM students' performance in STEM courses. These preliminary results suggest that faculty who endorse more fixed mindset beliefs have larger racial achievement gaps, in part, because they use less motivating pedagogical practices—for example, they are less likely to emphasize learning and development when teaching—at least as perceived by students. It will be important in future research to test this relationship with students' individual-level perceptions of faculty's pedagogical practices, more objective measures of faculty's pedagogical practices (e.g., videotaped and coded teaching behavior), and to examine which pedagogical practices are most related to growth mindset beliefs.

Do faculty who opted-in to the study differ from those who opted-out of the study?
While all currently employed STEM faculty (including adjuncts, lecturers, post-docs, and graduate students) that had taught at least one undergraduate course at the university (n = 483) were recruited to participate in the study, 40.8% (n = 197) responded to the survey. In addition, some faculty who responded to the survey had not taught at least one undergraduate course within the previous 2 years or did not answer the two mindset beliefs questions and were subsequently excluded (n = 47). This left a final sample of 150 STEM faculty who participated in the study.

To examine whether faculty who opted-in (vs. opted-out) of our study differed from each other, we examined differences between these faculty groups on tenure status, course grades, and course evaluations. First, we examined whether faculty who opted-in to the study differed by tenure status, compared to faculty who opted-out of the study. We were only able to test differences on tenure status, given that all other faculty characteristics (i.e., gender, race/ethnicity, age, and teaching experience) were obtained from the faculty survey and those

who opted-out of the study were missing these variables. A chi-square test revealed that tenure status did not significantly differ between faculty who opted-in (vs. opted-out), X^2 (1, N = 483) = 0.99, p =.320.

Next, we examined differences in course grades and course evaluations. We tested the same HLM models used in previous analyses and added a predictor variable that indicated whether the faculty member had opted-in (1) or opted-out (0). In these models, we controlled for the same student and course characteristics as in all previous models. We were only able to control for one faculty characteristic (tenure status), given that all other faculty characteristics (i.e., gender, race/ethnicity, age, and teaching experience) were obtained from the faculty survey and those who opted-out of the study were missing these variables.

Students in courses taught by faculty who opted-in (vs. opted-out) did not differ significantly in terms of course grades, $t(291) = 1.47$, $B = .06$, $p = .144$ or in terms of the amount of time and effort that the course required (as reported by students in their course evaluations), $t(316) = 1.56$, $B = -.08$, $p = .119$. Students perceived faculty who opted-in to the study as more motivating than faculty who opted-out, $t(305) = 2.56$, $B = .13$, $p = .010$, and perceived them to emphasize learning and development more than faculty who opted-out, $t(311) = 2.66$, $B = .10$, $p = .008$. Students were also more likely to recommend the courses of faculty who opted-in (vs. opted-out) to other students, $t(317) = 2.25$, $B = .08$, $p = .026$. Given that faculty with more of a growth mindset received more positive student evaluations (see table S6), we hypothesize that faculty who opted-out of the study were likely to have endorsed more fixed mindset beliefs. Thus, the primary results reported in the main text may actually underestimate the true relationship between faculty mindset and students' performance in STEM courses.

Table S1. Fixed effects estimates predicting students' grades in STEM courses.

	Primary Model			Primary Model + Interaction with Student Gender		
	B	***t* (df)**	***p***	***B***	***t* (df)**	***p***
Student Race/Ethnicity	-.14***	-5.00 (312)	.000	-.14***	-5.01 (309)	.000
Student First-generation Status	-.11***	-5.16 (14,560)	.000	-.11***	-5.17 (14,550)	.000
Student Gender	.12***	7.58 (15,100)	.000	.13***	6.18 (175)	.000
Student SAT	.38***	47.36 (15,360)	.000	.38***	47.35 (15,370)	.000
Course Enrollment	-.15***	-10.89 (388)	.000	-.15***	-10.85 (372)	.000
Course Level 200 Code	-.17***	-3.77 (572)	.000	-.17***	-3.63 (560)	.000
Course Level 300 Code	-.12**	-2.70 (609)	.007	-.11*	-2.55 (590)	.011
Course Level 400 Code	-.13*	-2.54 (769)	.011	-.12*	-2.38 (763)	.018
Faculty Gender	.09	1.47 (110)	.145	.07	1.26 (100)	.210
Faculty Race/Ethnicity	.02	0.14 (218)	.887	.02	0.15 (215)	.885
Faculty Teaching Experience	-.10*	-2.06 (115)	.041	-.11*	-2.11 (105)	.037
Faculty Tenure Status	.06	0.95 (132)	.345	.05	0.91 (123)	.363
Faculty Age	.13**	2.65 (105)	.009	.13**	2.65 (95)	.009
Faculty Mindset Beliefs	.08*	2.59 (137)	.011	.07*	2.33 (133)	.022
Faculty Mindset X Student URM	.04*	2.06 (115)	.041	.04*	1.99 (114)	.049
Faculty Mindset X Student Gender				.02	1.05 (84)	.298

Note. Gender was coded: female = 1, male = 0. Race/ethnicity was coded: URM (Black, Hispanic, Native American) = 1, non-URM (White, Asian) = 0. First-generation status was coded: first-generation = 1, continuing-generation = 0. Tenure status was coded: tenured = 1, non-tenured = 0. Course level codes represent dummy codes with level 100 as the reference group. Higher scores on faculty mindset beliefs reflect a more growth mindset. Higher numbers of course enrollment reflect courses with more enrolled students. All continuous measures were standardized.

Table S2. Testing the role of other faculty characteristics.

		Models Testing Other Faculty Characteristics				
	Primary Model	**Faculty Gender**	**Faculty Race**	**Faculty Age**	**Teaching Experience**	**Tenure Status**
	B (*SE*)	*B* (*SE*)	*B* (*SE*)	*B* (*SE*)	*B* (*SE*)	*B* (*SE*)
Faculty Mindset	.08* (.03)	.08* (.03)	.08* (.03)	.08** (.03)	.08* (.03)	.10* (.05)
Student Race	-.14*** (.03)	-.16*** (.03)	-.15*** (.03)	-.14*** (.03)	-.15*** (.03)	-.13*** (.03)
Faculty Mindset X Student Race	.04* (.02)	.05* (.02)	.04* (.02)	.04* (.02)	.05* (.02)	.05+ (.03)
Faculty Gender		.12+ (.07)				
Faculty Gender X Student Race		.05 (.05)				
Faculty Gender X Faculty Mindset		-.02 (.07)				
Faculty Gender X Faculty Mindset X Student Race		-.04 (.05)				
Faculty Race			.05 (.15)			
Faculty Race X Student Race			.30 (.24)			
Faculty Race X Faculty Mindset			-0.01 (.11)			
Faculty Race X Faculty Mindset X Student Race			-.11 (.17)			
Faculty Age				.12* (.05)		
Faculty Age X Student Race				-.02 (.02)		
Faculty Age X Faculty Mindset				.04 (.03)		
Faculty Age X Faculty Mindset X Student Race				.03 (.02)		
Teaching Experience					-.13* (.05)	
Teaching Experience X Student Race					-.03 (.03)	
Teaching Experience X Faculty Mindset					.03 (.03)	
Teaching Experience X Faculty Mindset X Student Race					.01 (.03)	
Tenure Status						.03 (.07)
Tenure X Student Race						-.05 (.05)
Tenure X Faculty Mindset						-.03 (.06)
Tenure X Faculty Mindset X Student race						-.01 (.04)

Note. *$p < .05$, **$p < .01$. ***$p < .001$. +$p < .10$ Higher scores on faculty mindset beliefs reflect a more growth mindset. All models control for student, course, and faculty covariates.

Table S3. Fixed effects estimates predicting course evaluations.

	How much did your instructor motivate you to do your best work?			How much did the instructor emphasize learning and development?		
	B	***t* (df)**	***p***	***B***	***t* (df)**	***p***
Course Enrollment	-.08***	-3.64 (520)	.000	-.07***	-3.99 (529)	.000
Course Level 200 Code	.15*	2.13 (553)	.034	.16**	3.05 (556)	.002
Course Level 300 Code	.17**	2.68 (550)	.007	.17***	3.54 (555)	.000
Course Level 400 Code	.32***	4.65 (549)	.000	.23***	5.58 (544)	.000
Faculty Gender	.12	1.30 (122)	.196	.14*	1.98 (118)	.050
Faculty Race/Ethnicity	-.24	-1.16 (182)	.246	-.23	-1.50 (187)	.136
Faculty Teaching Experience	-.16	-1.97 (118)	.051	-.13*	-12.25 (114)	.026
Faculty Tenure Status	.15	1.67 (126)	.097	.16*	2.43 (123)	.017
Faculty Age	.08	1.01 (109)	.312	.06	1.06 (104)	.291
Faculty Mindset Beliefs	.09*	2.23 (132)	.028	.09**	2.85 (129)	.005
	How likely would you be to recommend this course with this instructor?			**Compared to other courses you've taken how much time did this course require?**		
	B	***t* (df)**	***p***	***B***	***t* (df)**	***p***
Course Enrollment	-.06***	-3.74 (530)	.000	.18***	7.57 (538)	.000
Course Level 200 Code	.18***	3.58 (556)	.000	.46***	6.00 (555)	.000
Course Level 300 Code	.16***	3.55 (554)	.000	.41***	5.82 (556)	.000
Course Level 400 Code	.27***	5.45 (544)	.000	.42***	5.50 (556)	.000
Faculty Gender	.12	1.88 (123)	.062	-.09	-0.92 (117)	.361
Faculty Race/Ethnicity	-.11	-0.77 (192)	.443	-.10	-0.47 (196)	.639
Faculty Teaching Experience	-.11	-1.97 (119)	.051	.16*	1.99 (113)	.049
Faculty Tenure Status	.17**	2.65 (128)	.009	-.08	-0.87 (122)	.388
Faculty Age	.05	1.02 (108)	.311	-.17	-2.18 (101)	.032
Faculty Mindset Beliefs	.08**	2.78 (134)	.006	-.04	-0.94 (129)	.350

Note. Course level codes represent dummy codes with level 100 as the reference group. Gender was coded female = 1, male = 0. Race/ethnicity was coded URM (Black, Hispanic, Native American) = 1, non-URM (White, Asian) = 0. Tenure status was coded tenured = 1, non-tenured = 0. Higher scores on the faculty mindset beliefs measure reflect more of a growth mindset.

Table S4. Correlations among the variables at level 1 (student).

Variable	1	2	3	4	5
1. Student Average Course Grade	--				
2. Student Race/Ethnicity	-.12**	--			
3. Student First-generation Status	-.11**	.17**	--		
4. Student Gender	.03**	.03**	.03**	--	
5. Student SAT	.29**	-.25**	-.22**	-.11**	--
N	15,466	15,466	15,466	15,466	15,466
Mean/Frequency	2.80	--	--	--	1216.40
SD	1.04	--	--	--	149.97

Note. Gender was coded: female = 1, male = 0. Race/ethnicity was coded: URM (Black, Hispanic, Native American) = 1, non-URM (White, Asian) = 0. First-generation status was coded: first-generation = 1, continuing-generation = 0.

Table S5. Correlations among the variables at level 2 (course).

Variable	1	2	3	4	5	6	7	8
1. Course Enrollment	--							
2. Course Level 200 Code	-.06	--						
3. Course Level 300 Code	-.08*	-.38**	--					
4. Course Level 400 Code	-.28**	-.28**	-.35**	--				
5. How much did the instructor motivate you to do your best work?	-.21**	.08*	-.02	.15**	--			
6. How much did the instructor emphasize student learning and development?	-.27**	.09*	.01	.18**	.87**	--		
7. How likely would you be to recommend this course with this instructor?	-.26**	.08	.02	.15**	.83**	.89**	--	
8. Compared to other courses you've taken how much time did this course require?	.15**	.21**	-.03	.01	-.10*	.00	-.02	--
N	634	634	634	634	618	619	619	619
Scale	--	--	--	--	1-4	1-4	1-4	1-5
Mean/Frequency	61.37	--	--	--	3.21	3.35	3.47	3.65
SD	69.08	--	--	--	.58	.45	.42	.61

Note. Course level codes represent dummy codes with level 100 as the reference group. Students rated the first three evaluation questions on a 1 (not at all) to 4 (a lot/ very likely) scale. Students rated the item, "Compared to other courses you've taken how much time did this course require?") on a 1 (much less time) to 5 (much more time) scale.

Table S6. Correlations among the variables at level 3 (faculty).

Variable	1	2	3	4	5	6
1. Faculty Mindset Beliefs	--					
2. Faculty Gender	.08	--				
3. Faculty Race/Ethnicity	-.00	.08	--			
4. Faculty Years Teaching Experience	.04	-.10	.03	--		
5. Faculty Tenure status	-.03	-.25**	.01	.42**	--	
6. Faculty Age	.02	-.00	.02	.86**	.38**	--
N	150	150	150	150	150	150
Mean/Frequency	3.87	--	--	18.44	--	49.00
SD	1.46	--	--	12.04	--	12.54

Note. Higher scores on the faculty mindset beliefs measure reflect more of a growth mindset. Gender was coded female = 1, male = 0. Race/ethnicity was coded URM (Black, Hispanic, Native American) = 1, non-URM (White, Asian) = 0. Tenure status was coded tenured = 1, non-tenured = 0.

Table S7. Discipline-level mindset beliefs.

	B	***t* (df)**	***p***
Student Race/Ethnicity	-.14***	-5.00 (271)	.000
Student First-generation status	-.11***	-5.14 (14,550)	.000
Student Gender	.11***	7.61 (15,100)	.000
Student SAT	.38***	47.41 (15,360)	.000
Course Enrollment	-.14***	-10.51 (411)	.000
Course Level 200 code	-.17***	-3.74 (547)	.000
Course Level 300 code	-.11**	-2.60 (586)	.010
Course Level 400 code	-.13**	-2.61 (761)	.009
Faculty Gender	.05	0.94 (103)	.348
Faculty Race/Ethnicity	.07	0.48 (222)	.632
Faculty Teaching Experience	-.08	-1.74 (115)	.084
Faculty Tenure Status	.03	0.48 (125)	.635
Faculty Age	.11*	2.46 (94)	.016
Discipline Mindset Beliefs	.14***	5.32 (146)	.000
Discipline Mindset X Student URM	.04	1.79 (201)	.075

Note. Gender was coded: female = 1, male = 0. Race/ethnicity was coded: URM (Black, Hispanic, Native American) = 1, non-URM (White, Asian) = 0. First-generation status was coded: first-generation = 1, continuing-generation = 0. Tenure status was coded: tenured = 1, non-tenured = 0. Course level codes represent dummy codes with level 100 as the reference group. Higher scores on discipline-level mindset beliefs reflect a more growth mindset. Higher numbers of course enrollment reflect courses with more enrolled students. All continuous measures were standardized.

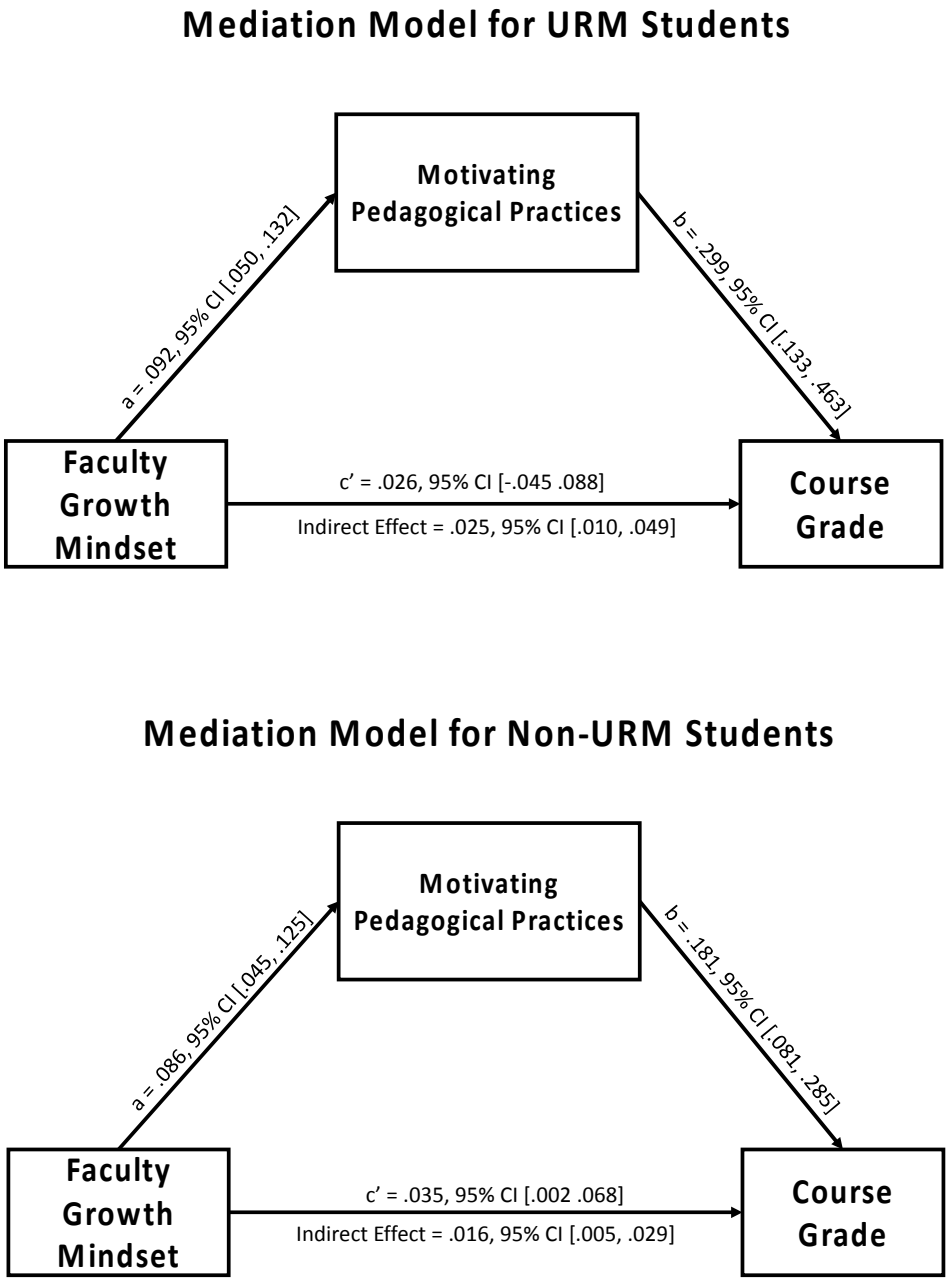

Fig. S1. Mediation models for URM and non-URM students.