Teacher Mindsets and Student Sense of Classroom Belonging¹

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Abstract

We investigate how teachers' mindsets—or their beliefs about learning and school—relate to adolescents' individual and collective reports of classroom belonging. Our pre-registered analyses of 1,200 middle school students show that teachers' *growth mindset* and *confidence in teaching* positively relate to students' math class belonging—explaining 40 percent of belonging among classes. Yet a teacher's own *sense of school belonging* is unrelated to the belonging students feel in class. We also find that the conditional association between math teaching confidence and students' classroom belonging is twice as strong for Black adolescents as it is for their White peers, and a teacher's growth mindset has no bearing on Asian adolescents' math class belonging.

Keywords: Belonging; growth mindset; self-efficacy; adolescence; classrooms

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When middle school-aged adolescents reflect on their feelings about school—whether they feel safe, are engaged in learning, or just simply like being there—what their teachers think and do matters. Adolescents feel like valued members of the school when they have trusting relationships with teachers (Bryk & Schneider, 2004) and feel apprehension and mistrust when those same relationships deteriorate (Okonofua, Walton, et al., 2016). They respond emotionally to teachers’ stereotypes and implicit biases (Steele, 1997), the behavioral standards they enforce (Rosenthal & Jacobson, 1968), and educators’ approaches to school and classroom punishments (Okonofua, Paunesku, et al., 2016; Pyne, 2019). These beliefs, actions, and reactions shape an adolescent’s sense of *belonging*, “a feeling of being accepted, included, respected in, and contributing to a setting, or anticipating the likelihood of developing this feeling” (Walton & Brady, 2017, p. 272).

Belonging underlies social-emotional well-being and the ability to learn new things (Allen et al., 2018; Goodenow, 1993). Because of its significance for learning, educators should want to nurture a keen sense of school and classroom belonging among students. And teachers *can* affect students’ belonging. Although different students’ feelings of belonging in the same context vary, one recent study implies a third of the variance in students’ classroom belonging is among classrooms, due in part to the influence of teachers (Farrington et al., 2019). That makes sense; teachers set the classroom’s tone and enforce norms of behavior by complementing or critiquing students (Okonofua, Walton, et al., 2016), providing challenge or ease of work (Dreeben & Barr, 1988), employing more or less culturally sensitive resources (Dee & Penner, 2017), and enabling or discouraging belonging, safety and trust (Osterman, 2010). Because teachers have so much influence, understanding what they think can help us better understand adolescents’ school and classroom belonging.

In this paper, we study how teachers’ *mindsets*—or their views on learning and school—relate to their students’ classroom belonging. Teachers hold considerable

power over adolescents' daily school lives (Okonofua, Paunesku, et al., 2016). For example, while educators who implement punitive, exclusionary and developmentally mismatched middle school disciplinary practices lead adolescents to emotionally disengage from school (Anderman, 2003; Eccles, 2004; Pyne, 2019), those who nurture high-quality and trusting relationships help their students feel more a part of the school community (Bryk & Schneider, 2004). Understanding teacher mindsets can thus help explain why adolescents feel the ways they do in school.

Researchers usually focus only on changing what students believe, despite teachers being central to—and responsible for—student sense of belonging. (cf. Okonofua, Paunesku, et al., 2016; Okonofua, Walton, et al., 2016). Although some social-psychological interventions appear to help adolescents feel a greater sense of school belonging (e.g., Borman et al., 2019), student-focused interventions are just salves, protecting against real and perceived school threats or encouraging positive relationships with educators—which adolescents themselves have relatively little power to control (Okonofua, Walton, et al., 2016). Helping adolescents appreciate or endure the ways others make them feel only goes so far. For example, messages promoting belonging do not work well in places that do not afford adolescents opportunities to feel belonging in the first place (Walton & Cohen, 2020). On the other hand, understanding effective teachers' mindsets could help clarify *why* they are so effective, so those strategies may be shared with others. As matters of policy, practice, and ethics, a broader focus including *teacher's* mindsets makes sense.

More precisely, we study teacher mindsets and adolescents' sense of belonging in *math classes*. Schools matter more for math growth than other core subjects, like reading (Bryk & Raudenbush, 1988), meaning adolescents need their math teachers to understand both class content and their feelings about math. We speculate that high reliance on teachers to succeed in the classroom heightens adolescents' sense of threat about their identity as a good and capable student, which makes them more sensitive to context. Adolescents develop their math identities in

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response to that heightened sensitivity, and some fall victim to stereotypes about their math ability (Steele, 1997). If teachers promote a welcoming classroom community, all students should feel belonging in math class, while negative teacher mindsets could instead push students to feel disconnected.

We highlight three malleable teacher mindsets that may relate to adolescent belonging. The first is a teacher's own sense of *school belonging*. Teachers may consciously or unconsciously pass on their feelings about school to their students. For example, teachers who feel connected to colleagues and administrators with whom they share a sense of purpose or mission are more likely to create positive classroom environments for their students and to engage with their students in affirming and constructive ways. Second, we examine teachers' *confidence in their math teaching*, reasoning that teachers who believe in their own teaching strategies better help their students feel successful in the classroom than teachers with less confidence. The third mindset we consider is a teacher's belief that math skills grow with effort, or their *growth mindset* about math ability. A teacher who believes math ability can grow may improve their students' sense of classroom belonging recursively; a teacher who thinks anyone can become good at math reinforces students' beliefs that they belong in math class. Those students' heightened motivation and performance in turn reinforces the teacher's growth mindset about math ability.

Pre-registered analyses guide us as we evaluate the relationship between these three positive teacher mindsets and adolescents' math class belonging (see <https://osf.io/5xw4z>). Our analysis plan uses multilevel modeling, combining teacher and student surveys with school district administrative data. The analytic sample includes over 1,200 middle school aged adolescents and 35 middle school math teachers in 84 classrooms. These data include adolescents' self-reported sense of belonging (in math class, English language arts [ELA] class, and school more

generally), and their past achievement and demographic characteristics—in addition to their math teachers’ mindsets about learning and school.

We find a teacher’s confidence and their growth mindset about math ability positively relate to their students’ math class belonging, net of students’ general feelings about school, feelings about ELA class belonging, their prior math achievement, and their demographic characteristics. Unexpectedly, a teacher’s *own* school belonging and their students’ math classroom belonging relate quite modestly, and without statistical significance. Together, these three teacher mindsets explain 40 percent of the variance in adolescents’ math class belonging between classrooms, conditional on student-level predictors. Finally, exploratory analyses not part of the pre-registered analysis plan suggest that teachers’ confidence more strongly relates to Black adolescents’ sense of math class belonging than White peers, and Asian adolescents seem unmoved by a teacher’s growth mindset about math ability.

Teacher Mindsets and Student Belonging

Teacher mindsets can be directed toward the school context, their students, or their own identity. Below, we discuss three key mindsets—math teachers’ *school belonging*, their *confidence in math teaching*, and their *growth mindset about math ability*—and how we expect they shape students’ classroom belonging. In general, we expect teacher mindsets will explain a substantial share of classroom-level variation in student math class belonging, and adolescents will report a greater sense of belonging when teacher mindsets are more positive.

Sense of School Belonging

Belonging is an essential human psychological need (Baumeister & Leary, 1995). More than a simple accounting of someone’s positive interpersonal relationships, belonging involves more abstract feelings about place, contributing to the ways people feel accepted, included, respected, and influential (Walton & Brady, 2017). This complex idea of belonging—considering the self, others, and the

context—implies that some who have many positive relationships feel like they do not belong somewhere while others with few positive relationships feel like they do.

We anticipate a teacher's own belonging relates to their students' classroom belonging. Relationships with colleagues and parents, time pressures, and their students' disciplinary issues affect teachers' sense of belonging (Skaalvik & Skaalvik, 2011). For example, schools with professional learning communities of teachers produce greater student achievement gains than those that do not, due to better teaching practices (Ronfeldt et al., 2015) and higher teacher self-efficacy (Goddard et al., 2004).

Another reason school belonging matters is it can indicate teachers' alignment to the schools mission and values. Rather than just capturing pleasant work experiences, belonging may capture the degree to which teachers believe in and approve of how colleagues are accomplishing the school's mission. Those feelings may lead teachers to see themselves as key players in making the school's mission come to life, and therefore investing in the students more intensely. It also could signal commitment to that school—meaning if teachers feel like they belong, they are more likely to stay working at the school.

We predict a teacher's response to contextual elements like those found in professional learning communities may influence how their students feel about school or class. That may mean teachers who feel belonging in their school are more engaged and focused on developing their students' classroom belonging. Or, when teachers do not feel valued, respected, or included, they may be too distracted by their own unpleasant work experiences to focus on the social-emotional needs of their students, and will feel less invested in the success of the school as a whole.

Hypothesis 1: Teacher sense of belonging in their school is positively associated with students' sense of belonging in their math class.

Confidence in Math Teaching

A teacher's confidence in their own math teaching ability is a part of their broader self-efficacy, or “judgments of their capabilities to organize and execute courses of action required to attain designated types of performance” (Bandura, 1986, p. 391). Self-efficacy is related to locus of control and social cognitive theories (Zee & Koomen, 2016), depends on context (Urdan & Pajares, 2006) and affects how someone makes *others* feel (Kernis et al., 1989).

Our subjective measure of confidence in math teaching ability is part of a self-efficacy mindset. Forty years of research suggests that teachers who report feeling effective in their jobs employ high-quality classroom practices, consider themselves highly satisfied and committed to their job, report low job burnout, and instruct motivated and high-achieving students (see Zee & Koomen, 2016). These correlates of teacher confidence should contribute to students' classroom belonging. Math teachers with high confidence in their instruction help students achieve academically, engage in learning, and perceive high-quality math classroom relationships (Perera & John, 2020). We predict those effects translate to increased classroom belonging among students.

Hypothesis 2: Teacher confidence in math teaching ability is positively associated with students' sense of belonging in their math class.

Growth Mindset about Math Ability

People disagree about whether we can control our thoughts and feelings, but often do not articulate those beliefs. Such *implicit theories* about the world include personal understandings of how psychological constructs—like intelligence, motivation, or emotion—work (Sternberg, 1985). For example, people hold implicit theories about the nature of human intelligence. Some believe we have a predetermined amount of intelligence that is variable in the population but constant within ourselves. Those who adhere to such a “fixed” understanding of human intelligence consider some individuals naturally intelligent, and some not. Others

instead believe we exact control over our level of intelligence, which consequently grows with concerted effort. These people implicitly believe that human intelligence changes, also known as a *growth mindset* about intelligence (Dweck, 2006).

Students' fixed and growth theories of intelligence affect their academic achievement and emotional engagement (Blackwell et al., 2007; Yeager et al., 2019). How students interpret their *teachers'* implicit theories influences their own feelings about school (Rattan et al., 2018). For example, teachers' implicit theories about people's math abilities predict children's motivation in their math class (Heyder et al., 2020) and adolescents' growth mindsets about math ability (Bostwick et al., 2020).

Despite conceptual links between student beliefs and teachers' implicit theories of intelligence, we know little about the relationship between teachers' growth or fixed mindsets of intelligence and adolescents' school belonging. To the extent that teachers' beliefs translate to actual words and deeds—and those words and deeds inform adolescents' beliefs about their teachers—teacher theories of intelligence will influence adolescent belonging considerably. A teacher's growth mindset of intelligence may help their students feel as though they can become better at math and thus feel belonging in math class, because a growth mindset influences how a teacher acts in class, which in turn signals a growth mindset to students. Teachers who believe that math ability is fixed could instead devote less effort to students who fail to grasp new math skills, ascribing failure to the students and not to the nature of instruction. As a result, struggling adolescents may feel as though they do not belong in math class because they interpret from their teachers that they are not good at math, simply because they are “not a math person” (Rattan et al., 2012).

Hypothesis 3: Teacher growth mindset about math skills is positively associated with students' math class belonging.

Data and Methods

Sample

To test these three hypotheses, we partnered with the Madison Metropolitan School District (MMSD), a diverse, mid-sized urban public-school district deeply committed to equity—including through fostering belonging among all students. The district serves a student population that is 44 percent White, 20 percent Black, 20 percent Latinx, 9 percent Asian, eight percent multiracial and one percent of another race or ethnicity. Nearly half of the students in the district participate in the district’s free or reduced-price meal programs. Collaboratively with MMSD, we have collected survey data on students in five of the district’s dozen middle schools and their math teachers from the third quarter of the 2019-2020 school year, linking those data to administrative records using unique student and teacher identifiers.

Of 2,275 eligible to participate in the survey, 1,891 did so, for a response rate of 83%. We achieved a response rate of 71% with the teacher survey. Attrition results from three sources: the teachers of 518 eligible students did not complete a survey, 17 additional students did not complete a survey themselves and another 118 students did not have prior-year math scores or classroom grades. The analytic sample does not vary meaningfully from the full sample on all observable student characteristics. Our analytic sample of 1,237 students and their 35 teachers across 84 math classrooms represents the overlap between the student and teacher survey samples.

Measures

Measures of student and teacher beliefs come from those survey data. Our sole, pre-registered dependent variable is the student *math class belonging* scale, which includes three items asking students about belonging in their current math class (e.g., “How much do you feel you belong in math class?”; $\alpha = 0.73$; see Appendix Table A1).¹ We evaluate how the math class belonging scale relates to three teacher mindset scales. First, the teacher *school belonging* scale contains ten items asking

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teachers the degree to which they feel like they belong at their school, are respected and trusted by colleagues, and respect and trust other staff (e.g., “I feel I belong at this school”; $\alpha = 0.86$). Second, the *confidence in math teaching* scale includes four items on the degree to which teachers believe they can help students learn math skills (e.g., “I can help the least prepared students”; $\alpha = 0.86$). Finally, the *growth mindset about math ability* scale contains five items assessing the degree to which teachers believe that intelligence, and math ability explicitly, grows with effort (e.g., “Some people are math people and some are not (R)”; $\alpha = 0.65$). Appendix Table A2 includes detailed information on each of the above items, while Appendix Table A3 reports on correlations between each scale. The Appendix also reports additional information on the sample and measures we use.

From linked MMSD administrative records, we obtain each student’s unique math class ID, connected to teacher identifiers, grade-level identifiers, demographics and other relevant school-related student data. A race or ethnicity indicator differentiates students reported as White, Black, Latinx, Asian, or else multiracial or of another ethnic category. Binary indicators code girls, English language learners, those participating in subsidized school meal programs, and those participating in special education programs as “1” and their counterparts “0”. Our measure of parental education differentiates students whose parents’ highest level of education is less than high school, a high school degree, some college, a four-year college degree, a graduate or professional degree, or not reported.

Research Design

In preliminary analyses, we estimated factor models to evaluate the quality of our teacher mindset and student belonging scales and to explore whether the measurement properties of these scales vary across school contexts. Finding that additive scales and those constructed using factor scores are highly correlated (between $r = .85$ and $.97$), we resolve to use additive scale scores so others can better interpret and replicate our results.

Let Y_{ic} be the math class belonging of student i in classroom c . We first estimate a preliminary model to decompose the variance in student math class belonging based on student-level predictors:

$$Y_{ic} = \gamma_{00} + \mathbf{Z}\boldsymbol{\beta} + u_{0c} + e_{ic} \quad (1)$$

in which u_{0c} is a classroom-specific random effect and e_{ic} is a student-specific random effect. Assuming these sources of variance are independent, this equation reflects how sense of belonging varies among students, between classrooms, and independent of a vector of student attributes $\mathbf{Z}$, which includes student general sense of belonging, ELA class sense of belonging, race or ethnicity, gender, special education status, English learner status, parental education and income, past academic achievement (i.e., prior-year tests and grades), and grade-level and school fixed effects.

To explore how teacher mindsets contribute to student math class belonging, we test hypotheses 1-3 by modifying equation (1) to reflect the contribution of teacher mindset at the classroom level, estimating parameters for the contribution of individual average measures of teacher mindset to student belonging:

$$Y_{ic} = \gamma_{00} + \mathbf{Z}\boldsymbol{\beta} + \mathbf{X}\boldsymbol{\lambda} + u_{0c} + e_{ic} \quad (2)$$

in which $\boldsymbol{\lambda}$ estimates the contribution represents a vector of the three teacher mindsets ($\mathbf{X}$) described in this paper. Finally, we test hypotheses 4a and 4b by interacting teachers' mindsets about the importance of student social background with student race or ethnicity and student participation in free or reduced-price school meal programs.

All the above models implicitly weight teacher-level coefficients in proportion to the number of classrooms each teacher instructs. To account for that implicit weighting, we add a classroom-level weight to all models that is equal to the inverse of the number of classrooms each teacher instructs (ranging from one to five). This has the effect of generalizing level-two results to teachers rather than classrooms, while maintaining classroom-level estimates of student sense of math

class belonging and capitalizing on additional power from classroom-level random effects.

Results

Table 1 reports descriptive statistics on the sample's 1,237 middle school students and their 35 math teachers. We report three distinct teacher mindset measures, all of which have left-skewed distributions. The average teacher's school belonging score is just above a four out of five among scale items (Mean = 4.15, SD = 0.53). Teacher confidence in their own math teaching abilities is just below a four out of five among scale items (Mean = 3.82, SD = 0.90). Teacher growth mindset about math ability is quite left-skewed (Mean = 4.39, SD = 0.57).

Student survey scales have left-skewed distributions too, but average closely to the middle range of response categories. The average student's reported math class belonging is just over three and two-thirds out of five (Mean = 3.67, SD = 0.85), their school belonging averages about three and a half points out of five (Mean = 3.56, SD = 0.72) and their reported English language arts class belonging scores similarly (Mean = 3.51, SD = 0.80). Students' prior-spring math test scores, standardized within grade level, are normally distributed, but their prior-spring math class grade distribution is left skewed.

White students comprise 40 percent, Black students 13 percent, Latinx students 30 percent, and Asian students 9 percent of the analytic sample, with the remaining 8 percent multiracial or identifying with another racial or ethnic group. Girls make up half of the analytic sample's students, and 49 percent of sample members participate in the district's free or reduced-price school meal program, a tenth participate in special education services, 38 percent are English language learners, and half have at least one parent with a bachelor's degree or higher.

Teacher-Level Predictors of Math Class Belonging

We next report multilevel model results. Figure 1 presents teacher mindset coefficient point estimates and 95% confidence intervals, conditional on students'

race or ethnicity, gender, subsidized lunch participation, prior test scores and classroom grades, and their self-reported school and English language arts class belonging. Hypothesis 1 predicts a math teacher's own reported school belonging positively relates to their students' math class belonging. A near-zero relationship between conditional teacher school belonging and student math class belonging implies otherwise ($\beta=-0.006$, $SE=0.056$, $p=0.915$). Results support hypothesis 2, suggesting a one standard deviation increase in teacher confidence about their math teaching ability corresponds to a fifth of a standard deviation increase in their students' math class belonging, net of student-level controls and other teacher mindsets ($\beta=0.198$, $SE=0.045$, $p<0.001$). Results also support hypothesis 3, implying a one standard deviation increase in teacher growth mindset about math ability relates to almost a fifth of a standard deviation increase in students' math class belonging ($\beta=0.168$, $SE=0.057$, $p=0.005$). See Appendix Table A4 for additional results.

Model results from Figure 1 (shown in Table A4, column 2) suggest that, conditional on the multilevel model's independent variables, 11 percent of variation in student math class belonging is among classrooms and 89 percent within classrooms (Intraclass Correlation Coefficient [or ICC]=0.105; Table A4, column 2). Compared to the model including only student-level covariates and school random effects (ICC=0.178; see Table A4, column 1), we conclude that the three teacher mindsets we measure explain 40 percent (i.e., $1 - [0.109/0.178]$) of the between-classroom variation in students' math class belonging.²

Teacher Mindsets and Classroom Belonging by Race and Ethnicity

Although not a part of the pre-registered confirmatory analyses, these results have motivated exploratory analyses on differences by students' race and ethnicity. To that end, we interact each of the three continuous teacher mindset measures with the categorical student race and ethnicity variable reported in previous models (with

reference category being “White”). We report the main results of those analyses in Table 2, with covariate estimates reported in Table A5.

The first column of Table 2 reports relationships between teacher school belonging and student math class belonging by race and ethnicity. We find there are no conditional within-race associations between teacher sense of school belonging and student math classroom belonging that are statistically significant or substantively large.

Column 2 of Table 2 suggests that White students experience a 0.16 standard deviation higher sense of math classroom belonging when their math teacher is one standard deviation above the mean in confidence about their teaching ($\beta=0.160$, $SE=0.055$, $p=0.004$). Latinx students enjoy a similar increase in belonging, and Asian students have slightly higher average levels than White students, although they are not statistically different. Black students’ math class belonging changes at twice the rate of their White peers (i.e., a 0.31 SD increase in classroom belonging) with each standard deviation increase in teachers’ confidence in their math teacher ability ($\beta=0.148$, $SE=0.074$, $p=0.046$).

The third column of Table 2 suggests that White students report feelings of math class belonging a fifth of a standard deviation higher with each standard deviation increase in their teacher’s growth mindset about math ability ($\beta=0.212$, $SE=0.063$, $p=0.001$). Latinx students do not vary at all from White students in this relationship. The interaction term among Black students suggests *smaller* associations than among White students, but the interaction term is not statistically significant ($\beta=-0.120$, $SE=0.114$, $p=0.294$). However, the growth mindset-by-Asian student interaction term suggests that teacher’s growth mindset about math ability appears to have almost no bearing (i.e., a -0.03 SD change) on the math class belonging of Asian adolescents ($\beta=-0.179$, $SE=0.067$, $p=0.008$).

In similar interaction models not shown, we find that family income, gender, and prior math achievement do not moderate the relationships between any of the

three teacher mindsets and students' feelings of math class belonging, net of controls (results available upon request). We also find no statistically significant race-by-gender interactions predicting math class belonging.

Discussion

We have shown how three teacher mindsets predict students' math class belonging. Following our pre-registered analyses, we conclude that teachers' confidence in their math teaching and their growth mindset about people's math abilities are positively associated with a typical middle school student's belonging in math class, conditional on the student's feelings of school belonging, their belonging in other classes, their prior math achievement (i.e., test scores and grades), and their demographic characteristics. The same is *not* true of teachers' own reported feelings of school belonging, which appear to have no relationship with their students' math classroom belonging. Together, these teacher mindsets explain about 40 percent of the variation in the conditional class averages of student math class belonging.

Consider the ways a teacher's confidence in their ability to teach math may shape student math classroom belonging. First, their beliefs may reflect the reality that teaching skills vary. If so, we would expect students in classes taught by more effective teacher to experience greater feeling of success and thus greater feelings of belonging in the classroom. Second, even net of actual skill, teachers who believe they are effective instructors may be more willing to try to reach all of their students than teachers who feel less effective. This sort of effort is likely not lost on those in the classroom and may contribute to a classroom-level sense of worth and belonging. A math teacher's confidence relates to student learning, motivation, engagement, and classroom relationships (Perera & John, 2020; Zee & Koomen, 2016) Those outcomes may mean teachers influence students' belonging in class beyond their confidence in the content area, including their confidence in how they relate to students, believe in their ability to manage and hold the room, and so on.

Although not a part of our main, pre-registered research agenda, exploratory analyses suggest a teacher's confidence in their math instruction is more predictive of math classroom belonging for Black students than for White students, all else equal. This finding fits into a larger pattern by which Black students are more sensitive to teacher inputs than White students. Black students benefit more than their White peers from early childhood education (Gormley & Gayer, 2005), having the same teacher across adjacent grade levels (Hill & Jones, 2018), and smaller class sizes in the early grades (Krueger & Whitmore, 2002; Nye, Hedges, & Konstantopoulos, 2004). Perhaps Black students are more receptive to different teaching skills, or beliefs about those skills, than are otherwise similar White students.

Consider next that when teachers believe a student's math ability grows with effort (i.e., the teacher's growth mindset) affects more than just students' grades and test scores. Growth mindset teachers have students who are motivated and who themselves have growth mindsets about math ability (Bostwick et al., 2020; Heyder et al., 2020). Teachers' and students' individual theories about people's math abilities can then affect classroom belonging collectively. For example, if a teacher signals to the class that math ability is something they can change—that people are not simply natural math learners—that is going to relate to how students feel about the community being built in that class day after day, month after month, as they all continue to work and learn together.

Our exploratory analyses of teacher growth mindset suggest Asian students' math classroom belonging is *less* related to teacher growth mindset than the belonging reported by White students. With much less certainty (i.e., $p = 0.29$), the same may be true of Black students—which seemingly contradicts our analysis that Black students generally have *higher* sensitivity to teacher inputs than White students. Although we are unable to empirically address the sources of these disparities in student responses, we speculate about several possibilities. First, teachers may be less effective at communicating their beliefs to Asian (and perhaps Black) students than

they are to White students. Or, teachers may hold beliefs about growth versus fixed mindsets that vary across student racial/ethnic groups, such that on average they believe students in some groups are more capable of learning math than students in other groups.

It could also be that Asian (and perhaps Black) students have stronger prior beliefs about growth mindset than White students, on average. Those beliefs could come from family and community influences or through internalized stereotypes. For example, students could internalize beliefs about being part of a “model minority” group assumed to naturally do well in school (Lee, 2015), or a group considered inherently “bad” at school (Steele, 1997). Such strong priors about one’s growth mindset may simply defy the influence of teachers. We unfortunately lack data to address any of these possibilities.

Conclusion

These findings about math teachers and their students reinforce the notion that what teachers think and believe influences how students feel when in class—both individually and collectively. While most studies show us how students’ feelings about school are important, our work in math class—a critical core subject for student success—attends to how teacher mindsets shape students’ belonging in classrooms, which could influence how students feel across the school more broadly. If we want to improve adolescents’ feelings of belonging in classrooms, understanding the influence of their teachers’ mindsets makes sense. A next step is better understanding how and whether we can improve teachers’ mindsets so that adolescents feel more belonging in class and in school.

Endnotes

1. Between-race differences in reliability of the math class belonging scale are negligible, ranging from $\alpha = 0.67$ among Asian students, $\alpha = 0.70$ among Black students, $\alpha = 0.71$ among Latinx students, and $\alpha = 0.75$ among White students.
2. We experimented with the functional form of the two statistically significant teacher mindset measures (i.e., teacher confidence and growth mindset) by constructing somewhat arbitrary binary categorical versions of those scales. We found the binary measures were also meaningfully related and statistically significant predictors of student math class belonging. However, Akaike information criteria (AIC) and Bayesian information criteria (BIC) fit indices both suggested that simplifying these two scales into binary measures worsens model fit. We thus report the continuous scales only in this paper, but binary results are available upon request.

References

- Allen, K. A., Kern, M. L., Vella-Brodrick, D., Hattie, J., & Waters, L. (2018). What schools need to know about fostering school belonging: A meta-analysis. *Educational Psychology Review*, 30, 1-34.
- Anderman, L. H. (2003). Academic and social perceptions as predictors of change in middle school students' sense of school belonging. *The Journal of Experimental Education*, 72(1), 5-22.
- Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359-373.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497-529. doi:10.1037//0033-2909.117.3.497.
- Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development*, 78(1), 246-263.
- Borman, G. D., Rozek, C. S., Pyne, J., & Hanselman, P. (2019). Reappraising academic and social adversity improves middle-school students' academic achievement, behavior, and well-being. *Proceedings of the National Academy of Sciences*, 116(33), 16286-16291.
- Bostwick, K. C. P., Collie, R. J., Martin, A. J., & Durksen, T. L. (2020). Teacher, classroom, and student growth orientation in mathematics: A multilevel examination of growth goals, growth mindset, engagement, and achievement. *Teaching and Teacher Education*, 94, 103100.
- Bryk, A. S., & Raudenbush, S. W. (1988). Toward a more appropriate conceptualization of research on school effects: A three-level hierarchical linear model. *American Journal of Education*, 97(1), 65-108.
- Bryk, A. S., & Schneider, B. (2004). *Trust in schools: A core resource for improvement*. New York: Russel Sage Foundation.
- Dee T. S., Penner E. K. (2017). The causal effects of cultural relevance: Evidence from an ethnic studies curriculum. *American Educational Research Journal*, 54(1):127-166.
- Dreeben, R., & Barr, R. (1988). Classroom composition and the design of instruction. *Sociology of Education*, 61(3), 129-142.
- Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.
- Eccles, J. S. (2004). Schools, academic motivation, and stage-environment fit. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (2 ed., pp. 125-153). Hoboken, NJ: John Wiley & Sons.
- Farrington, C., Porter, S., & Klugman, J. (2019). *Do classroom environments matter for noncognitive aspects of student performance and students' course grades*. Chicago, IL: University of Chicago Consortium on School Research.

- Goddard, R. D., Hoy, W. K., & Hoy, A. W. (2004). Collective efficacy beliefs: Theoretical developments, empirical evidence, and future directions. *Educational Researcher*, 33(3), 3-13.
- Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools*, 30, 79-90.
- Gormley, W. T., & Gayer, T. (2005). Promoting school readiness in Oklahoma: An evaluation of Tulsa's pre-k program. *Journal of Human Resources*, 40(3), 533-558. doi:10.3368/jhr.XL.3.533
- Heyder, A., Weidinger, A. F., Cimpian, A., & Steinmayr, R. (2020). Teachers' belief that math requires innate ability predicts lower intrinsic motivation among low-achieving students. *Learning and Instruction*, 65, 101220.
- Hill, A. J., & Jones, D. B. (2018). A teacher who knows me: The academic benefits of repeat student-teacher matches. *Economics of Education Review*, 64, 1-12.
- Kernis, M. H., Grannemann, B. D., & Barclay, L. C. (1989). Stability and level of self-esteem as predictors of anger arousal and hostility. *Journal of Personality and Social Psychology*, 56(6), 1013-1022.
- Krueger, A. B., & Whitmore, D. M. (2002). Would smaller classes help close the Black-White achievement gap? In J. E. Chubb & T. Loveless (Eds.), *Bridging the achievement gap* (pp. 11-46). Washington, D.C.: Brookings Institution Press.
- Lee, S. J. (2015). *Unraveling the "model minority" stereotype: Listening to Asian American youth*. Teachers College Press.
- Nye, B., Hedges, L. V., & Konstantopoulos, S. (2004). Do minorities experience larger lasting benefits from small classes? *The Journal of Educational Research*, 98(2), 94-100.
- Okonofua, J. A., Paunesku, D., & Walton, G. M. (2016). Brief intervention to encourage empathic discipline cuts suspension rates in half among adolescents. *Proceedings of the National Academy of Sciences*, 113(19), 5221-5226.
- Okonofua, J. A., Walton, G. M., & Eberhardt, J. L. (2016). A vicious cycle: A social-psychological account of extreme racial disparities in school discipline. *Perspectives on Psychological Science*, 11(3), 381-398.
- Osterman, K. F. (2010). Teacher practice and students' sense of belonging. In T. Lovat, R. Toomy, & N. Clement (Eds.), *International research handbook on values education and student wellbeing* (pp. 239-260). New York: Springer.
- Perera, H. N., & John, J. E. (2020). Teachers' self-efficacy beliefs for teaching math: Relations with teacher and student outcomes. *Contemporary Educational Psychology*, 61, 101842.
- Rattan, A., Good, C., & Dweck, C. S. (2012). "It's ok—not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. *Journal of Experimental Social Psychology*, 48(3), 731-737.

- Rattan, A., Savani, K., Komarraju, M., Morrison, M. M., Boggs, C., & Ambady, N. (2018). Meta-lay theories of scientific potential drive underrepresented students' sense of belonging to science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, 115(1), 54-75.
- Ronfeldt, M., Farmer, S. O., McQueen, K., & Grissom, J. A. (2015). Teacher collaboration in instructional teams and student achievement. *American Educational Research Journal*, 52(3), 475-514.
- Rosenthal, R., & Jacobson, L. (1968). Pygmalion in the classroom. *The Urban Review*, 3(1), 16-20.
- Skaalvik, E. M., & Skaalvik, S. (2011). Teacher job satisfaction and motivation to leave the teaching profession: Relations with school context, feeling of belonging, and emotional exhaustion. *Teaching and Teacher Education*, 27(6), 1029-1038.
- Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, 52(6), 613-629.
- Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of intelligence*. Cambridge: Cambridge University Press.
- U.S. Department of Education Office for Civil Rights. (2016). 2013-2014 Civil Rights Data Collection: A first look. Washington, DC: U.S. Government Printing Office.
- Urdu, T., & Pajares, F. (2006). *Self-efficacy beliefs of adolescents*. Greenwich, CT: Information Age.
- Walton, G. M., & Brady, S. T. (2017). The many questions of belonging. In A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation: Theory and application* (2nd Edition ed., pp. 272-293). New York: Guilford Press.
- Walton, G. M., & Yeager, D. S. (2020). Seed and soil: Psychological affordances in contexts help to explain where wise interventions succeed or fail. *Current Directions in Psychological Science*, 29, 219-226.
- Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., . . . Hinojosa, C. P. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, 1-6. doi:10.1038/s41586-019-1466-y.
- Zee, M., & Koomen, H. M. Y. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational Research*, 86(4), 981-1015.

Figures

Figure 1. Relationships between Teacher Mindsets and Student Math Class Belonging

Note: Teacher-level statistics include 35 teachers. Student-level statistics include 1,237 students. Estimates are conditional on each other, as well as students' race or ethnicity, gender, subsidized lunch participation, prior test scores and classroom grades, and their self-reported school and English language arts class belonging. Results in figure correspond to coefficients and standard errors reported in Table A4, column 2.

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Tables

Table 1. Descriptive Statistics

	Mean	Standard Deviation	Skewness	Kurtosis
Teacher-Level Variables				
Sense of School Belonging	4.15	0.53	-0.90	3.72
Confidence in Own Math Teaching	3.82	0.90	-0.77	3.98
Growth Mindset about Math Ability	4.39	0.57	-1.33	5.43
Student-Level Variables				
Sense of Math Class Belonging	3.67	0.85	-0.57	3.12
Sense of General School Belonging	3.56	0.72	-0.56	3.57
Sense of ELA Class Belonging	3.51	0.80	-0.48	3.20
Prior MAP Math Test Score (Standardized within grade level)	0.00	1.00	-0.03	2.73
Prior Math Class Grade (Standardized within grade level)	0.00	1.00	-0.71	3.44
	%	Frequency		
Race/Ethnicity				
White	40	493		
Asian	9	113		
Black	13	161		
Latinx	30	367		
Other	8	103		
Female	50	623		
Subsidized Lunch Participation	49	607		
Special Education Participant	10	122		
English Language Learner	38	476		
Parental Education				
Less than High School	8	100		
High School Degree	17	216		
Some College	22	270		
Four-Year College Degree	18	226		
Graduate/Professional Degree	32	398		
Not Reported	2	27		
Grade Level				
6 th	40	499		
7 th	27	333		

Note: Teacher-level statistics include 35 teachers. Student-level statistics include 1,237 students. This analytic sample is derived from a full sample that includes 1,890 students in middle school math classrooms. All teacher and student survey scales are constructed by averaging all nonmissing values in the scale. Attrition results due to 518 students who were in math classes in which teachers did not complete a survey, followed by an additional 17 students who did not complete a student survey and another 118 students for whom prior-year math scores or math grades are unavailable.

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Table 2. Teacher Mindsets and Classroom Belonging, by Race and Ethnicity

Independent Variable	Teacher Mindset Variable		
	Sense of School Belonging	Confidence in Math Teaching	Growth Mindset about Math Ability
Teacher Mindset Variable	-0.03 (0.06)	0.16** (0.05)	0.21*** (0.06)
Race/Ethnicity (REF = White)			
Asian	-0.08 (0.09)	-0.08 (0.10)	-0.09 (0.09)
Black	-0.05 (0.11)	-0.03 (0.09)	-0.07 (0.10)
Latinx	-0.07 (0.10)	-0.07 (0.10)	-0.09 (0.10)
Other	-0.24* (0.10)	-0.22* (0.11)	-0.23* (0.09)
Teacher Mindset X Asian	0.07 (0.06)	0.09 (0.07)	-0.18** (0.07)
Teacher Mindset X Black	0.07 (0.08)	0.15* (0.07)	-0.12 (0.11)
Teacher Mindset X Latinx	0.04 (0.07)	0.02 (0.07)	-0.00 (0.08)
Teacher Mindset X Other	-0.04 (0.10)	0.06 (0.08)	-0.14 (0.08)
Constant	0.15 (0.17)	0.16 (0.18)	0.15 (0.18)

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Note: The analytic sample consists of 1,237 students in 84 classrooms containing 35 unique teachers. Standardized estimates shown are derived from a multilevel model in which students are nested in classrooms, with standard errors clustered within teachers. Model includes controls for student sense of general belonging, student sense of ELA class belonging, student race/ethnicity, parental education, gender, subsidized lunch eligibility, special education status, English proficiency, and prior-spring math test scores and grades (see Appendix Table A5 for covariate estimates). The dependent variable is a standardized average score of students' self-reported sense of belonging in math class items (see Table A1). High teacher confidence and math growth mindset categories are defined as those who are within 1 standard deviation from the highest possible score, relative to a group of teachers who are more than 1 standard deviation from the highest score on confidence or math growth mindset scales. Models are weighted at the classroom level by the inverse of the number of math classrooms each teacher is in and include grade-level and school fixed effects. Robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Appendix

TEACHER MINDSETS AND STUDENT BELONGING

Table A1. Student Survey Item Responses

Survey Items	Mean	Standard Deviation	Likert Category (%)				
			1	2	3	4	5
Sense of Math Class Belonging ($\alpha = 0.74$)							
How much do you feel like you belong in math class?	3.69	1.06	5	8	26	37	24
How connected do you feel to your classmates in math class?	3.54	1.02	4	10	31	37	18
How much does your math teacher listen to and value your ideas?	3.78	1.06	4	7	23	38	28
General Sense of School Belonging ($\alpha = 0.71$)							
I feel I belong in this school	3.76	0.92	3	6	23	50	18
I enjoy going to school	3.15	1.09	9	14	38	28	10
I make an effort to learn even when work feels hard	3.90	0.85	1	4	20	51	23
How well do you fit in your school?	3.42	0.92	4	10	36	41	9
Sense of ELA Class Belonging ($\alpha = 0.67$)							
How much do you feel like you belong when you are in ELA class?	3.56	0.99	4	9	32	39	17
How connected do you feel to your classmates in ELA class?	3.36	0.98	4	14	35	36	11
How much does your ELA teacher listen to and value your ideas?	3.60	1.05	4	11	26	38	20

Note: N = 1,237 students. Some items contain slightly fewer students due to nonresponse.

TEACHER MINDSETS AND STUDENT BELONGING

Table A2. Teacher Survey Item Responses

Survey Items	Mean	Standard Deviation	Likert Category (%)				
			1	2	3	4	5
Sense of School Belonging ($\alpha = 0.86$)							
I feel I belong at this school	4.54	0.66	0	3	0	37	60
Staff members respect each other's work	4.40	0.6	0	0	6	49	46
I enjoy going to work	4.29	0.75	0	0	17	37	46
Staff help each other when it is needed	4.51	0.70	0	3	3	34	60
Comfortable discussing feelings, worries, and frustrations with staff	3.77	0.81	3	0	29	54	14
Trust other teachers in this school	3.83	0.66	0	3	23	63	11
Respect other teachers in this school	4.17	0.57	0	0	9	66	26
Trust my principal	3.91	1.09	6	0	29	29	37
Respect my principal	4.11	0.93	0	6	20	31	43
Believe in the equity vision of the school	4.34	0.68	0	0	11	43	46
Confidence in Math Teaching ($\alpha = 0.91$)							
I can help the least prepared students	3.66	1.11	3	11	31	26	29
I can directly impact students' achievement in math	4.09	0.89	3	0	17	46	34
I can get students in class interested in math	3.46	1.07	3	11	46	17	23
I can clearly explain mathematical concepts to students	3.91	1.01	3	6	20	40	31
Growth Mindset about Math Ability ($\alpha = 0.65$)							
To be honest, students have a certain amount of intelligence	1.37	0.69	71	23	3	3	0
Some people are math people and some are not	1.60	1.03	69	14	6	11	0
Anyone can learn math if they put in the effort	4.60	0.88	3	0	9	11	77
Your intelligence is something about you that you can't change very much	1.34	0.73	77	14	6	3	0
I worry my students will become discouraged if I challenge them	2.34	1.30	37	23	11	26	3

Note: N = 35 teachers. Some items contain slightly fewer teachers due to nonresponse.

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Table A3. Student and Teacher Survey Scale Correlations

Panel A. Student Scale Correlations (n = 1,237)

	Math Class Sense of Belonging	General Sense of School Belonging
Sense of Math Class Belonging	1.00	
General Sense of School Belonging	0.56	1.00
Sense of ELA Class Belonging	0.41	0.53

Panel B. Teacher Scale Correlations (n = 35)

	Sense of School Belonging	Confidence in Math Teaching
Sense of School Belonging	1.00	
Confidence in Math Teaching	0.21	1.00
Growth Mindset about Math Ability	0.11	0.23

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Table A4. Predictors of Student Sense of Belonging in Math Class

Independent Variable	(1)	(2)
Teacher Sense of School Belonging	--	-0.01 (0.06)
Teacher Confidence in Math Teaching	--	0.20*** (0.04)
Teacher Growth Mindset about Math Ability	--	0.17** (0.05)
Student Sense of General School Belonging	0.40*** (0.03)	0.39*** (0.03)
Student Sense of ELA Class Belonging	0.21*** (0.03)	0.21*** (0.03)
Race/Ethnicity (REF = White)		
Asian	-0.10 (0.09)	-0.10 (0.09)
Black	-0.08 (0.10)	-0.07 (0.10)
Latinx	-0.08 (0.10)	-0.08 (0.10)
Other	-0.26* (0.10)	-0.24* (0.10)
Female	-0.15** (0.05)	-0.16*** (0.05)
Subsidized Lunch Participation	0.06 (0.07)	0.06 (0.07)
Prior MAP Math Test Score (Standardized)	-0.01 (0.05)	-0.00 (0.05)
Prior Math Class Grade (Standardized)	0.00 (0.03)	-0.00 (0.03)
Constant	-1.06*** (0.03)	-0.29*** (0.03)
Level-2 Variance	0.120	0.068
Level-1 Variance	0.556	0.557
Intraclass Correlation Coefficient	0.178	0.105

TEACHER MINDSETS AND STUDENT BELONGING

Note: The analytic sample consists of 1,237 students in 84 classrooms containing 35 unique teachers. Estimates shown are derived from a multilevel model in which students are nested in classrooms, with standard errors clustered within teachers. model is weighted at the classroom level by the inverse of the number of math classrooms each teacher is in. The dependent variable is a standardized average score of students' self-reported sense of belonging in math class items (see Table A1). Model also accounts for parental education, special education participation, English Language Learner status and grade-level and school fixed effects. Robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

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Table A5. Covariate Estimates from Table 2

Independent Variable	Sense of School Belonging	Confidence in Math Teaching	Growth Mindset about Math Ability
Sense of School Belonging	--	0.00 (0.06)	-0.01 (0.05)
Confidence in Math Teaching	0.20*** (0.05)	--	0.20*** (0.04)
Growth Mindset about Math Ability	0.17** (0.06)	0.17** (0.06)	--
Student Sense of General School Belonging	0.39*** (0.03)	0.39*** (0.03)	0.39*** (0.03)
Student Sense of ELA Class Belonging	0.21*** (0.03)	0.22*** (0.03)	0.21*** (0.03)
Female	-0.16*** (0.05)	-0.16*** (0.05)	-0.16*** (0.05)
Subsidized School Meal Participation	0.06 (0.07)	0.06 (0.07)	0.06 (0.07)
Parental Education (REF = High School Degree)			
Less than High School	-0.07 (0.11)	-0.09 (0.10)	-0.07 (0.10)
Some College	-0.10 (0.10)	-0.11 (0.10)	-0.09 (0.10)
Four-Year Degree	-0.03 (0.12)	-0.04 (0.12)	-0.02 (0.12)
Graduate/Professional Degree	0.00 (0.12)	-0.02 (0.11)	0.00 (0.12)
Missing	0.05 (0.15)	0.02 (0.14)	0.07 (0.15)
Special Education Participation	-0.03 (0.07)	-0.03 (0.07)	-0.03 (0.07)
English Language Learner	0.00 (0.08)	0.01 (0.08)	0.01 (0.08)
Prior Spring Math Score (Standardized)	-0.01 (0.05)	-0.01 (0.05)	-0.01 (0.05)
Prior Spring Math Class Grade (Standardized)	-0.00 (0.03)	-0.01 (0.03)	-0.01 (0.03)

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Note: The analytic sample consists of 1,237 students in 84 classrooms containing 35 unique teachers. Estimates shown are derived from the multilevel model reported in Table 2 and includes measures of teacher beliefs. The dependent variable is a standardized score of students' self-reported sense of belonging in math class items (see Table A1). Models are weighted at the classroom level by the inverse of the number of math classrooms each teacher is in and include grade-level and school fixed effects. Robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.