Supporting Information

Beilock et al. 10.1073/pnas.0910967107

SI Methods

Teacher Participants. Teachers' math anxiety and math knowledge were assessed during the last 2 months of the school year along with other measures of cognitive ability and social attitudes for a separate project not discussed further.

Example items of the Elementary Number Concepts and Operations subtest of the Content Knowledge for Teaching Mathematics measure (1) used to assess teachers' math knowledge can be found in *Appendix S1*.

Student Participants. At the beginning of the school year, parent consent forms were distributed in the classrooms of the 17 teachers described in the text. Consent forms were returned for 133 students. Eight girls and eight boys were excluded from the study: four (two girls and two boys) because they did not complete the math achievement task, five (four girls and one boy) because they transferred to a different school between the sessions at the beginning and end of the year, and seven (two girls and five boys) because their end-of-year math achievement scores were more than 2 SDs below the mean for their gender or for students as a whole. The remaining 117 participants consisted of 65 girls and 52 boys.

Yearly household income was reported by parents for 104 of the children. The mean household income was $40,553 (SE = $2,693). The poverty line for a household of four in the United States, which is set annually by the US Department of Health and Human Services, was $22,050 in 2009.

Race was reported by parents for 117 of the children: 41% were Hispanic, 33% were black or African American, 15% were white, 5% were Asian, and 6% were other or multiple races. Including race as a factor did not alter the significance of the mediation analyses reported in the main text in any way.

Finally, the number of girls and boys was fairly evenly distributed across the two grades (girls: 40 first graders and 25 second graders; boys: 38 first graders and 14 second graders). Including grade as a factor did not alter the significance of the mediation analyses reported in the paper in any way.

Student Tasks. Students' math achievement and gender ability beliefs were assessed during the first 3 months and the last 2 months of the school year along with other measures of cognitive ability and social attitudes for a separate project not discussed further. Math achievement was measured using the Applied Problems subtest of the Woodcock–Johnson III Tests of Achievement (2). The Applied Problems subtest consists of orally presented word problems involving arithmetic calculations of increasing difficulty. Students were assessed at school during a one-on-one session with an experimenter. A different form of the Woodcock–Johnson Applied Problems subtest was used for each assessment. Testing continued until basal (six items correct in a row) and ceiling (six items incorrect in a row) levels were established. Because of experimenter error, some subjects only completed between three and five items for the basal or ceiling level. These subjects were scored as if they had completed the full basal or ceiling level.

Students' gender ability beliefs (3) (*Appendix S2*) were assessed after the math achievement task. Given the early grade level of the children in this study, we thought that an indirect assessment of the beliefs students held about who should succeed in particular academic domains (i.e., our drawing task) would elicit a better measure of girls' and boys' gender ability beliefs than explicitly asking students for their views about gender and ability. Moreover, given that we were interested in how female teachers' anxieties might differentially influence girls' math achievement relative to that of boys, we expected these gender-related measures of ability beliefs to provide optimal explanatory power regarding the relation between teacher math anxiety and girls' and boys' math achievement—as opposed to, for example, a domain general measure of students' fear or anxiety about math (and/or other subjects in school) that does not tap into students' gender beliefs in these areas.

Data Analysis

Descriptive Analysis. Teacher math anxiety scores ranged from 1.6 to 4.2 of a possible 5 (M = 2.4, SD = 0.85). Teacher math knowledge scores ranged from 3 to 22 of a possible 26 (M = 10.0, SD = 5.0). No differences were found between first- and second-grade teachers in math knowledge [$t(15) = 0.31$, $P = 0.76$] or math anxiety [$t(15) = 0.54$, $P = 0.60$]. Teacher math anxiety was negatively correlated with teacher math knowledge but did not reach statistical significance ($r = -0.35$, $P > 0.15$).

As mentioned in the main text, we did not find gender differences in math achievement at either the beginning [$t(115) = 0.18$, $P = 0.86$] or end [$t(115) = -0.44$, $P = 0.66$] of the school year (beginning of the year: girls: M = 100.69, SE = 1.29; boys: M = 100.29, SE = 1.98 and end of the year: girls: M = 106.20, SE = 1.04; boys: M = 107.10, SE = 1.85).

On the measure of gender ability beliefs, the number of students who fell into each of the three categories (1: boy is good at math, girl is good at reading; 0: same gender for math and reading; −1: girl is good at math, boy is good at reading) was as follows. At the beginning of the year, 25% of students received a score of 1, 55% received a score of 0, and 19% received a score of −1 (two students did not complete this measure in the fall). At the end of the year, 31% of students received a score of 1, 46% received a score of 0, and 23% received a score of −1. These distributions did not differ as a function of students' gender (beginning of the year: $\chi^2 = 0.09$, $P = 0.96$; end of the year: $\chi^2 = 0.23$, $P = 0.89$) or grade (beginning of the year: $\chi^2 = 1.66$, $P = 0.44$; end of the year: $\chi^2 = 0.29$, $P = 0.86$).

Predictive Models. As reported in the main text, there was no significant relation between teacher math anxiety and student math achievement at the beginning of the school year (girls: $r = -0.13$, $P = 0.32$; boys: $r = 0.12$, $P = 0.40$). Thus, we focused our predictive models on the relation between teacher math anxiety and student math achievement at the end of the school year, where a significant relation for girls ($r = -0.28$, $P = 0.022$) but not for boys ($r = -0.04$, $P = 0.81$) existed. Here, we performed analyses for girls and boys separately.

Simple mediation model. For girls, a regression analysis established that teachers' math anxiety had a significant negative effect on their math achievement at the end of the school year, controlling for teachers' math knowledge and girls' math achievement at the beginning of the year ($\beta = -0.21$, $t = -2.17$, $P = 0.034$). As one might expect, in this regression model, girls' beginning-of-year math achievement did predict their end-of-year achievement ($\beta = 0.70$, $t = 7.97$, $P < 0.01$). In contrast, teachers' math knowledge did not relate to girls' end-of-year math achievement ($\beta = -0.04$, $t = -0.39$, $P = 0.70$). This is somewhat surprising, given that previous work has shown that teachers' math knowledge relates to students' end-of-year math achievement (4). However, this previous work did not take into account the math anxiety of students' teachers. In the current work, when both teacher math knowledge and math anxiety are used to predict girls' end-of-year math achievement, only teacher math anxiety shows a relation to girls' achievement.

Teachers' math anxiety (controlling for teachers' math knowledge) also had a significant effect on girls' endorsement of common gender ability beliefs (i.e., drawing a boy as good at math and drawing a girl as good at reading) at the end of the year ($\beta = 0.31$, $t = 2.22$, $P = 0.030$). Finally, girls' gender ability beliefs ($\beta = -0.23$, $t = -2.81$, $P = 0.007$) were a significant predictor of their math achievement at the end of the school year, controlling for girls' math achievement at the beginning of the year. When teacher math anxiety and girls' gender ability beliefs were simultaneously entered as predictors of math achievement, teacher math anxiety no longer significantly predicted girls' math achievement ($\beta = -0.16$, $t = -1.59$, not significant), whereas girls' gender ability beliefs ($\beta = -0.19$, $t = -2.24$, $P = 0.029$) remained significant in the equation. Note that teachers' math knowledge and girls' beginning-of-year math achievement (i.e., beginning-of-year correlate to the dependent variable) were also entered into this equation.

We used bias-corrected bootstrapping (a nonparametric sampling procedure) to test whether girls' gender ability beliefs significantly mediated the relation between teacher math anxiety and girls' math achievement (recommended over other popular procedures, such as the Sobel test) (5). Bootstrapping results based on 1,000 resamples showed that the indirect effect was estimated to lie between −2.4143 and −0.0045, with 95% confidence. Because zero was not included in this 95% CI, girls' gender ability beliefs can be said to be a significant mediator of the association between teachers' anxiety and girls' math achievement ($P < 0.05$).

To rule out other explanations for this relation (e.g., model misspecification), we also conducted a reverse mediation analysis with girls' end-of-year math achievement serving as the mediator and girls' gender ability beliefs serving as the dependent variable. In contrast to the primary mediation analysis (where the effect of teachers' math anxiety on girls' end-of-year math achievement was significantly mediated by girls' gender ability beliefs), the effect of teachers' math anxiety on girls' gender ability beliefs was not significantly mediated by girls' end-of-year math achievement. Note that teachers' math knowledge and girls' beginning-of-year gender ability beliefs (i.e., beginning-of-year correlate to the dependent variable) were also entered into this equation. Bootstrapping results based on 1,000 resamples showed that the indirect effect in our reverse mediation was estimated to lie between −0.0061 and 0.2265 with 95% confidence. Because 0 was included in this 95% CI, girls' math achievement was not a significant mediator.

These analyses provide greater support for the hypothesis that girls' gender ability beliefs mediate the effect of teachers' anxieties on girls' end-of-the year math achievement than for an alternative model in which girls' end-of-year math achievement mediates the effect of teachers' anxieties on girls' beliefs. Nonetheless, it is important to note that even if the reverse model were to hold, it would still be the case that teachers' math anxiety is negatively affecting girls' (but not boys') end-of-year math achievement. If this relatively lower math achievement, in turn, has an impact on girls' gender ability beliefs, the result would still be the same; namely, having a female elementary school teacher who is relatively higher in math anxiety results in a decrease in girls' math achievement and affects these girls' beliefs about their ability, as female students, to succeed in math.

For boys, a regression analysis established that teachers' math anxiety did not have a significant effect on boys' math achievement at the end of the school year, controlling for teachers' math knowledge and boys' math achievement at the beginning of the year ($\beta = -0.04$, $t = -0.40$, $P = 0.69$). Similar to girls, boys' math achievement at the beginning of the year did predict their end-of-year achievement ($\beta = 0.82$, $t = 8.56$, $P < 0.01$). Moreover, teacher math knowledge also predicted boy's math achievement in this equation ($\beta = 0.22$, $t = 2.09$, $P < 0.05$). The higher teachers' math knowledge, the better was end-of-year math achievement of boys (4).

In contrast to girls, teachers' math anxiety (controlling for teachers' math knowledge) did not have a significant effect on boys' endorsement of common gender ability beliefs (i.e., drawing a boy as good at math and a girl as good at reading) at the end of the year ($\beta = 0.11$, $t = 0.73$, $P = 0.47$). Finally, boys' gender ability beliefs were not a significant predictor of their math achievement at the end of the school year (controlling for their math achievement at the beginning of the year) ($\beta = 0.11$, $t = 1.14$, $P = 0.26$).

Hierarchical linear model. It is also possible to use hierarchical linear models (HLMs) to model our data. An HLM accounts for the fact that students are nested within classrooms (6). Because, in our dataset, the HLM and simple regression model yielded similar results, for simplicity and to avoid excessive jargon in the main text, we confine the HLM analysis to the supplementary methods presented here.

Our HLM consisted of two levels: (*i*) a student-level model that predicted individual students' outcomes based on student-level covariates, and (*ii*) a classroom-level model that used teacher characteristics to predict differences across classrooms. As in the simple regression, each HLM was run separately for girls and for boys. Because only boys returned permission slips in one classroom (although all classrooms were coeducational), the number of classrooms in the sample is 17 for boys and 16 for girls.

Model 1: Teacher Math Anxiety as a Predictor of Student Math Achievement

The first HLM model used teacher math anxiety to predict differences in students' end-of-year math achievement scores, controlling for students' beginning-of-year math achievement and for teachers' math knowledge. In the student-level model, the outcome variable was the students' end-of-year math achievement scores, controlling for students' beginning-of-year math achievement scores:

$$\mathrm{EndMath}_{ij} = \beta_{0j} + \beta_{1j} * (\mathrm{BeginningMath}_{ij}) + \mathrm{r}_{ij}, \qquad \textbf{[S1]}$$

where $\mathrm{EndMath}_{ij}$ is the end-of-year math achievement score for student i in classroom j and $\mathrm{BeginningMath}_{ij}$ is the beginning-of-year math achievement score for student i in classroom j (centered at the overall mean for all students). β_{0j} is the expected end-of-year math achievement score in classroom j for a student of average beginning-of-year math achievement, β_{1j} is the expected increase in end-of-year math achievement score associated with a one-point increase in beginning-of-year math achievement (for a student in classroom j), and r_{ij} is the random variation between students not otherwise accounted for by the model.

The classroom-level model used the teachers' math anxiety (controlling for teachers' math knowledge) to predict differences across classrooms in students' end-of-year math achievement:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * (\mathrm{TMathAnxiety}_j) + \gamma_{02} * (\mathrm{TMathKnowledge}_j) + \mathrm{u}_{0j}, \qquad \textbf{[S2]}$$

where $\mathrm{TMathAnxiety}_j$ is the math anxiety score of teacher j and $\mathrm{TMathKnowledge}_j$ is the math knowledge score of teacher j (both centered at the overall mean). The term γ_{00} is the average end-of-year math achievement score for all students, γ_{01} is the expected change in students' end-of-year math achievement associated with a one-unit increase in teacher math anxiety, γ_{02} is the expected change in students' end-of-year math achievement associated with a one-unit increase in teacher math knowledge, and u_{0j} is the random variation in end-of-year math achievement across classrooms not otherwise accounted for by the model.

The classroom-level model also predicted the relation between students' beginning-of-year and end-of-year math achievement scores using the following model:

$$\beta_{1j} = \gamma_{10} + u_{1j}, \quad \textbf{[S3]}$$

where γ_{10} is the average increase in students' end-of-year math achievement associated with a one-unit increase in beginning of the year math achievement and u_{1j} is the random variation in this increase across classrooms.

The results of model 1, as defined by Eqs. **S1–S3**, are shown in Table S1. The results of central interest indicate that the higher the teachers' math anxiety, the lower girls scored on the test of end-of-year math achievement, even after controlling for teachers' math knowledge and students' beginning-of-year math achievement. This association did not hold for boys.

Model 2: Teacher Math Anxiety as a Predictor of Student Gender Ability Beliefs

Model 2 used teachers' math anxiety as a predictor of students' end-of-year gender ability beliefs. In this model, the outcome variable was students' end-of-year gender ability beliefs and no covariates were entered at the student level:

$$\text{GenderBeliefs}_{ij} = \beta_{0j} + r_{ij}, \quad \textbf{[S4]}$$

where $\text{GenderBeliefs}_{ij}$ is students' end-of-year gender ability beliefs, β_{0j} is the average gender ability beliefs in classroom j, and r_{ij} is the random variation between students in gender ability beliefs.

At the classroom level, teachers' math anxiety and math knowledge were entered as predictors of students' gender ability beliefs:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * (\text{TMathAnxiety}_j) + \gamma_{02} * (\text{TMathKnowledge}_j) + u_{0j}, \quad \textbf{[S5]}$$

where γ_{00} is the average gender ability belief across all students, γ_{01} is the change in students' gender ability beliefs associated with a one-unit increase in teacher math anxiety, γ_{02} is the change in students' gender ability beliefs associated with a one-unit increase in teacher math knowledge, and u_{0j} is the remaining variation across classrooms in gender ability beliefs.

The results of model 2, as defined by Eqs. **S5** and **S6**, are presented in Table S2. Teachers' math anxiety was a significant predictor of end-of-year gender ability beliefs for girls but not for boys, even after controlling for teachers' math knowledge.

Model 3: Student Gender Ability Beliefs as a Predictor of Student Math Achievement

Model 3 predicted students' end-of-year math achievement from their end-of-year gender ability beliefs, controlling for beginning-of-year math achievement:

$$\text{EndMath}_{ij} = \beta_{0j} + \beta_{1j} * (\text{BeginningMath}_{ij}) + \beta_{2j} * (\text{GenderBeliefs}_{ij}) + r_{ij}, \quad \textbf{[S6]}$$

where β_{0j} is the expected end-of-year math achievement score for a student with average beginning-of-year math achievement and gender ability beliefs in classroom j, β_{1j} is the increase in end-of-year math achievement score associated with a one-unit increase in beginning-of-year math achievement score for a student in classroom j, β_{2j} is the change in end-of-year math achievement score associated with a one-unit increase in students' end-of-year gender ability beliefs for a student in classroom j, and r_{ij} is the remaining random variation between students in end-of-year math achievement.

At the classroom level, no teacher predictors were entered in this model. Random variations between classrooms were allowed in the mean end-of-year math achievement and in the relation between beginning-of-year and end-of-year math achievement. The relation between end-of-year gender beliefs and end-of-year math achievement was assumed to remain constant across classrooms:

$$\beta_{0j} = \gamma_{00} + u_{0j}, \quad \textbf{[S7]}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}, \quad \textbf{[S8]}$$

$$\beta_{2j} = \gamma_{20}, \quad \textbf{[S9]}$$

where γ_{00} is the mean end-of-year math achievement score across all classrooms, u_{0j} is the random variation between classrooms in end-of-year math achievement, γ_{10} is the mean relation between beginning-of-year and end-of-year math achievement across classrooms, u_{1j} is the random variation between classrooms in this relation, and γ_{20} is the mean relation between end-of-year gender ability beliefs and end-of-year math achievement across classrooms. The results of model 3, as defined by Eqs. **S6–S9**, are reported in Table S1. The results indicate that girls who were more likely to subscribe to traditional gender ability beliefs scored lower on the test of end-of-year math achievement, even after controlling for their beginning-of-year math achievement. Again, this association did not hold for boys.

Model 4: Teacher Math Anxiety and Student Gender Ability Beliefs as Predictors of Student Math Achievement

Model 4 was identical to model 3, except that teachers' math anxiety and ability were added as predictors of students' end-of-year math achievement. The results of model 4 are shown in Table S1. For girls, the results indicate that teachers' math anxiety was no longer a significant predictor of girls' end-of-year math achievement after girls' end-of-year gender ability beliefs were entered as a predictor (the coefficient of teacher anxiety was reduced from $\gamma_{01} = -3.33$, $t = -0.96$, $P < 0.05$ to $\gamma_{01} = -2.48$, $t = -0.88$, $P = 0.15$), whereas girls' gender ability beliefs remained significant ($\gamma_{20} = -3.03$, $t = -2.40$, $P < 0.05$). In contrast to girls, there was no association between gender ability beliefs or teacher anxiety and students' math achievement for boys.

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2. Woodcock R-W, McGrew K-S, Mather N (2001) *Woodcock-Johnson III Tests of Achievement* (Riverside Publishing, Itasca, IL).
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5. MacKinnon D-P, Lockwood C-M, Williams J (2004) Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behav Res* 39:99–128.
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Table S1. Impact of teacher math anxiety, teacher math knowledge, and student gender ability beliefs on students' end-of-year math achievement

	Girls (n = 65)			Boys (n = 52)		
	Model 1	Model 3	Model 4	Model 1	Model 3	Model 4
Intercept						
Intercept, γ_{00}	470.7*** (1.12)	470.8*** (1.12)	470.7*** (1.18)	467.9*** (1.62)	467.7*** (1.76)	468.0*** (1.66)
Teacher math anxiety, γ_{01}	−3.33* (1.53)	—	−2.48 (1.64)	−0.63 (2.02)	—	−0.40 (2.12)
Teacher math knowledge, γ_{02}	−0.22 (0.23)	—	−0.21 (0.24)	0.68* (0.35)	—	0.72* (0.32)
Student beginning math achievement						
Intercept, γ_{10}	0.51*** (0.07)	0.51*** (0.06)	0.50*** (0.07)	0.69*** (0.08)	0.64*** (0.09)	0.69*** (0.09)
Student gender ability beliefs						
Intercept, γ_{20}	—	−3.38** (1.22)	−3.03* (1.26)	—	2.79 (2.26)	2.95 (2.18)

Numbers in parentheses are SEs. Teacher math knowledge, teacher math anxiety, student beginning-of-year math achievement, and student end-of-year gender ability beliefs are centered at their mean values.
$^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

Table S2. Model 2: Impact of teacher math anxiety and teacher math knowledge on student end-of-year gender ability beliefs

	Girls (n = 65)	Boys (n = 52)
Intercept		
Intercept, γ_{00}	0.06, 0.09	0.07, 0.13
Teacher math anxiety, γ_{01}	0.27*, 0.12	0.08, 0.15
Teacher math knowledge, γ_{02}	0.01, 0.02	−0.00, 0.02

Numbers in parentheses are SEs. Teacher math knowledge and teacher math anxiety are centered at their mean values.
$^{*}P < 0.05$.

Other Supporting Information Files

Appendix S1 (PDF)
Appendix S2 (PDF)