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Why does teacher gender matter?

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Motivation

- **Gender gap** in STEM
 - PISA and SAT math scores
 - STEM majors in college

- **Shortage of workers** in STEM fields (Carnevale et al, 2011)
 - Female professors
 - Female engineers and computer scientists

Motivation /2

- **Extensive research** on the gender gap in STEM
Guiso et al. (2008), Fryer and Levitt (2010)
- Focus on the impact of **teacher gender** on students in primary and secondary schools.
Dee (2007), Parades (2014), Antecol et al. (2015)
- And higher education
Carrell et al. (2010), Price (2010), Bottia et al (2015)
- **Mixed results**

Effect of teacher gender

- **Role model:** female students exposed to successful women in STEM
- **Stereotype threat:** students may internalized an expected negative stereotype due to their gender
- **Teacher biases**
- Female teachers may **structure** their classroom and select **topics** differently

Research question

- **Why does teacher gender matter?**
- Does teacher gender have an intrinsic value?
- Control for how teachers treat male and female students
- Control for how teachers compare men and women in math and science

Preview findings

- Outcome variables: student **interest and self-efficacy** in math and science
- Estimation strategy: compare 9th grader in her math and science classes
- Result: **teacher gender** affect students, but **not significant** once teacher behaviors and attitudes is included. **Omitted variable bias**
- What matters:
 - How teacher treats boys and girls
 - How teacher compares men and women in math/science
 - Positive learning environment
 - Whether teacher makes the subject interesting

Data

- High School Longitudinal Study of 2009 (HSL:09).
- Panel database **26,000 students** in 9th grade from 944 schools
- 1st round: students, parents, math and science teachers, school administrator, school counselor
- 2nd round: 11th grade (no teachers)
- 3rd round: freshman year in college
- Data on math test scores, HS transcripts, SAT scores, demographics, family background, school characteristics, expectations.

Dependent Variable

- Whether the 9th grader **enjoyed her math/science class** in the Fall 2009.
- Whether the 9th grader's **favorite subject** is math/science
- **Self-efficacy in math/science:** PCA standardized to zero mean and unit variance. Higher values for students confident that:
 - They could do an excellent job in their math/science tests and assignments.
 - They could master the skills in these courses.
 - They could understand the textbook.
- Female students: lower mean self-efficacy (and same SD).

Teacher Characteristics

- Students asked whether their math/science teacher:
 - **Valued and listened to students' ideas**
 - **Treated males and females differently**
 - **Made their subject interesting**
 - **Thought that every student can succeed**
- Reminded that answers were anonymous
- Teachers asked to **compare boys and girls in math and science**

Identification strategy

- Compare math (M) and science (N) teachers for each 9th grader (Dee, 2005). Boys and girls separately.

$$y_{is} = \beta tgender_{is} + x'_{is}\gamma_1 + w'_{is}\gamma_2 + z'_{is}\gamma_3 + \mu_i + \alpha_s + \varepsilon_{is} \quad \forall s \in \{M, N\}$$

- y_{is} student i interest/self-efficacy in subject s
- $tgender_{is}$ math/science **teacher gender**
- x_{is} math/science teacher education and experience
- w_{is} math/science **teacher gender attitudes and behavior**
- z_{is} math/science **teacher ability, expectation, behavior**
- μ_i observable and unobservable student fixed-effect
- α_s subject fixed-effect
- ε_{is} error term

FE advantages

- Possible to control for unobservable variables **constant across subjects** at the individual level.
 - Student individual characteristics (e.g. race or skills).
 - School characteristics.
 - Family background.
- **Subject-specific ability?**
 - High correlation between math and science SAT.
Petterson and Kobrin (2012)
 - Control for performances in 8th grade.

Without additional controls

- Female teachers **boost confidence** in girls

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.015 (0.017)	0.005 (0.011)	0.050* (0.028)
Observations	13,270	14,530	13,080

- And **reduce interest** among boys

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.053** (0.015)	-0.021* (0.011)	-0.001 (0.024)
Observations	13,190	14,600	12,960

Teacher ability, expectations and behavior - Girls

- Teacher gender **still significant**

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.009 (0.013)	0.004 (0.012)	0.065** (0.026)
Listen student ideas	0.128*** (0.021)	0.012 (0.015)	0.131*** (0.041)
Make subject interesting	0.397*** (0.015)	0.132*** (0.012)	0.413*** (0.028)
All can succeed	0.116*** (0.025)	0.037* (0.019)	0.204*** (0.050)
Observations	13,050	12,970	12,880

Teacher ability, expectations and behavior - Boys

- Teacher gender **still significant** for enjoyment

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.027**	-0.015	0.021
	(0.012)	(0.011)	(0.024)
Listen student ideas	0.177***	0.008	0.124***
	(0.021)	(0.015)	(0.041)
Make subject interesting	0.384***	0.134***	0.367***
	(0.016)	(0.012)	(0.028)
All can succeed	0.025	-0.006	0.097*
	(0.026)	(0.020)	(0.057)
Observations	12,940	12,810	12,750

Gender attitudes and behavior - Girls

- Teacher gender not significant anymore

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.015 (0.014)	0.006 (0.013)	0.042 (0.029)
Listen student ideas	0.133 ^{***} (0.022)	0.007 (0.016)	0.152 ^{***} (0.045)
Make subject interesting	0.385 ^{***} (0.017)	0.132 ^{***} (0.013)	0.427 ^{***} (0.031)
All can succeed	0.101 ^{***} (0.028)	0.043 [*] (0.022)	0.207 ^{***} (0.056)
Boys better math/science	0.015 (0.019)	-0.009 (0.020)	-0.050 (0.042)
Treats girls differently	-0.053 ^{**} (0.027)	-0.043 ^{**} (0.021)	0.043 (0.051)
Observations	11,640	11,560	11,490

Gender attitudes and behavior - Boys

- Teacher gender not significant anymore

	Enjoy	Fav Subj	Self-Efficacy
Female teacher	-0.021 (0.013)	-0.019 (0.012)	0.018 (0.025)
Listen student ideas	0.189 ^{***} (0.024)	0.017 (0.016)	0.124 ^{***} (0.046)
Make subject interesting	0.379 ^{***} (0.017)	0.138 ^{***} (0.013)	0.380 ^{***} (0.030)
All can succeed	0.021 (0.029)	-0.016 (0.023)	0.068 (0.063)
Boys better math/science	0.015 (0.021)	-0.019 (0.021)	0.015 (0.044)
Treats girls differently	-0.061 ^{**} (0.025)	0.028 (0.019)	0.025 (0.045)
Observations	11,520	11,410	11,350

Interaction with teacher gender

- Having a **good teacher who is a woman** may still make a difference.
- Add interactions between teacher gender and teacher behavior.
- Almost all interaction terms are insignificant.
- Self-efficacy for male and female students lower when **female teachers believe that men are better** than women in math/science
- Lower enjoyment among male students when **female teachers treat boys and girls differently**

Student-teacher sorting

- Possible source of endogeneity if non-random
- **OK if same sorting mechanism in math and science, or based on observables** (e.g. past grades)
- Similar math/science teacher assignment to advance classes
- Similar student/parents bargaining power in selecting 9th grade math or science course
- Same conclusions when controlling for:
 - How parents compare boys/girls in math/science
 - How confident they feel in helping math/science HW
- No evidence of sorting on observables

Can we identify good teachers?

- Test whether teachers with desirable/undesirable behaviors can be identified from their CV
- **Formal measures not enough to signal top teachers**

Mean teacher characteristics – Listen student ideas

Variable	Math			Science		
	No	Yes	Diff	No	Yes	Diff
Female	0.62	0.6	0.02*	0.6	0.56	0.04***
More than Bachelor	0.51	0.51	0	0.58	0.57	0.01
STEM major	0.42	0.4	0.02	0.55	0.59	-0.04***
Experience	11.1	10.32	0.78***	11.57	10.84	0.73***
HS Certified	0.81	0.78	0.03***	0.82	0.8	0.01
Education degree	0.51	0.54	-0.04***	0.56	0.56	0
Observations	2,030	12,450		1,690	11,060	

Can we identify good teachers? /2

- Small differences also for “treat boys/girls differently” and “expect all students to succeed”

Mean teacher characteristics – Make subject interesting

Variable	Math			Science		
	No	Yes	Diff	No	Yes	Diff
Female	0.63	0.59	0.03***	0.6	0.55	0.05***
More than Bachelor	0.53	0.5	0.03***	0.58	0.57	0.02
STEM major	0.43	0.4	0.03***	0.57	0.59	-0.02**
Experience	10.87	10.15	0.71***	11.43	10.74	0.69***
HS Certified	0.8	0.78	0.02***	0.82	0.8	0.02***
Education degree	0.52	0.55	-0.03***	0.57	0.56	0.01
Observations	5,310	9,150		3,710	9,000	

Deeper look at gender

- Students asked whether they **talked with a teacher** about which math or science courses to take during their first year of high school
- If female teachers played strong role model, expect female students to talk more with female teachers
- Percentage of students reporting to discuss course selection with a teacher same for female students with a male or female math teacher

Deeper look at gender/2

- Female teachers may **adjust the content** of their courses to include topics and examples which raise the curiosity of female students
- Science more attractive to girls if they understood the impact that they would have on the society
- Science teachers asked how much emphasis they were placing on teaching students about the relationship between **science, technology and society**
- Female teachers reported more frequently to put minimal or no emphasis on such goal

Conclusions

- **Teacher gender** does not affect student interest and confidence in math/science once teacher behaviors, expectations and attitudes are controlled for
- What matters is a **positive learning environment** and whether the teacher **makes the subject interesting**
- Teacher quality and effort pivotal
- Policy-makers worried that top female students outperformed in STEM because of low confidence (**OECD, 2015**)
- This study investigates how to affect it