The Gender Gap in High School Physics:

Examining the Context of Schools and Communities

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September 23, 2011

Extended Abstract for the 2011 Annual Meeting of the Population Association of America.

Gender gaps in math and science achievement have strongly diminished across the last several decades, yet female students still lag behind male students in rates of Physics course taking. While the overall percentage of students taking Physics has increased over time, the gender gap has remained fairly constant over the past 30 years (Freeman 2004; Nord et al. 2011). In 2009, 36 percent of female high school graduates had taken Physics compared to 41 percent of male graduates. This gender gap is especially concerning given evidence that course taking in high school has strong implications for the selection of science, technology, engineering, and math (STEM) majors in college, which in turn has implications for future employment and earnings (Riegle-Crumb and King 2010).

Previous research tends to treat the gender gap in Physics course taking as homogenous across the U.S., with little attention to variation across contexts. However, there is reason to believe that this gap may vary by schools and communities. Several recent studies have found that the male advantage in math achievement may be attenuated or eliminated in more gender equitable countries. This research has shown that fewer gender stereotypes, more equitable labor markets, and other social factors are significantly correlated with better female math and science outcomes (Hyde and Mertz 2009; Nosek et al. 2009; Penner 2008; Guiso et al. 2008).

Following this logic, we believe that community context within the U.S. may influence math and science outcomes, including girls' decisions about science course taking. We argue that a community's female labor force may shape girls' perceptions of their future opportunities. Therefore, in communities with large percentages of females in science, technology, engineering, and mathematics (STEM) occupations, girls may perceive STEM occupations as viable career options, and, therefore, take more rigorous science courses like Physics.

Analytic Plan

In this paper, we plan to further explore the gender gap in physics course taking using data from the National Longitudinal Study of Adolescent Health (Add Health) and the Adolescent Health and Academic Achievement (AHAA) Study. First, we examine how physics course taking varies across schools. Next, we explore possible school and community contextual information that may help to explain variation in course taking across schools. Specifically, we look to see whether a community's female occupational context helps to explain the variation in physics course taking across schools.

Data

We use data from Add Health and the AHAA study. Add Health is a longitudinal study that includes a nationally representative sample of 80 high schools and 52 "feeder" middle schools with a sample of 20,745 students. The first wave was collected in 1994-1995, with follow-ups in 1995-1996 (Wave 2) and 2001-2002 (Wave 3). The AHAA study includes transcript and contextual data for 81% of the Wave 3 Add Health sample.

Because we are interested in high school course taking, our analytic sample is limited to students in the 9^{th}, 10^{th}, 11^{th}, or 12^{th} grades in the base year. We also choose to focus on public schools, excluding private schools from our sample. Finally, we limit our sample to students with valid information on our dependent variable, key independent variables, and analytic weights. This results in a final analytic sample of 63 schools and 5821 students.

Measures

Our dependent variable is a dichotomous variable of whether the student took Physics by the end of high school.

Our primary independent variables use contextual census data from the AHAA study. First, we include a measure of the percentage of employed females 18 and over who are employed in technology, mathematical, architectural, and engineering occupations. We include a measure of the percentage of employed females 18 and over in professional occupations. We also control for community size, urbanicity (urban, rural, or suburban), region (South, Northeast, Midwest or West), the percentage of parents with a college degree in the school, school size (large or other), and whether the school is a magnet school.

At the individual level, we include measures of the students' gender, race/ethnicity (African American, Latino, and Asian, or white), GPA, freshman science course, parent education (less than high school, high school degree or equivalent, vocational degree, some college, college degree, or advanced degree), mother's occupation (professional or non-professional), and logged family income.

Methods

After looking at physics course taking descriptively, we use hierarchical generalized linear modeling (HGLM) to help better understand the variability in the gender gap in physics taking across schools. We grand mean center all variables except our primary independent variable, gender, for improved interpretability. First, we ran a two-level, unconditional model to ensure significant variability between schools in physics course taking. We then expanded this model to include our individual-level predictors. Finally, to help explain variation across schools, we add our school-level predictors, shown below.

Level 1: $\text{Physics}_{ij}=b_{0j}+b_{1j}(\text{female})+b_{2\text{-}13}(\text{individual-level controls})+e_{ij}$

Level 2: $b_{0j}=\gamma_{00}+\gamma_{01}(\text{\%females in STEM occupations})+\gamma 02(\text{\%females in professional occupations}) +\gamma_{03\text{-}012}(\text{school-level controls})+u_{0j}$

$b_{1j}=\gamma_{10}+\gamma_{11}(\text{\%females in STEM occupations})+\gamma_{11}(\text{\%females in professional occupations}) +\gamma_{13\text{-}111}(\text{school-level controls})$

Table 1. Descriptive Statistics for Select Variables

Variable	**Mean/Prop**	**SD**	**Min**	**Max**
Physics Course Taking	0.27	0.45	0	1
Female	0.53	0.5	0	1
%Female in STEM Occ	1.62	1.67	0	11
%Female in Prof Occ	23.21	5.16	8	37

N=5821 students; N=63 Schools

Preliminary Results

Table 1 provides some descriptive information of our sample of students and schools. We see that our primary independent variable, the percentage of employed females 18 years or older employed in STEM occupations, ranges from 0 percent to 11 percent with a mean of 1.62 percent, and the percentage of employed females in professional occupations ranges from 8 percent to 37 percent with a mean of 23.21 percent.

Figure 1. Percentage of Students Taking Physics by Gender

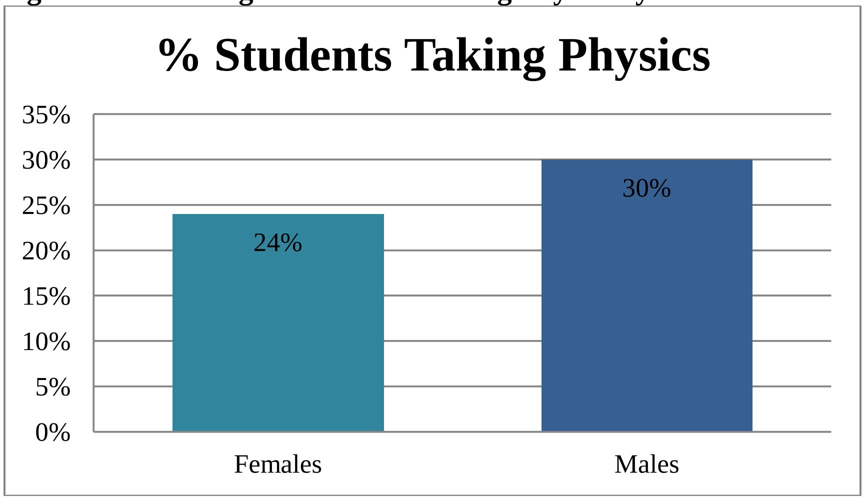

Figure 2. Variation in Gender Gap across Schools

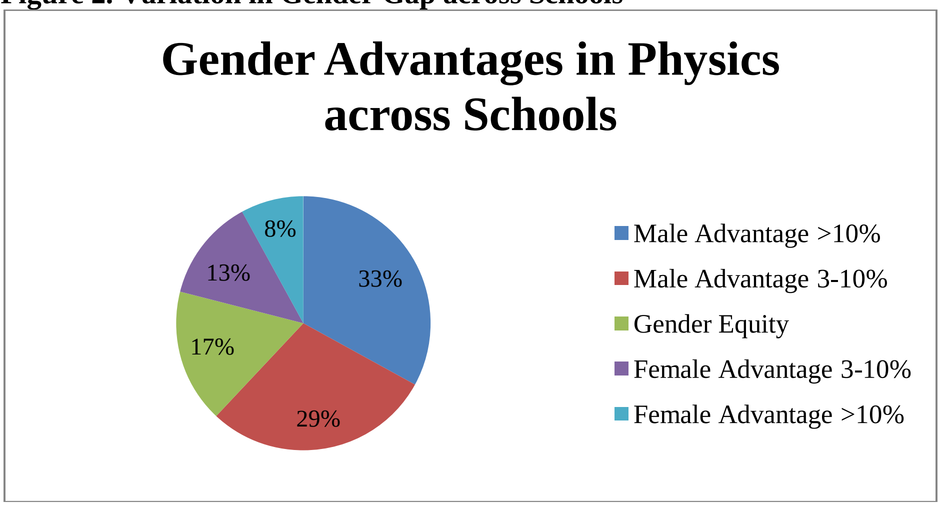

Figure 1 shows that, overall, 30 percent of males take Physics compared to 24 percent of females. Figure 2, however, reveals that this varies across schools. In 62 percent of schools, males have at least a 3 percent advantage in physics course taking, while 17 percent of schools have equity or near equity, and 21 percent of schools actually have a female advantage of 3 percent or more.

To explore this further, we turn to our HGLM models. Model 1, our student-level model, shows that females are significantly less likely to take physics than males (the odds of taking physics for females is 0.47 times that of males), net of controls. Adding our school-level variables in Model 2 shows that students in magnet schools and schools in the Midwest and Northeast have an increased likelihood of taking Physics compared to non-magnet schools and schools in the West, respectively, net of controls, but the percentage of the female labor force in STEM has no effect on Physics course taking overall. However, we are primarily interested in how the percentage of females in STEM occupations affects girls' likelihood of taking Physics. Adding our cross-level interaction in Model 3 reveals that schools in communities with higher proportions of the female labor force in STEM occupations have significantly smaller gender gaps than schools in communities with lower proportions of the female labor force in

STEM occupations. This suggests that community context may be an important influence on girls' decisions regarding science course taking, which is consistent with other research that suggests that gender norms and perceived opportunity structures influence individuals' behaviors and performance.

Table 3. HGLM Results Predicting Physics Course Taking

	Model 1			Model 2			Model 3		
Level 1	**Coef**		**SE**	**Coef**		**SE**	**Coef**		**SE**
Female, b1	-0.748	***	(0.125)	-0.748	***	(0.126)	-0.721	***	0.115
Hispanic, b2	-0.117		(0.229)	-0.160		(0.237)	-0.131		(0.240)
Black, b3	-0.210		(0.174)	-0.276		(0.182)	-0.285		(0.178)
Asian, b4	0.676	*	(0.284)	0.642	*	(0.285)	0.712	**	(0.269)
Mother Prof, b5	-0.070		(0.186)	-0.063		(0.186)	-0.063		(0.197)
GPA, b6	1.282	***	(0.114)	1.294	***	(0.113)	1.310	***	(0.113)
Sci Course Sequ, b7	0.459	***	(0.114)	0.457	***	(0.112)	0.458	***	(0.114)
Logged Income, b8	0.130		(0.103)	0.131		(0.105)	0.148		(0.095)
Less than HS, b9	0.133		(0.204)	0.125		(0.204)	0.091		(0.205)
Vocational, b10	0.351		(0.192)	0.351		(0.194)	0.359		(0.196)
Some College, b11	0.794	***	(0.166)	0.806	***	(0.169)	0.800	***	(0.166)
College Deg, b12	0.554	**	(0.177)	0.552	**	(0.179)	0.565	**	(0.177)
Advanced Deg, b13	0.660	**	(0.201)	0.655	**	(0.203)	0.630	**	(0.201)
Intercept, b0	-1.055	***	(0.126)	-1.074	***	(0.118)	-1.092	***	(0.116)
Level 2									
%Female in STEM, $\gamma01$				0.086		(0.069)	0.008		(0.073)
%Female in Prof Occ, $\gamma02$				0.192		(0.116)	0.035		(0.029)
Community Size, $\gamma03$				-0.001		(0.028)	0.189		(0.119)
Magnet, $\gamma04$				0.752	*	(0.283)	0.629		(0.338)
Urban, $\gamma05$				-0.146		(0.264)	-0.108		(0.321)
Rural, $\gamma06$				0.726		(0.403)	0.782		(0.421)
Midwest, $\gamma07$				0.584	*	(0.271)	1.034	**	(0.335)
South, $\gamma08$				0.397		(0.265)	0.405		(0.321)
Northeast, $\gamma09$				0.857	**	(0.282)	0.916	**	(0.310)
Large School, $\gamma010$				-0.299		(0.249)	-0.399		(0.276)
%Parents with Coll Deg, $\gamma011$				0.010		(0.010)	0.004		(0.011)
Cross-level interaction									
Female X Females in STEM, $\gamma11$							0.151	*	(0.073)

N=5821 Students; N=63 Schools; *p<0.05, **p<0.01, ***p<0.001

Note: The cross-level interaction in Model 3 also includes all other level-2 predictors.

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