Girls' Math Scores Could Indicate Success and Aspirations

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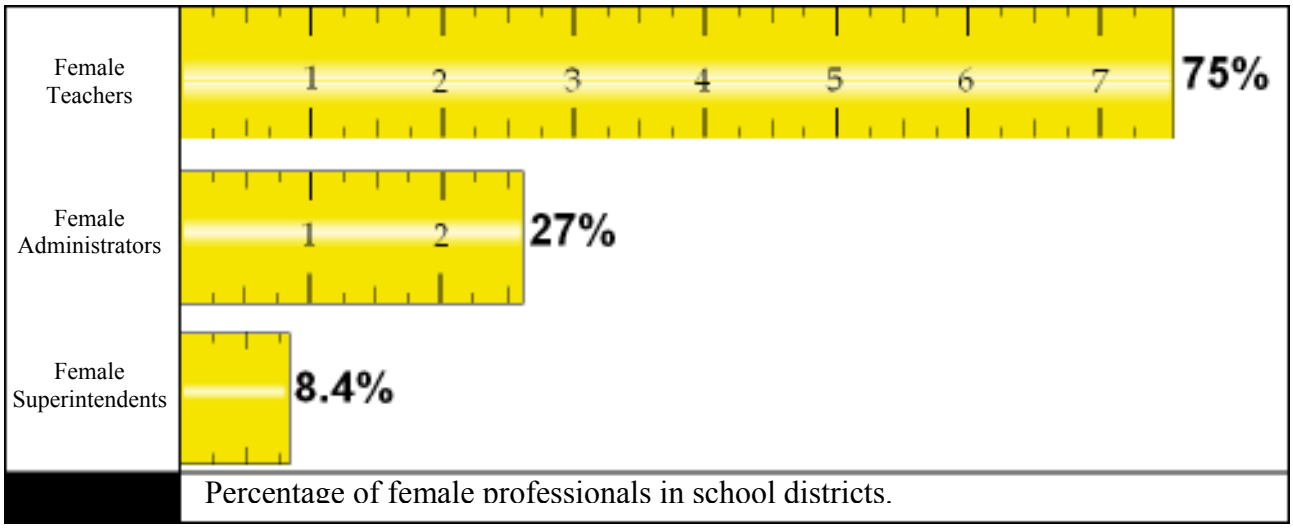
Within education systems, female math teachers can affect female students' math scores and, subsequently, can influence female student aspirations. Nation-wide a persistent gender gap exists with girls scoring lower than boys on math tests. This performance gap on standardized math tests becomes a barrier to continuing education especially in fields that emphasize math or mathematical reasoning. Initial findings show that female teachers in the classroom combined with female superintendents benefited girls' education in math.

School Districts and their Structure

In many school districts only three organizational levels exist–teachers, principals and the superintendent. Administrators rarely visit classrooms and, thus, cannot closely monitor interaction between teachers and students. Administrative control is limited to the textbooks used, whether a lesson plan was filed and access to instructional resources. However, despite the rather flat organizational form, school districts are highly stratified by gender and can be considered classic glass-ceiling organizations. Fully 75% of teachers in our districts are female, however only 27% of supervisors (principals, assistant principals and assistant superintendents) are female but more importantly, only 8.4% of superintendents are female.



Percentage of female professionals in school districts.

How can female instructors affect students?

Female teachers affect the math grades of female students in four ways. One of these four methods of influence requires that an individual student come into contact with a specific math teacher in a classroom; the other three processes can work through out the organization.

- First, female teachers, aware of the math gap, might spend additional time with and generate more positive reinforcement for girls when teaching math.
- Second, girls who do not have a female math teacher could still identify with another as a role model; this identification could then result in a greater effort to succeed in math classes.
- Third, non-math teachers might facilitate the learning process by encouraging students who run into difficulty. Although math teachers are in a better position to provide this encouragement, a student might identify more closely with another teacher with a different specialization.
- Fourth, female teachers may be more likely than male teachers to advocate that schools adopt policies that will encourage girls in fields in which they historically have under-performed.

Who did we study?

Our study spanned Texas school districts from 1995 to 1998. Texas provided an ideal setting for our study for two reasons. First, Texas has state-wide standardized testing of students and an elaborate data base that permits analysis by gender. Second, Texas is an extremely diverse state in terms of race, ethnicity, resources, and other factors that affect education performance. Texas also contains more than 8% of all school districts in the United States. The large number of districts (1000+) and their diversity suggest that findings from Texas will also apply to other educational systems as well. If Texas differs from other states, it is because educational performance is a highly salient issue and because expenditures have increased more rapidly in Texas than the nation as a whole.

What did we study?

Texas requires standardized tests of all students in grades 3, 5, 6, 7, and 8 as well as an exit exam. First, we studied the percentage of female students who passed the math exams in each of these grades. We looked at these particular grades because literature suggests math scores diverge in junior and senior high. In Texas, boys and girls math scores are essentially the same in grades 3 through 8, but boys' pass rates exceed girls' by 4.1 percentage points on the exit exam.

We also studied whether performance on standardized tests is a hurdle along the way to educational attainment if students who perform poorly on exams also perform poorly on other exams or if low scores reduce their overall educational aspirations. To investigate this hurdle we studied girls' decision to take college boards, their average SAT scores, and their successful completion of advanced placement exams (for which college credit is given). Girls in Texas are more likely than boys to take college boards (55.4% vs. 50.1%) and more likely to pass advanced placement classes (15.7% vs. 14.1%) but score well below boys on SAT exams (933 vs. 962).

What are the results?

Female math teachers are positively associated with girls' math scores in grades 7 and 8 and on the exit exam. Girls' exam scores for grades 3, 5 and 6 are not statistically different from boys' scores. These findings are consistent with the literature that finds gender differences in math performance do not arise until junior high.

The study also examined organizations with more female administrators (20%+) and districts with female superintendents. Studies show that there is little difference in math exam scores in districts with female administrators, but math scores in districts with female superintendents surpassed all other categories.

Increased math exit scores also are indicators of increased math scores on the SAT. Female math teachers only have an indirect impact on SAT scores through the math exit exam; however, female teachers in general are directly associated with SAT scores for girls. While not all students who take the SAT will go on to attend college (and some who do not may take them later and subsequently attend college), it provides an estimate of the proportion of students interested in higher education. Our final indicator of college aspirations is taking and passing an advanced placement class.

Girls' SAT scores were higher in districts with more female teachers; and in districts with female superintendents, the impact was even greater. The number of females taking SAT exams and advanced placement classes also is positively associated with female teachers and superintendents.

Turning results into positive action.

Sat scores are only one example where an increase in the representation of female math teachers and female teachers in general will increase educational benefits for girls especially in girls' math scores. In school districts with female superintendents, female teachers had the largest positive impact on the number of girls taking advanced placement tests, the number of girls taking the college board exam, girls' math test scores and girls' SAT scores. These relationships held for female administrators as well, although the results were not as substantial.

For those seeking to increase girls' educational benefits and math scores attention must be paid to not only the number of female teachers in districts, but also to increasing female representation among the upper levels of the organization.

The Texas Educations Excellence Project seeks to apply scholarly research to educational policy issues in order to make recommendations for greater quality and equity in Texas school systems. TEEP is a joint program in the George Bush School of Government and Public Service and the Texas A&M University's Department of Political Science, with research associates at the University of Texas-Pan American and Oakland University.

According to the theory of representative bureaucracy, passive representation among public agency employees will lead to active representation in bureaucratic outputs. The existing research demonstrates that the link between passive and active representation exists for race but not for sex. Past research on this topic has not, however, taken into account the contextual environment that affects whether sex will translate into gender and lead to active representation in the bureaucracy. We create a framework that specifies the conditions that affect whether passive representation results in active representation for sex. We find that passive representation of women in education leads to active representation and that the institutional context affects the extent that this link between passive and active representation occurs.

With this discretion female teachers could affect the math grades of female students in one of four ways.[1] First, female teachers, aware of the math gap, might spend additional time with and generate more positive reinforcement for girls when teaching math. Second, girls who do not have a female math teacher could still identify with one as a role model; this identification could then result in a greater effort to succeed in math classes. Third, nonmath teachers might facilitate the learning process by encouraging students who run into difficulty. Although math teachers are in a better position to provide this encouragement, a student might identify more closely with another teacher with a different specialization. This might be specific and linked to math classes and or general and linked to overall aspiration levels. Some of this influence could work through an informal advising process; some might require no personal contact at all. Fourth, female teachers may be more likely than male teachers to advocate that schools adopt policies that will encourage girls in fields in which they historically have under-performed. Only one of these four methods of influence requires that an individual student come into contact with a specific math teacher in a classroom; the other three processes can work through out the organization.

The ratio of the number of teachers to the total number of administrators in the organization is a one factor that affects how well female teachers influence female students. As the ratio increases, administrators supervise more teachers; resulting in less time available to supervise any one teacher. Despite the preference for flat organizational forms, school districts are highly stratified by gender and can be considered classic glass-ceiling organizations. Fully 75% of teachers in our districts are female, but only 27% of supervisors (principals, assistant principals and assistant superintendents) and only 8.4% of superintendents are.

Dependent Variables

Texas requires standardized tests of all students in grades 3, 5, 6, 7, and 8 as well as an exit exam. Our first dependent variables will be the percentage of female students who pass the math exams in each of these grades. We conduct the analysis by grades because the literature suggests that math scores diverge only in junior and senior high (Fennema and Sherman 1977; Strauss and Subotnik 1994; Oakes 1990; Catsambis 1994; Meece and Parson 1982). In Texas, boys and girls math scores

[1]There is actually a fifth possibility. Because schools operate in a segmented labor market, female math teachers might simply be better teachers (see Meier, Wrinkle and Polinard 1999).

are essentially the same in grades 3 through 8, but boys' pass rates exceed girls' by 4.1 percentage points on the exit exam.

Performance on standardized tests is a hurdle along the way to educational attainment. Students who perform poorly on such exams may also perform poorly on other exams or might reduce their overall educational aspirations. To investigate these phenomena in the context of representative bureaucracy, three other dependent variables will be examined–the decision to take college boards, average SAT scores, and the successful completion of advanced placement exams (for which college credit is given). Girls in Texas are more likely than boys to take college boards (55.4% vs. 50.1%) and more likely to pass advanced placement classes (15.7% vs. 14.1%) but score well below boys on SAT exams (933 vs. 962). The lower SAT scores are not a function of more girls taking the test; correlations between the number of test takers and average scores approach 0 when more than 30% of students take the exam. The correlation in Texas where 46% take the SAT is only .12 and that disappears with a control for poverty.

Control Variables

In addition to the key independent variables (female math teachers or female teachers, hierarchy and stratification), several control variables are included in the models to minimize spurious relationships. The primary control variable will be an indicator of overall school quality--measured as the performance rate for boys on each of these dependent variables, that is, boys' SAT scores will be a control when girls' SAT scores are examined, etc. Some schools will attract better teachers or have a more challenging curriculum; these and other unmeasured variables affecting overall quality should be reflected in the performance of male students.

Two other sets of controls are used–one set for the task difficulty facing the organization and the other for organizational resources. Task difficulty reflects the truism that some students are easier to educate than others. The literature consistently finds poverty and race are correlated with greater education problems (Jencks and Phillips 1998). Poverty and race are associated both with a lack of educational resources in the home and with other factors (e.g. single family households) that affect student learning. The three specific measures are the percentage of black students, the percentage of Latino students, and the percentage of poor students (measured as students eligible for free school lunch programs). Each of these control variables should be negatively related to student performance.

Recent research using well-crafted longitudinal data sets and well designed experiments, however, generally shows that additional resources are associated with higher student performance (Evans, Murray and Schwab 1997; Wenglinsky 1997). Two measures of resources are included–average teacher salary and average class size. Teacher salaries should be positively related to student performance and class size should be negatively related to performance.

Because our data are pooled (four years and 1000 districts), we also include a set of control variables to deal with the time series aspect of the data set. Dummy variables for individual years were included in each equation. These dummy variables were always jointly significant reflecting the overall positive trends in the student performance. To deal with the other source of problems related to pools, we assessed the cross-sections of each equation for heteroscedasticity problems. Levels of heteroscedasticity were modest and had little impact on the findings presented here.

Findings

Female math teachers are positively associated with girls' math scores in grades 7 and 8 and on the exit exam. The slopes for grades 3, 5 and 6 are not statistically different from zero. These findings are consistent with the literature that finds gender differences in math performance do not arise until junior high. At lower grade levels where there are no gender differences, the gender of math teachers appears to be irrelevant. In junior high and senior high, female math teachers are associated with higher math scores for girls even when controlling for boys' scores and other factors. Many elementary schools do not have specialized math teachers.

On the math exit exam, a one percentage point increase in female math teachers is associated with a .03 percentage point increase in the girls' pass rate, all other things being equal. While this appears to be a relatively modest relationship, in fact, a one standard deviation change in the percentage of female math teachers is associated with a 16% reduction in the gap between boys' and girls' math scores. While the gender of math teachers is clearly not the most important factor in math education, reductions of this size would be substantively important and well worth pursuing.

The control variables' relationships are all consistent with expectations. Except for teachers' salaries for eighth grade students, all relationships are statistically significant and in the correct direction. The largest influence, as expected, is our measure of quality education–boys' math scores.

Representation is a process that should be affected by institutional factors. In this specific case, both hierarchy and stratification vary, but we do not expect these factors to affect the process by which female math teachers interact with female students. That process is highly discretionary, and organizations are likely to find it difficult to modify.

Next, we examine the math exit exam and split our districts according to the key institutional variables (we split the data rather than use interaction effects to avoid the massive collinearity generated by interaction terms). In addition to the overall regression, regressions are also run for non-hierarchical organizations (span of control greater than 14), for organizations with more female administrators (20%+) and for districts with female superintendents. Our institutional hypothesis (which we do not expect to hold in this case) is that the impact of female math teachers should increase (that is, the regression coefficient should increase) in flat organizations and in organizations with more female administrators. The results are mixed. The teachers' slope drops for flat organizations and organizations with more female administrators; it increases dramatically, however, in districts with female superintendents.

Although math exams are a relatively narrow slice of the public school curricula, they have long-term implications for building human capital. Table 3 relates math exit exams to average SAT scores (the verbal and math total, individual tests are not available). Several findings are relevant. First, math exit scores are positively correlated with SAT scores; all things equal a one percentile increase in the pass rate is associated with a .54 point increase on the SAT (about 8.7 points for a standard deviation change). Second, female math teachers have no direct impact on female SAT scores; their impact is indirect through the math exit exam. Third, female teachers in general, however, are associated with a substantial increase in female SAT scores; a one percentile increase in female teachers is associated with an increase of 2.1 points on the SAT (about 17 points for a one

standard deviation change), all other things equal.

Results suggest a slight change in focus to female teachers in general and to indicators of college aspirations. Because the influence of female teachers is likely to be diffused through out the organization, the institutional factors in our theory–hierarchy and stratification–in this case, are also more likely to come into play. The next three tables examine SAT scores, taking college board exams, and passing advanced placement exams and how the relationships between these three variables and female teachers are structured by hierarchy and stratification. Again our working hypothesis is that the influence of female teachers will be enhanced in decentralized organizations and organizations with women in positions of administrative authority.

Results also show how institutional structures interact with female teachers to affect SAT scores. The partial impact of female teachers on female SAT scores (2.054 overall) increases to 2.474 in decentralized organizations, to 2.197 in those with more female administrators, and to 2.378 for those with a female superintendent. All three relationships support the institutional hypotheses.

The first step in going on to higher education is taking the college board exams (either the SAT or the ACT). While not all students who take the exams will go on to attend college (and some who do not may take them later and subsequently attend college), it provides an estimate, albeit an overestimate, of the proportion of students interested in higher education. The relationship between female teachers and female students taking the exams is relatively modest for all school districts; all things being equal, a one percentage point increase in female teachers is associated with a .12 percentage point increase in taking the test. In decentralized organizations, the slope effectively drops to zero, thus rejecting our hypothesis about flat organizations. The two stratification hypotheses, however, do gain some additional support. The coefficient for systems with more than 20% female administrators is slightly larger (1.23 v. 1.20) and the coefficient for districts with a female superintendent is approximately 3.5 times larger. Two of the three relationships, therefore, support the institutional hypotheses.

Our final indicator of college aspirations is taking and passing an advanced placement class. Unfortunately only about one-fourth of the school systems offer advanced placement classes, thus reducing our sample substantially. Female teachers are positively associated with more female students passing advanced placement classes; a one percentage point increase in female teachers is associated with a .6 percentage point increase in female students who pass advanced placement classes, all other things being equal. Consistent with our hypotheses, this slope increases for decentralized organizations (.665), for organizations with more than 20% female administrators (.624) and for systems with a female superintendent (1.263).

Conclusion

According to our framework, public education meets the necessary conditions for the transfer of passive representation to active representation for women. Consistent with our theory, passive representation leads to active representation in public education for sex. An increase in passive representation for female math teachers and for female teachers in general increases educational benefits for girls. The level of passive representation for women in the bureaucracy has consequences for the policy benefits the bureaucracy produces for women. In contrast to past research, our findings suggest that the link between passive and active representation can exist for sex, as well as race.

Our findings also support our contention that the institutional context affects whether passive representation will lead to active representation. Although the findings were mixed for decentralization, the findings show consistent support that stratification plays an important role. In school districts with female superintendents, female teachers had a larger positive impact on the number of girls taking advanced placement tests, the number of girls taking the college board exam, girls' math test scores and SAT scores. These relationships held for female administrators as well, although they are not as strong. Clearly, stratification is an important institutional variable that affects whether passive representation will lead to active representation. For those seeking to increase active representation on the basis of sex, attention must be paid to not only increasing overall passive representation but also increasing representation among the upper levels of the organization. Institutional barriers that create glass ceilings for women have policy consequences that go beyond the lack of opportunity for individual women.

In order to fully explore whether passive representation leads to active representation for women in the bureaucracy, researchers must examine a variety of cases. Hopefully the framework we have presented in this analysis will provide guidance in terms of the cases where we should look for gender representation. Thus far, little attention has been paid to identifying cases where theoretically gender representation should occur and where it should not. The case of education suggests that passive representation can lead to active representation for sex. Future research is needed, however, to verify whether this will occur across policy areas that meet our necessary conditions. Once we select cases where opportunities exist for representative bureaucracy, additional empirical tests can be conducted to determine whether the institutional variables we have identified matter.

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