Is Teaching More Girls More Math the Key to Higher Wages?i

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Introduction

Science and engineering occupations are among the highest paid in the U.S. economy. Employment in these occupations is predominantly male, and requires more than the average amount of coursework in mathematics. Are young women unable to enter science and engineering occupations because they don’t know enough math? Are women prevented from filling other well-paid jobs because of inadequate math preparation? Could the gender differential in economic outcomes be substantially reduced if more girls learned more math?

Given the current opportunity structure, both girls and boys who learn more math do tend to have better labor market opportunities later in life. But this does not mean that the gender gap in earnings could be eliminated by teaching more girls more math. The key to this apparent contradiction is understanding one of the most important lessons in the study of public policy: An action that tends to improve the earnings of an individual will not necessarily have the same effect on the earnings of a large group of people.
In this chapter we describe what is known about the complex relationships between gender, math and labor market outcomes. We perform a simulation showing that U.S. women, as a group, would fare somewhat better if they knew as much math as men. We then describe how occupational structures have changed over the past thirty years, as gender differences in mathematics education have decreased, and as other barriers to the career development of women have fallen. We conclude that continued improvement of gender equity in math education is likely to have modest effects on income, but that other policies have a greater potential to improve the economic well-being of U.S. women.

*Historical Context*

Gender disparities in pre-college mathematics preparation were once taken for granted. Just as few girls participated in organized athletics, few girls were trained in mathematics and science. Until relatively recently, even the most academically and socioeconomically privileged young women had little math preparation. In 1974, Lucy Sells wrote a paper observing that, among girls admitted to the elite University of California Berkeley campus, 92 percent did not have enough high school math preparation to qualify them for most college majors. At first, this paper was not deemed important enough to publish (Tobias, 1978). After further research and publicity, however, the issue of insufficient math preparation as a barrier to economic achievement became a major policy issue (Sells, 1978; Tobias, 1978, 1990). The American Association of
University Women has released several highly publicized reports on gender equity in education, broadening the base of support for policy action (AAUW, 1991, 1999).

Because most schools are not segregated by sex, increasing the gender equity of mathematics preparation is often a matter of encouraging, or requiring, girls to enroll in existing classes within the schools they already attend. Reducing inequities of mathematics preparation by socioeconomic status, race and ethnicity is more challenging because schools are more highly stratified along these dimensions. Advanced mathematics courses with highly qualified teachers are not currently available at many high schools serving poor or minority students (Jones, 1984, 1987; Oakes, 1990). Even within high schools, traditional systems of “tracking” tend to assign the slightly more advanced students to the best teachers. This custom contributes to maintaining the status quo of students from less affluent homes and students of color having less access to high quality math education (Oakes, 1990; Eccles, 1997). Despite these traditions, levels of high school math education are increasing for all groups of students, and intergroup differences in math preparation are diminishing (NCES, 1995).

In the early seventies boys outnumbered girls in upper-level high school mathematics classes by a four-to-one ratio (Tobias, 1978). Since the mid-eighties more girls than boys have taken high school math at every level but calculus, where girls are not far behind (NCES, 1997). Since the eighties, the trend has been toward greater numbers of high school students, both boys and girls, taking upper-level math. Among 1982 high school
seniors, 38% of boys and 37% of girls completed Algebra II (NCES, 1995). By 1992, the numbers had risen substantially to 54% of boys and 58% of girls (NCES, 1995). Over the 1982 to 1992 period, remaining differences across racial, ethnic and socioeconomic groups continued to decrease.ii

At every level, from junior high school through college, girls tend to earn higher grades in math classes than do boys (Kimball, 1989; Bridgeman and Wendler, 1991). Nevertheless, girls’ scores on standardized math tests remain somewhat below those of boys (Kimball, 1989; Rosser, 1989; Hyde, Fennema and Lamon 1990; Byrnes and Takahira, 1993; NCES, 1994; Hyde, 1997). Gender differences in math test scores are largest among those with the highest scores (Benbow and Stanley, 1980, 1982; Hedges and Nowell, 1995). But differences in math test scores cannot fully explain the low numbers of women in technical careers: Young women are less than half as likely as young men with equally high math test scores to pursue a bachelor’s degree with a major in engineering, mathematics, computer science or physical science (Weinberger, 1999a). The proportion of technical college degrees conferred on women increased substantially during the 1970’s and early 1980’s, but did not grow between the mid-1980’s and mid-1990’s (NCES, 1997). If women pursued technical degrees at rates comparable to men with equally high math test scores, women would be earning about two-fifths, rather than one-fifth, of technical college degrees (Weinberger, 1999a).
Studies of why so few college women choose technical college majors describe both subtle and overt social pressures to conform to gender norms (Tobias, 1978, 1990; Betz and Hackett, 1981, 1983; Hall and Sandler, 1982; Lunneborg, 1982; Eccles, 1987; Ware and Lee, 1988; Seymour and Hewitt, 1994; Arnold, 1994; Hanson, 1996; Lapan, Shaughnessy and Boggs, 1996; Hyde, 1997; Betz, 1997; Leslie, McClure and Oaxaca, 1998; Badgett and Folbre, 1999). These pressures are often internalized as personal preferences or as unrealistically low perceptions of ability. Recent work by Claude M. Steele and others demonstrates that simple reminders of widely held stereotypes that women, African Americans, or non-Asians are not good at math can actually impair cognitive functioning. This effect is observed even in mathematically competent and confident women (Steele and Aronson, 1995; Steele, 1997; Spencer, Steele and Quinn, 1999; Aronson, et al, 1999).

Despite these barriers, many women successfully complete college degrees in technical subjects and enter professional technical occupations. Currently in the U.S., 60,000 women are employed as pharmacists, 150,000 as medical doctors, 200,000 as engineers, and 440,000 in computer science or mathematics occupations. The women in these professional technical occupations earn, on average, $880 per week, compared with only $680 per week for all women employed full time in professional or managerial occupations, and only $460 per week for all women employed full time (U.S. B.L.S., 1999).
Research on Math Preparation and Labor Market Outcomes

Policy interest in math equity is based on the observation that many well-paid job opportunities require knowledge of math. Of course, scientists, engineers and doctors must learn math. Knowledge of math also improves employment opportunities for those taking civil service or military qualifying exams (Sells, 1978; Tobias, 1978). Math tests are required for graduation from many two-year college programs, for admission into most bachelor degree programs, and for entrance into graduate school in seemingly unrelated fields, including law schools and business schools. The cognitive skills associated with strong math test scores are useful in a wide range of occupations. Within some occupations, people with stronger math skills are more productive, but earn no more than their coworkers who know less math (Bishop, 1992). Along many different career paths, better math preparation leads to more occupational options, higher productivity and higher earnings (Sells, 1978; Murnane, Willet and Levy, 1995; Grogger and Eide, 1995; Murnane and Levy, 1996).

In research studies, an individual’s mathematics knowledge is measured either by the score on a standardized test of mathematics or by the number of math courses taken. Obviously, these measures are related: Math test scores tend to increase with the number of high school or college math courses taken (Jones, 1984, 1987; Angoff and Johnson,
1990), and increase more if the teacher has taken more college math classes (Monk, 1994; Goldhaber and Brewer, 1997). On average, later earnings are higher for individuals with either more math coursework or higher math scores. Interpretation of these studies is complicated by the fact that students who learn more math might also differ in other ways; their higher earnings may be partially due to factors unrelated to learning math. Studies estimating how earnings increase with the number of math courses tell us something about the effect of policies to increase course requirements. Studies estimating how earnings increase with math scores may provide a better control for the fact that individual students might realize different educational and economic benefits from the same number of courses--because they have different teachers, because they are in different types of math classes, or because they have different amounts of talent or prior knowledge.

The most thorough study of the relationship between mathematics coursework and later earnings finds stronger effects for women than for men (Levine and Zimmerman, 1995). Girls who take more math classes during high school do tend to earn more as adults than comparable girls who take fewer. However, this relationship is not particularly strong. The primary effect on earnings is to increase the probability that a girl will pursue a technical college degree and career. There appears to be little economic benefit of taking math for girls who do not go on to college, or who pursue a non-technical career path. Overall, Levine and Zimmerman (1995) estimate that “if girls took the same amount of math and science in high school as boys, the wage gap would be reduced by no
more than about one percentage point.” Among the full-time, year-round workers studied in Levine and Zimmerman’s sample, women who completed high school would continue to earn about 83% of what men earned, even if they took as many math courses.

There is considerable evidence that young women with strong high school math test scores have higher average earnings later in life (Bishop 1992; Grogger and Eide, 1995; Murnane, Willett and Levy, 1995). Again, at least part of the explanation is that individuals with higher mathematics test scores are more likely to pursue college degrees in high-paying technical fields (Wise, Steel and MacDonald, 1979; Fiorito and Dauffenbach, 1982; Blakemore and Low, 1984; Angoff and Johnson, 1990; Hanson, 1996).

Women with technical college majors earn more than female college graduates with other college majors, but less than men with the same college major (Polachek, 1978, 1981; Daymont and Andrisani, 1984; Rumberger and Thomas, 1993; Eide, 1994; Hecker, 1995, 1998; Brown and Corcoran, 1997; Weinberger, 1998, 1999b). The gap in wages between men and women with the same college major appears during the first year after college graduation, before gender differences in labor force participation are a factor (Weinberger, 1998, 1999b). By midcareer, gender differences are dramatic. For example, among midcareer college graduates who work full-time, median annual earnings are above $40,000 for men who majored in Engineering, Math, Computer Science, Pharmacy, Physics, Accounting, Economics, Chemistry, Business, Nursing, Architecture, Biology,
Geology, Political Science and Psychology. For similar women, earnings are above $40,000 only for those who majored in Economics, Engineering, Pharmacy, Architecture, Computer Science, Nursing, and Physical Therapy. While choosing a technical college major improves the chances of a high-paying job for both men and women, men face a much wider range of high-paying career options.

What if More Girls Learned More Math?

While the existing research paints a picture of high school mathematics preparation increasing the likelihood that a girl will have higher earnings later in life, it is difficult to visualize exactly how math education affects a young person’s future, or the overall distribution of earnings. The examples that follow illustrate how high school math preparation and technical college coursework affect later labor market outcomes. The first example shows the full range of occupational outcomes for girls, and for boys, who earn very high math scores in high school. The second example simulates what might happen to average labor market outcomes if girls learned as much math as boys. The third example shows how the occupational distributions of men and women changed over time as girls learned more math, and as other barriers to women’s occupational attainment diminished.

Example 1:

What happens to people who had very high math test scores in high school?
Most people believe that those who excel in math in high school go on to become doctors, engineers, and computer programmers. Many do. However, the relationship is not as strong as most people believe it to be.

Table 1 shows the occupations of 32-year-old men and women who had very high math test scores as high school seniors. “Very high” is defined to be above the median score of white men who later completed college degrees in engineering. By this definition, 12 percent of the men and 6 percent of the women have very high math scores. In Table 1, the occupational distributions of men and women with very high scores are compared to the occupational distribution of the entire high school class.

Both men and women who had very high math scores in high school are more likely than their high school classmates to become doctors, or to become engineers, scientists or computer programmers. High scoring men and women are also more likely to enter a highly skilled profession, such as accountant, architect, economist, lawyer, librarian or psychologist. In addition, high scoring men, but not women, are overrepresented among managers. High scoring men are overrepresented among Ph.D. college professors, and high scoring women are overrepresented among non-Ph.D. college instructors.

It is very interesting to note that women who had very high math scores as high school seniors are overrepresented among schoolteachers. This is a statistic that defies
common misconceptions. While it is true, as is often repeated, that teachers, tend to have lower average test scores than other college graduates (Schlechty and Vance, 1982; Weaver, 1983; Manski, 1987; Hanusheck and Pace, 1994), many young women with very high math scores enter and remain in the teaching profession.\textsuperscript{ix}

TABLE 1 ABOUT HERE

Similarly, women who had very high math scores as high school seniors are heavily overrepresented in nursing and other health related occupations, such as physical therapist or pharmacist. High scoring women are much more likely to become nurses than to become doctors.

Finally, strong math performance is no guarantee of occupational attainment. More than a quarter of employed men and one-fifth of employed women who had very high math scores as high school seniors are, at age 32, employed in sales, clerical, craft, unskilled labor, or service occupations. The average hourly earnings of the high-scoring women in these occupations are remarkably low--virtually the same as the earnings of average-scoring women with no college degree.\textsuperscript{x}

TABLE 2 ABOUT HERE

Example 2:
How much difference might more math education make?

Gender equity of math education is a noble goal in and of itself. Mathematics used to be considered one of the humanities, a subject to be studied for the sake of personal enrichment. But how much will it affect the bottom line of women’s economic security? This is impossible to know with certainty. However, by running a simulation, we can make an estimate of the maximum effect to expect from math equity alone.

In this example, we simulate a world in which there are more women like the women with higher math test scores. Technically speaking, we “weight” the high scoring women until the distribution of women’s scores is just like that of men. This procedure (described in the Technical Appendix) is a bit like cloning the high scoring women to make more of them. We can then observe the distribution of women’s occupations in this simulated world, where girls learn as much math as boys.

Given equal math test scores, women are less likely than men to pursue technical college degrees (Weinberger, 1999a). We therefore also reweight the women who are college graduates, until the resulting distribution has approximately the same math scores and the same distribution of college majors as the men. We can then compare existing economic outcomes with estimates of what economic outcomes might look like in a world where women learned the same amount of math as men in high school, and then pursued the same college majors as men do.
One limitation of this method is that it can only tell us what might happen if there were more women like the high scoring women--not what might happen if more of the lower scoring women learned math. If the higher scoring women are better employees partly for reasons other than their math skills, then simply teaching math will not produce as large a gain in hourly earnings as is estimated in this way. A second limitation is that this method assumes a relatively large increase in the number of workers with math skills, but no adverse effects on the wages of mathematically skilled workers. For both of these reasons, this simulation probably overstates the potential improvement in wages resulting from gender equity of math education.

The results of this analysis are reported in Table 3. The first column shows means for men in the real world, the second column shows means for women in the real world, the third column shows means for women weighted to have the same high school math scores as men, and the fourth column shows means for women weighted so that math skills--both math scores and college majors--are the same as for men. The means of math test scores, college completion rates, and the representation of women with technical college majors are all, of course, higher for the “math-enhanced” women in the third and fourth columns.

As we already know, women are less likely than men to be employed in the labor force, and less likely to work full-time if employed. These gender differences are
unaffected by simulated improvements in math skills: With or without math skills, only about 73 percent of the women are in the labor force at age 32, and of those, only about 78 percent work full time in paid employment. Fully 95 percent of the men are in the labor force, and 96 percent of those work full time. After simulated gains in math skills, women spend just as much time in unpaid activities. They may be more productive in some of these activities (for example, helping with homework) but will not earn more as a result.

About 70% of both the men and the women are married. Simulated changes in the math preparation of women have virtually no effect on the marital status of women. Nearly one-third of the women are reliant on their own earnings at age 32. In addition, many of the married women are likely to become self-supporting at some time in the future.

[TABLE 3 ABOUT HERE]

Gender differences in earnings are reported for full-time workers only. Among full-time workers, the men in this sample earn an average of $12.70 per hour, while the women average $9.50--only 75 percent of what the men earn. When the women’s sample is weighted to have the same math skills as the men’s sample, women’s average hourly earnings increase to $10.20, or 80 percent of what men earn. There is an effect on the wage gap, but it is relatively small. No more than one-fifth of the earnings gap between
women and men working full-time might disappear if women had the same math skills as men.

For the majority of the population with no college degree, gender equity in math has almost no effect on the gender wage gap. The average hourly earnings of men with no college degree employed full-time are $11.50, compared to $8.40 for women, 73% of what men earn. When the women’s sample is weighted to have the same math test scores as the men’s sample, women’s average hourly earnings increase only to $8.60, or 75 percent of what men earn. Most of the effect of math on earnings is through increasing the probability of pursuing higher education, and of choosing a technical college major.\textsuperscript{x1} Among full-time workers with no college degree, less than 8 percent of the gender gap would be eliminated by equalizing math achievement. For those with no college degree, fully 92 percent of the gender wage gap must be addressed through policies other than math equity.

The gender wage gap among college graduates is more strongly affected by improvements in math skills. Male college graduates average $15.10 per hour. When the women’s sample is weighted to have the same math skills as the men’s sample, the average hourly earnings of female college graduates employed full-time increase from $11.90 to $12.60, or from 79 percent to 84 percent of what men earn. Among full-time workers with college degrees, equalization of math scores and college major choices reduce the wage gap by one-fourth. While improvements in math skills are likely to increase the
wages of women with college degrees, these improvements in skills cannot close the
gender gap.

Simulated changes in math have little effect on the occupational distribution of
women. In the math-weighted sample, more women do enter science, engineering, and
managerial occupations and other skilled professions, and fewer women end up in clerical
and less skilled positions. However, the changes are marginal. When women’s math
skills are simulated to match men’s, fewer than 10 percent of all women move from one
sector of the occupational distribution to another. Women remain greatly overrepresented
in teaching and nursing--in fact the numbers of women in teaching and in nursing increase
with simulated increases in math scores alone. This is further evidence that lower math
ability is not what keeps women in these vital occupations. Simulating changes in math
skills has absolutely no impact on the proportions of women in skilled technical or craft
positions. Increasing the numbers of women with training in mathematics may improve
productivity in some occupations, but is not likely to dramatically change the kinds of
jobs women do. Policies to value women’s work have much greater potential for
increasing the incomes of U.S. women.

Example 3:

*Occupational changes before and after gender equity in high school mathematics*
The analysis described above relies on data from 1986, the only large data set with both academic test scores from the senior year in high school, and earnings data at age 32. It is likely that the labor market opportunities of women have changed since 1986. To see how much they have changed, we compare the occupational distributions of the 1986 sample of 32-year-olds who completed high school in 1972 with a sample of 1999 31-33 year-olds who completed high school in the mid-eighties. We also compare these with occupational distributions for a sample of 1970 31-33 year-olds who completed high school in the fifties. We refer to the 1986 32-year-olds as the 1972 senior cohort, since that is the year they completed high school. Similarly, we refer to the 1970 32-year-olds as the 1956 senior cohort, and to the 1999 32-year-olds as the 1985 senior cohort.\textsuperscript{xii}

The results can be seen in Table 4. Over the period 1970 to 1999, there was a dramatic decline in the proportion of 32-year-old women engaged only in unpaid work such as full time childrearing, falling from 55\% to 22\%. There was a corresponding increase in the representation of women in many occupations. Women’s representation grew substantially among scientists and engineers, physicians, managers, skilled technicians, sales personnel, and skilled tradesmen.

Although the 1985 senior cohort (1999 32-year-old women) had a much more solid foundation of high school mathematics than the women in either of the earlier cohorts, the
entry of women into several traditionally male occupations increased much more quickly between 1970 and 1986 than during the 1986 to 1999 period. This is true for scientists and engineers, managers, skilled technicians, and the skilled trades, and is true whether we look at the numbers of women in these occupations, or at the proportions of employed women in these occupations. Differences in high school mathematics cannot be responsible for keeping the women of the 1956 senior cohort out of these jobs, since the gender differences in math were also present for the 1972 senior cohort. The 1985 senior cohort enjoyed continued opening of occupational opportunities. But it is not clear that this opening was due to changes in math skills, since the entry of women to many traditionally male occupations went more slowly for this more mathematically educated cohort.

As women continue to enter traditionally male occupations, there is also a remarkable stability in the occupational distributions of 32-year-old women between 1986 and 1999. Between the two later cohorts, there is absolutely no change in the proportion of women employed in science or engineering occupations (1.7% in both years). It is possible that more women are now engaged in science and engineering careers, but have been promoted up to management. Many changes are visible: The proportion of women employed as physicians increased from 0.3% to 0.7%. This change involves a small number of women, but is a large change in the gender composition of the profession. There are also visible increases in the fraction of women employed in skilled technician (2.8% to 3.8%), sales (4.0% to 6.2%), and skilled trades (1.4% to 1.8%) occupations. A large increase in the
proportion of women employed in managerial professions (from 9.3% to 15.0%) is
tempered by the continued scarcity of women at higher levels of management (Reskin and
Roos, 1992), and by the assignment of managerial job titles to positions that were
formerly classified as clerical (Reskin and Padavic, 1994).

Women’s participation in some traditional activities is now lower: Fewer women are
employed in teaching (5.0% to 4.4%) and nursing (4.7% to 3.9%), and the proportion of
women engaged only in unpaid work continued to fall, from 27% to 22%. However,
despite changing opportunities for women, about half of all 32-year-old women are
currently engaged in traditionally female activities including unpaid child rearing, clerical
work, teaching and nursing.

Despite large improvements in mathematics preparation, the occupations of 32-year-
old women in 1999 look much more like the occupations of women in 1986 than like the
occupations of men in 1999.

*Limitations of Math Equity as a Tool to Raise Women’s Incomes*

For the small group of women who complete college degrees in technical fields,
investing heavily in mathematics-intensive education is an effective strategy for high later
earnings. However, fewer than five percent of all U.S. workers are employed as doctors,
scientists, engineers or computer programmers. Learning math improves the chances that
an individual woman will get one of these scarce and potentially remunerative jobs, but this strategy simply cannot have a significant impact on the earnings of all women.

Even the few highly trained women cannot expect economic outcomes equal to those of men. Women with technical skills are not exempt from earning lower wages than equally experienced men with the same amount and type of education (Ferber and Kordick 1978; Vetter, 1979; Jagacinski, 1987; Strober and Arnold, 1987a; Zuckerman, 1990; Bielby, 1990; Haberfeld and Shenhav 1990; Mcllwee and Robinson, 1992; Hampton and Heywood, 1993; Hecker, 1995; Weinberger, 1998, 1999b; Ferree and McQuillan, 1998; Schiebinger 1999). While overtly exclusionary policies are no longer as prevalent as they once were, gender differences in labor market outcomes among scientists and engineers are as large as gender differences in the labor market as a whole (Bielby, 1990).

Social scientists in economics, sociology and psychology are all working to understand the complex processes that lead to women’s lower earnings. One factor is that women in technical jobs are subject to the pervasive cultural norms and expectations about women’s roles as helpers and caregivers. Anecdotal evidence suggests that when technical jobs are filled by women, the job description can change to include a requirement to provide nurturing and caregiving (see BOX). For example, when men are employed as computer systems managers, their job is to keep the computers running. A woman in the same occupation can also be expected to help the users feel comfortable with the
technology and to console frustrated users. Women who are employed as systems analysts are more likely than men to spend their working hours helping customers and less likely to be involved in managerial decision making (Donato, 1990). Women who are doctors are more accommodating to their patients than are male doctors (Tannen, 1994). When female college professors fail to be nurturing, feminine, and available outside of class hours, students give lower teaching evaluations despite forming higher estimations of the professor’s technical competence (Scheibinger, 1999). Women who are on the faculty at research universities are expected to serve on more committees and to be better teachers than their male colleagues (Tack and Patitu, 1992; Park, 1996; Scheibinger, 1999). Unfortunately, the time spent in this way interferes with time for research, and therefore with opportunities for promotion (Tack and Patitu, 1992; Park, 1996).

[SECOND BOX, “WOMEN IN THE COMICS’ ABOUT HERE]  

Often these gender-normed expectations are explicit in job descriptions. Within a given technical occupation, women are more likely to be hired into jobs that require both technical and people skills (Reskin and Roos, 1990). But even when women and men are hired into exactly the same job, expectations differ. Bielby (1990) argues that women scientists might behave in ways that accommodate the expectations of their colleagues, sometimes without even being aware of being influenced in this way.
If women did their jobs differently, but were paid as much as men, then we might simply celebrate what women bring to technical occupations as new opportunities for women open up. In practice, those who help and nurture on the job tend to be valued and paid less (England, et al, 1994; Kilbourne, et al, 1994; England and Folbre, 1999). If job descriptions change when women fill them, is it ever really possible to move women into men’s jobs?

There are other reasons to believe that increasing the number of technically trained women might have a limited ability to raise women’s wages. As has been discussed in other chapters of this book, jobs that are predominantly filled by women tend to have lower pay than predominantly male jobs that require similar levels of skill (Treiman and Hartman 1981; Sorensen, 1989; England, et al, 1994; Kilbourne, et al, 1994; Bellas 1994, 1997). Historically, when the proportion of female workers in an occupation has risen, relative wages have fallen. This occurred for clerical workers at the turn of the century (Davies, 1982; Cohn, 1985), bank tellers at mid-century (Strober and Arnold, 1987b), and, more recently, for pharmacists, news reporters, insurance adjusters, bartenders and bus drivers (Reskin and Roos, 1990). As women entered these occupations, employers adjusted wages downward toward those paid for other women’s jobs. Greatly increasing the numbers of women trained for professional technical occupations could very well result in decreasing the earnings of all workers in those occupations, including and especially the women.
Finally, it is possible that some employers currently advertise for individuals with strong technical training simply because it is a legal way to maintain a predominantly male applicant pool. If so, then policies to increase the number of women with technical training will not guarantee women access to these high wage jobs. Another loophole will surely be found to fill desirable positions with men if, in fact, employers would prefer men in these jobs.

Among all U.S. women, gender equity in math education can have, at best, a small effect on gender equity in U.S. incomes. Previous research indicates that gender equity in high school math preparation might have reduced the gender wage gap among those in their late twenties by no more than 1% (Levine and Zimmerman, 1995). The simulation described in this chapter estimates that gender equity in high school math education and college major choices might have improved the later earnings of women, working full-time at age 32, from 75% to 80% of what men earned. However, even this modest effect is probably overstated. Simple laws of supply and demand suggest that large increases in the number of people with mathematics training are likely to diminish the economic value of math in the labor market; as any skill becomes more abundant, its price falls unless demand for the skill rises even faster than the supply.\textsuperscript{XV} Hence, teaching many more girls more math will tend to reduce the economic return associated with knowledge of math.

Given the tendency for women to be paid less than men with the same skills, the knowledge that math skills might be valuable because they are relatively scarce or because
men have them, and the fact that women spend more time engaged in activities where they receive no compensation for their skills, policies to significantly increase the number of women who know math have a limited potential to increase women’s wages. This analysis suggests that policies designed to value the work done by women, and enforcement of laws to protect women from discrimination in hiring and promotion, will continue to have an important role in improving women’s incomes.

Conclusion

Math education opens the doors to many educational and career opportunities. As increasing numbers of young men and women enroll in college, high school mathematics preparation is becoming important to a larger proportion of the population. It is simply wrong to make that preparation unavailable to large segments of the population, such as girls, or students in poorly funded school districts. In fact, increasing numbers of students, both girls and boys, are studying math in high school. There is an important role for policy to ensure that all students have access to well-educated math teachers and understand the importance of math for maintaining future career options.

Women with strong high school math preparation are more likely than other women to enter technical careers, but are less than half as likely as men with the same math test scores to choose technical college majors. Among college-educated women who do pursue careers in technical fields, earnings are high, relative to the earnings of other women. This
strategy effectively raises the wages of a small number of women, but is limited by the fact that fewer than five percent of all U.S. workers are employed in technical occupations--we simply cannot all become scientists and engineers. A further limitation is that women earn less than men, even among scientists and engineers.

In the larger labor market, high school math preparation is only a first step toward occupational attainment, and is no guarantee of high later earnings. This is especially true for women. Among women with very strong high school math preparation, more wind up as teachers than as engineers or doctors. One-fifth of women with very strong high school math test scores land in very low status jobs, earning no more than women who entered the labor market with weak math preparation. Yet, on average, mathematically trained women tend to earn more than other women.

How much of the gender gap in wages is due to gender differences in math skills? The results of my mathematical simulation suggest that if women had the same math skills as men, but had labor market opportunities and career paths typical of women, the gender gap in wages would be reduced, but not dramatically. Simulated increases in women’s math skills have no effect on either the proportion of women working in paid employment or the proportion working part-time. Among those with no college degree, improving the math skills of girls has almost no effect on the 25 percent wage gap. Among those with college degrees, those who know more math earn substantially higher wages. Simulated gender equality in both pre-college math preparation and college major
reduces the gender gap in wages from 21 percent to 16 percent among college graduates employed full time. Among all women employed full-time, the pay gap is reduced from 25 percent to at 20 percent. Simulated math equity reduces earnings inequality, but more than 80% of the gender pay gap among full-time workers is due to other factors.

These simulations probably overstate the potential economic effect of policies to improve gender equity of mathematics education. If technically trained individuals are valued in the labor market because they are relatively scarce, or because most of them are men, then a large increase in the number of technically trained young women is likely to diminish the earnings advantage associated with mathematical training.

Historically, the largest gains in young women’s occupational attainment occurred before many learned upper-level high school math. Many careers were simply closed to women for reasons other than math preparation. Conversely, gender equity of high school math education will not necessarily open career opportunities to women. But as more high-status jobs become accessible to women, women who know more math might be better prepared to fill them.

With or without high school mathematics preparation, large numbers of highly educated women fill valuable but undervalued roles in our economy including teaching, nursing, and mothering. Policies to insure the economic security of women who perform these jobs are vital to the health of our economy.
I do encourage every girl and boy I know to learn as much math as possible.

Girls who learn more math can certainly expect to have more educational and career opportunities in the future. When they go to work, women with technical skills can expect to earn more, on average, than other women.

However, teaching more girls more math can not insure the lifelong economic security of U.S. women. Policies to ensure equity of educational opportunities must be joined by policies to ensure that women will be rewarded for all of the work that they do.
Data Appendix

Examples 1-3 all use data from the National Longitudinal Study of the Class of 1972. This study is used because it follows individuals from the 1972 senior year of high school through 1986, and because all participants were given a standardized math test as high school seniors. The Cognitive Test of Mathematics had 25 questions, with one point given for each correct answer, and a 1/3 point penalty for incorrect answers.

All estimates are weighted using weights provided with the data set to control for differential sampling, response and attrition rates. These weights are constructed so that weighted estimates are representative of a cross-section of 1972 U.S. high school seniors.

Example 1 uses the sample of 4327 men and 4791 women with both scores from the 1972 math test and information on 1986 activities. Table 1 is based on all 9118 observations. Table 2 is based on the subset of 3276 men and 2404 women who were full-time workers in 1986, and for whom hourly earnings were reported.

Among white men who earned an engineering, math, computer science or physical science bachelor’s degree by 1979, the median score on the Cognitive Test of Mathematics was $22 \frac{1}{3}$. The 577 men and 324 women with “very high” scores described in Example 1 have scores greater than $22 \frac{1}{3}$.
Example 2 uses the full sample of 15860 students who took the 1972 math test to determine score frequencies for men and women. College major frequencies similarly make use of all observations with this data available. (See the Technical Appendix for a description of how the weights were constructed).

After the weights were created, the simulations reported in Table 3 used the same sample of 9118 that was used in Table 1. Full-time hourly earnings are based on the same subset used in Table 2.

The 1986 occupational distributions described in Table 4 again use the sample of 9118 used in Tables 1 and 3. The 1970 data are from an ipums extract of the 1970 census (n=45356). This extract is representative of all individuals who were ages 31-33 in 1970, and who had at least 12 years of education. The 1999 tabulations were computed by the U.S. Bureau of Labor Statistics Ferret System based on all individuals in the March 1999 CPS who were ages 31-33, and who had at least 12 years of education (n=5112).
Technical Appendix --

Description of Weighting Procedure to Simulate Equal Distributions of Math Skills

In Example 2, weighted averages of women’s labor market outcomes estimate what labor market outcomes might be in a simulated world with more women like the higher scoring women, and fewer women like the lower scoring women. The simulated effect on earnings cannot tell us exactly what would happen if more women knew math, but can give us a ballpark estimate. The weighting procedure used is described in this Appendix.

For each possible score on the Cognitive Test of Mathematics, \( i \in \{1, 2, 3, \ldots, 24, 25\} \), the proportion of boys who earned that score \( (p^m_i) \) was computed. Similarly, the proportion of girls who earned each score was computed \( (p^f_i) \). The first set of weights, bringing the women to match the men’s math scores, is: \( w^1_i = \frac{p^m_i}{p^f_i} \). For example, 8.0% of men and 4.6% of women score 23. All women with score 23 were weighted by 8.0/4.6=1.74, or counted as 1.74 people. Similarly, 3.8% of men and 5.2% of women score 8, so women with score 8 were weighted by 0.73.

The mean of a variable (for example, n observations of the wage) is usually understood to be the sum of all observations divided by the number of observations, or
\[ \bar{w}_j = \frac{1}{n} \sum_{j=1}^{n} \bar{w}_{s(j)} \] 

The weighted mean is computed as: \[ \bar{w}_j = \frac{1}{n} \sum_{j=1}^{n} \bar{w}_{s(j)} \], where \( \bar{w}_{s(j)} \) is the weight applied to individual \( j \), who has score \( s(j) \). Note that the mean of \( \bar{w}_{s(j)} \) over all \( j \) is 1.

To create the second set of weights, we computed the proportion of male college graduates in each college major, \( M^m_k \), where \( k \in \{ \text{biology, business, computer science, education, engineering, health, math, physical science, other} \} \). We then computed the proportion of female college graduates in each college major, \( M^f_k \), after applying the first set of weights. For individuals who did not graduate from college, the second set of weights is equal to the first (\( w^2_i = w^1_i \)). For the college graduates, \( w^2_{i,k} = w^1_i \frac{M^m_k}{M^f_k} \).

A third and fourth set of weights were also created, using additional information about SAT-M scores for those students who took the SAT exam (about one-third of all students). Where the SAT-M score was available, the first weight was replaced by the ratio of the proportion of men to the proportion of women with SAT-M scores in the same 50-point range. (These proportions were taken from Table 4, Column 7 of Paglin and Rufolo, 1990). For example, women with scores between 700 and 750 were weighted by 2.97. Using this additional information permits greater differentiation at higher levels of math scores. The fourth set of weights was computed in the same way as the second, but with college major distributions computed after applying the third, rather than the first, set of weights. The analysis using SAT-M based weights had almost the same results, which are not reported in the tables. The estimated percentage of women who
would be scientists and engineers and average hourly earnings both fell slightly. Among college graduates, simulated hourly earnings rose very slightly, from $12.60 to $12.65, when SAT-M based weights were used.

Note: the weights described in the Technical Appendix are, in fact, multiplied by the weights described in the Data Appendix—a detail omitted to simplify the explanation.
Gender Barriers to Careers in Technical Fields

Barriers to women’s educational opportunities in science, math, engineering and medicine have become much more porous than they once were. Many women I have met or read about faced barriers that were humiliating, limited their career development, and left lasting emotional scars. Each of the women I am about to describe remembered, verbatim, what was said to her during her ordeal.

My grandmother wanted to be a doctor. As a college senior in the 1920’s, she received special permission to take a medical school course that she was particularly interested in. However, she was asked to leave the class when no other women enrolled.

In the 1950’s my friend Shirley excelled in science and math during high school, and easily passed the pre-med hurdles in college, only to be advised that she would never be accepted into a state medical school she could afford because only one woman would be admitted per year—a space that was reserved for the daughter of a doctor or someone so unattractive that there was no risk that she would marry and leave the profession.

In the 1960’s, Betty Friedan completed writing The Feminine Mystique and decided to pursue a Ph.D. The classic book that would later be credited with igniting the women’s movement had not yet been printed, and was still unknown. Its author was denied entry to the graduate program in social psychology on the basis that she would not have the mastery of statistics that was required. She protested: “But I used statistics throughout the book,” to which the baffled chair responded: “Well, my dear, what do you want to bother your head getting a Ph.D. for, anyhow?” (Friedan, 1983).
A 1970’s college graduate was a math major until she went to her professor to ask about a homework problem. She was told that if she needed help, she shouldn’t be a math major.

In the early 1980’s I worked with a talented African American engineer who had just dropped out of a very prestigious graduate school. She was greeted on the first day of a new class by the professor’s telling query: “What are you doing here?”

Today, girls and women are legally entitled to an educational environment free of discrimination or sexual harassment. But these legal protections are meaningful only if people work to ensure that schools follow through. One such person is Dr. Vinetta C. Jones. Once denied entry to a middle school algebra class, she now works with school districts to promote a systemwide commitment to preparing and expecting every child to learn algebra (Matthews, 1997).
Women in the Comics

Even in the comics, women with technical skills are expected, or choose, to use them to nurture and help people. In the strip *Dr. Katz*, a woman comes to the psychologist for career counseling and proclaims: “I teach remedial math and I’m wondering where I could do the most good.” Rather than work to clarify her goals and motivations, the doctor recommends the express checkout line. The character June of *Rex Morgan* is a very competent nurse who often goes far beyond the call of duty to help people. The character Deana of *For Better or Worse* recently completed her degree in pharmacy and signed on as a medical volunteer in Honduras with the comment: “...how often do you have the chance to make a difference in someone’s life?” And Dr. Burber of *9 Chickweed Lane*, a tenured biology professor, was recently instructed by her department chair: “I don’t want you to change the content. Just try looking a bit more reassuring--smile a little.”

[INCLUDE FOR BETTER OR WORSE AND DILBERT HERE]

[SHOW DILBERT WITH CAPTION:

“If she were an engineer, would they stop expecting tissues?”]

************
BOX: Even in the comics, women with technical skills are expected to use them to nurture and help people. In the strip Dr. Katz, a woman comes to the psychologist for career counseling and proclaims: "I teach remedial math and I'm wondering where I could do the most good." Rather than work to clarify her goals and motivations, the doctor recommends the express checkout line. The character June of Rex Morgan is a very competent nurse who often goes far beyond the call of duty to help people. The character Deana of For Better or Worse recently completed her degree in pharmacy and signed on as a medical volunteer in Honduras with the comment: "how often do you have the chance to make a difference in someone's life?" The character Kim of Doonesbury, a talented computer programmer with graduate training from MIT, has given up her high-paying job to help in her husband's failing company. And Dr. Burber of 9 Chickweed Lane, a tenured biology professor, was recently instructed by her department chair: "I don't want you to change the content. Just try looking a bit more reassuring-smile a little."

(include For Better or worse and Dilbert here)


Benbow, Camilla and Julian Stanley. 1980. "Sex Differences in Mathematical Ability: Fact or Artifact?" Science 210 (December) :1262-64.


Weinberger, Catherine J. 1999a. ”Mathematics Test Scores, Gender, Race, Ethnicity and the Science and Engineering Workforce.” Unpublished Manuscript, University of California, Santa Barbara.


Table 1 --
1986 Occupational Distributions of Men and Women Who Had Very High Mathematics Test Scores During the 1972 Senior Year of High School (Percent of Each Group with Specified Occupation or Activity).

<table>
<thead>
<tr>
<th>Occupation/Activity</th>
<th>1972 Seniors with very high math scores, occupations in 1986</th>
<th>All 1972 Seniors, occupations in 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>men</td>
<td>women</td>
</tr>
<tr>
<td>Engineer, Scientist, Computer Specialist, Mathematician</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Physician or Other Health Diagnosing</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Nurse or Other Health Providing</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Ph.D. College Professor</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Post-Secondary Instructor (no Ph.D.)</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Teacher (Preschool through High School)</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Highly Skilled Professional</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Other Professional</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Managerial</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Skilled Technician</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Sales</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Clerical</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Skilled Trades</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Less Skilled Labor or Service Occupation</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Full-Time Mother</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Student Only</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Other Voluntary Withdrawal</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Unemployed</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Sample Size</td>
<td>577</td>
<td>324</td>
</tr>
</tbody>
</table>
Table 2 --
1986 Hourly Earnings of Full-Time Workers by Sex, Occupation, Mathematics Test Scores During the 1972 Senior Year of High School, and Education

<table>
<thead>
<tr>
<th></th>
<th>men</th>
<th>women</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Full-Time Workers</td>
<td>12.70</td>
<td>9.50</td>
</tr>
<tr>
<td>By High School Math Scores and Employment in a Professional, Managerial or Technical (PMT) Occupation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very High Math Scores and PMT occupation</td>
<td>16.20</td>
<td>13.60</td>
</tr>
<tr>
<td>Very High Math Scores and non- PMT occ</td>
<td>13.60</td>
<td>8.60</td>
</tr>
<tr>
<td>Lower Math Scores and PMT Occ</td>
<td>13.60</td>
<td>11.00</td>
</tr>
<tr>
<td>Lower Math Scores and Non-PMT occ</td>
<td>11.40</td>
<td>8.00</td>
</tr>
<tr>
<td>By Education Level:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor’s Degree or Higher</td>
<td>15.10</td>
<td>11.90</td>
</tr>
<tr>
<td>Less than Bachelor’s Degree</td>
<td>11.50</td>
<td>8.40</td>
</tr>
<tr>
<td>Sample Size</td>
<td>3276</td>
<td>2404</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MEN actual</th>
<th>WOMEN actual</th>
<th>WOMEN weighted to match men’s math scores</th>
<th>WOMEN weighted to match men’s math scores and college majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean 1972 Math Score</td>
<td>14.2</td>
<td>12.1</td>
<td>14.2</td>
<td>14.2</td>
</tr>
<tr>
<td>Proportion with Any College Degree</td>
<td>.34</td>
<td>.28</td>
<td>.34</td>
<td>.34</td>
</tr>
<tr>
<td>Proportion with Technical College Degree</td>
<td>.05</td>
<td>.01</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>Proportion in Labor Force</td>
<td>.95</td>
<td>.73</td>
<td>.74</td>
<td>.73</td>
</tr>
<tr>
<td>Proportion Employed in Full-Time Jobs</td>
<td>.96</td>
<td>.78</td>
<td>.78</td>
<td>.79</td>
</tr>
<tr>
<td>Proportion Married</td>
<td>.69</td>
<td>.70</td>
<td>.70</td>
<td>.68</td>
</tr>
<tr>
<td>Hourly Earnings of Full-Time Workers</td>
<td>12.70</td>
<td>9.50</td>
<td>10.00</td>
<td>10.20</td>
</tr>
<tr>
<td>Hourly Earnings of Full-Time Workers with College Degree</td>
<td>15.10</td>
<td>11.90</td>
<td>12.20</td>
<td>12.60</td>
</tr>
<tr>
<td>Hourly Earnings of Full-Time Workers with no College Degree</td>
<td>11.50</td>
<td>8.40</td>
<td>8.60</td>
<td>8.60</td>
</tr>
<tr>
<td>Occupation (percent of group with this occupation or activity)</td>
<td>Engineer, Scientist, Computer Specialist, Mathematician</td>
<td>6.6</td>
<td>1.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Physician or Other Health Diagnosing</td>
<td>1.7</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Nurse or Other Health Providing</td>
<td>0.9</td>
<td>4.7</td>
<td>5.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>
### Table 3, Continued

<table>
<thead>
<tr>
<th>Occupation (percent of group with this occupation or activity)</th>
<th>MEN actual</th>
<th>WOMEN actual</th>
<th>WOMEN weighted to match men’s math scores</th>
<th>WOMEN weighted to match men’s math scores and men’s college majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. College Professor</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Post-Secondary Instructor (no Ph.D.)</td>
<td>0.4</td>
<td>0.6</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Teacher (Preschool through High School)</td>
<td>1.9</td>
<td>5.0</td>
<td>5.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Highly Skilled Professional</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other Professional</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Managerial</td>
<td>19</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Skilled Technician</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sales</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Administrative Support (Clerical)</td>
<td>5</td>
<td>22</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Skilled Trades</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Less Skilled Labor or Service Occupation</td>
<td>21</td>
<td>12</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Active Military Duty</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Full-Time Mother</td>
<td>0</td>
<td>21</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Other Voluntary Withdrawal from Labor Market</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Unemployed</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sample Size</td>
<td>4327</td>
<td>4791</td>
<td>4791</td>
<td>4791</td>
</tr>
</tbody>
</table>
Table 4 -- Occupational Distributions of 32-Year-Old Men and of 32-Year-Old Women with At Least 12 Years of Education for Three Cohorts of High School Graduates. (Percent of Each Group with Specified Occupation or Activity).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1970 Occupations (n=45356)</td>
<td>1986 Occupations (n=9118)</td>
<td>1999 Occupations (n=5112)</td>
</tr>
<tr>
<td>MEN</td>
<td>WOMEN</td>
<td>MEN</td>
<td>WOMEN</td>
</tr>
<tr>
<td>Engineer, Scientist,</td>
<td>7.3</td>
<td>6.6</td>
<td>6.8</td>
</tr>
<tr>
<td>Computer Specialist,</td>
<td>0.3</td>
<td>1.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Mathematician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician or Other</td>
<td>1.4</td>
<td>1.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Health Diagnosing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurse or Other Health</td>
<td>0.5</td>
<td>0.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Providing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School Teacher</td>
<td>3.1</td>
<td>1.9</td>
<td>5.0</td>
</tr>
<tr>
<td>Other Professional</td>
<td>10.0</td>
<td>7.8</td>
<td>6.4</td>
</tr>
<tr>
<td>Managerial</td>
<td>12.9</td>
<td>18.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Skilled Technician</td>
<td>3.5</td>
<td>4.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Sales</td>
<td>7.6</td>
<td>6.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Administrative</td>
<td>7.0</td>
<td>5.0</td>
<td>21.7</td>
</tr>
<tr>
<td>Support (Clerical)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled Trades</td>
<td>17.3</td>
<td>16.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Less Skilled Labor</td>
<td>24.5</td>
<td>20.6</td>
<td>12.2</td>
</tr>
<tr>
<td>or Service Occupation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voluntary</td>
<td>3.1</td>
<td>5.6</td>
<td>27.3</td>
</tr>
<tr>
<td>Withdrawal from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Market</td>
<td>55.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>1.7</td>
<td>4.6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

51
This chapter was written while the author was a National Academy of Education Spencer Postdoctoral Fellow. The very early stages of this research were funded by a grant from the American Educational Research Association. I would like to thank Shirley Alvord-Shepherd, Rani Bush, Noah Friedkin, Mary King, Peter Kuhn, John Mohr, Krista Paulsen, John Sonquist, Lisa Torres and Sonia Utt for insightful comments on earlier drafts of this chapter.

In 1982 23% of Hispanic, 26% of African American, 41% of white, and 55% of Asian high school seniors had completed Algebra II. By 1992 these figures had increased and converged substantially, to 47% of Hispanic, 41% of African American, 59% of white and 61% of Asian high school seniors (NCES, 1995). Similarly, in 1982 only 33% of seniors with high school educated parents completed Algebra II, compared with 53% of those with college educated parents. By 1992, the figures were far more equitable: 55% of those with high school educated parents and 59% of those with college educated parents (NCES, 1995). These increases in participation are particularly dramatic given that they occurred during a period of falling dropout rates for students of all ethnic groups (NCES, 1997, 1999).

The average weekly earnings of women employed full time in these technical occupations are $985 for pharmacists, $966 for doctors, $859 in computer occupations, and $831 for engineers (U.S. B.L.S., 1999).

This study estimated the effect of math coursework with and without careful controls for family and personal characteristics that might affect later earnings, including cognitive test scores.

Unpublished work by Ackerman (1999) suggests that better controls for the type of math classes, and whether they were successfully completed, (rather than the number of classes enrolled in) would lead to a somewhat higher estimate of the effect of math education on earnings.

Ages 35-44 with a bachelor’s degree and no higher degree. Listed in order of descending median annual earnings. Note that Physics would probably also be listed for women, except that the number of women is too small to make a reliable estimate. This example draws on median annual earnings listed in Hecker (1995).
For discussion of the data and methods used in Examples 1-3, see the Data Appendix and the Technical Appendix at the end of this chapter. A more detailed discussion of Example 1 can be found in Weinberger (1999c).

The “highly skilled professional” category is constructed in Weinberger (1999c). It contains the following occupations: accountant, actor, author, economist, editor or reporter, lawyer, librarian, psychologist, researcher, urban planner. Average high school math scores are high in each of these occupations.

The same holds for a younger sample--among 1980 seniors 8% of women with very high math test scores, compared to only 2% of the full cohort, were school teachers in 1986 (Weinberger, 1999c).

See Table 2. The high-scoring men in sales, clerical, craft, unskilled labor, or service occupations averaged $13.60 per hour, 18% more than an average-scoring man with no college degree. These high-scoring men in lower status occupations earned as much as high-scoring women or low-scoring men in higher status occupations. In contrast, the average hourly earnings of high-scoring women employed full-time in sales, clerical, craft, unskilled labor, or service occupations are only $8.60 per hour, only 2% more than an average-scoring woman with no college degree.

The number of people who benefit from improved scores on civil service or military entrance exams might be too small to be noticed in this analysis.

A “cohort” is a group of people who were born (or, in this case, who finished high school) at about the same time. Usually, we can just call a group born earlier the “older” group. That would be confusing here, since we are looking at each group at age 32.

The entry of women into health diagnosing and sales occupations was greater during the later period.

This example was taken from an article in Working Woman magazine.

For example, Grogger and Eide (1995) found that demand for technical college graduates rose faster than the supply during the early 1980’s. During this period, both supply and wages rose--but wages probably did not rise as much as they would have without the increase in supply.