

At the end of my junior year in high school, I had a conversation with my counselor about what I was going to take in my senior year. The year before, the girls' school that I attended had made an arrangement with the nearby boys' school to allow students at each school to attend the other school if their own school did not offer a course they wanted. I was excited as it meant that, in my senior year, I would be able to take upper-level math and science courses not available at my school. When I raised this possibility with my guidance counselor, she patted my hand and said, and I remember her words exactly, "My dear, what possible use are you ever going to have for calculus and physics?" I was upset, but without anyone to contradict her, I accepted her decision and took analytical algebra and biology at my own school instead.

In retrospect, I do see her point of view. After all, at that point in my life, I had decided to attend nursing school, and if that is all that I had ever done, she might have been right. However, given the changes in the profession of nursing since that time, especially with the advent of nurse practitioners, I would have had plenty of use for advanced math and science.

In the years since that time, I became a teacher of math and science and had to take calculus and physics in college, not an easy task since all of my classmates had taken the courses first in high school. I taught math and science in girls' schools and pressed each of those institutions to offer upper-level courses even if there were only a few students who expressed an interest. I was delighted to see my students enjoying these subjects and was thrilled when some of my students majored in science and math in college.

When I was in high school, it was accepted that math and science were not subjects in which most girls were going to do well. Since that time, the world has changed its perspective and now the idea is that girls should have the chance to do math and science if they want to. However, from working with young women, I have noticed that many girls believe they are probably not going to do well in math or science or, at the very least, will not be interested in those subjects, and it appears that this belief is pervasive and widespread.

Is there any evidence that math and science are not subjects for girls? See if you know the answers to the following questions.

Hint: All the individuals are women.

QUIZ

1. Who was the first person to win two Nobel Prizes?
2. Who was the first child of a Nobel Prize winner to also win a Nobel not shared with the parent?
3. Who was the inventor of the computer language COBOL?

4. Who developed the first major drug treatment for leukemia?
5. Who invented Kevlar, the material used in bulletproof vests?
6. Who led the team that developed the Mars Pathfinder rover?
7. Who invented the computer games King's Quest, The Dark Crystal, The Dagger of Amon-Ra, and Phantasmagoria?
8. Who discovered the physical basis for DNA as well as the structure of the tobacco mosaic virus?
9. Who developed the technique of radioimmunoassay, one of the most significant methods of chemical analysis used in medicine?
10. Who invented the disposable cell phone?

Answers are found on page 7.

Lest you think that these women were spending their lives in a laboratory somewhere not having a real life, six of the ten were married and they had eight children among them. More importantly, these accomplished women and many more like them did not believe that the areas of science, technology, engineering, and math (STEM) were subjects for which they were not suited. Also noteworthy is that a great many prominent women scientists and mathematicians, including some of those mentioned in the quiz, began their careers in the nineteenth or at the beginning of the twentieth century. After the beginning of the twentieth century, the number of women active in science and math dropped and has only recently shown an upturn.

Today many people are not aware that during the latter part of the nineteenth century the prevailing wisdom was that literature and classics were subjects best suited for men; women should study science and math because those subjects were practical and provided discipline and training (Tolley, 2003). In California in 1895, there were 14% more boys than girls enrolled in trigonometry and 2% more boys than girls enrolled in physics. A mere twenty years later in 1915, there were 34% more boys than girls enrolled in trigonometry and 20% more boys than girls enrolled in physics (Tyack & Hansot, 1990). While the reasons for this shift are complicated, two possible explanations for this change stand out.

The first reason has to do with access. In the nineteenth century, admission to the elite male universities required knowledge of the classics, and men who wished to attend those institutions were expected to study Greek, Latin, philosophy, and literature. It was rare for a woman to go to college, so women were encouraged to study subjects in high school that provided practical applications, specifically science. The second

reason is economic. Before 1900, there were few highly remunerative careers that benefited from scientific or mathematical skills (Tolley, 2003). Once the knowledge of science began to result in highly paid jobs, men began to turn their attention to those subjects once considered better suited for women.

Even though girls were not expected to go to college at the beginning of the twentieth century, girls and boys in public high schools took basically the same academic courses. The only difference was that some girls might have taken home economics while some boys might have enrolled in manual training or vocational courses. The students may have been taking the same courses, but the assumption was that boys should have been the superior students. Reports from the era note that educators were surprised that the girls did as well if not better than the boys in most classes including mathematics (Tyack & Hansot, 1990). One suggestion made at the time for this disparity was that the more capable boys had left to seek employment. That would make the unlikely assumption that the best male students were not planning to attend a university. For whatever reason, in most courses, on average the girls' performance on exams surpassed the boys'.

The fact that boys did not do as well as girls in math was not considered a major problem because history and languages were seen as more important for higher-status jobs in offices and management. Even though they had the math and science training, women had been excluded from higher-level engineering and business positions where they might have competed with men (Posadas, 1997). By the 1930s, because of the increase in technology in business, science and math were seen to be very important for career advancement, so the percentage of men taking those courses increased and the percentage of women decreased.

When the men went off to World War II, women quickly moved into industrial management and other high-paying areas (Coleman, 2000; Posadas, 1997). Once the men came back from war, women were relegated to the lower-paying positions where educational training was not required but which were now being unionized. During the 1950s, women began to rise up the ladder in union and industrial jobs, one of many factors causing social pressure resulting in the women's movement of the 1960s and 1970s (Coleman, 2000). As women became more politically active, it was quickly apparent that the abysmal state of math and science training for women was preventing them from obtaining employment in highly paid technical fields. In fact, between the 1900s when math and science were considered women's courses and the 1960s, the idea had developed that math and science were not subjects in which girls could do well (American Association of University Women [AAUW], 1992). One facet of the women's movement has been on helping girls obtain parity in education, especially in technical fields.

The rebound of women in science and math is beginning. In 1978, 11% of bachelor's degrees in physics were awarded to women; by 2004, women received 23% of bachelor's degrees in physics. Doctorate degrees for women in the same field are showing a similar upturn from 7% in 1978 to 16% in 2004 (Mulvey & Nicholson, 2006). Astronomy was considered part of natural history and, therefore, during the late nineteenth century, studied by more girls than boys (Tolley, 2003). In 1978, only 14% of all bachelor's degrees in astronomy were awarded to women, but by 2004, women received 38% of those degrees (Mulvey & Nicholson, 2006).

Great strides for women have been made in the STEM areas. As you can see from Table 0.1, women are graduating with degrees in these areas in increasing proportions even though the total number of students in math, physics, and engineering has dropped. Only the areas of biological and computer sciences have shown consistent growth in the total numbers of students graduating with degrees in those areas.

Table 0.1 Percentage of Degrees Presented to Women in Various Academic Disciplines: Comparing Data From Previous and Recent Years

	<i>Bachelor Degrees</i>	<i>Bachelor Degrees in 2006</i>	<i>Doctorate Degrees</i>	<i>Doctorate Degrees in 2006</i>
Math and statistics	(1950) 22%	45%	(1950) 5.6%	29.5%
Biological and biomedical sciences	(1952) 26%	62%	(1952) 11%	49%
Computer and information science	(1971) 13.5%	20.6%	(1971) 2%	22%
Engineering and engineering technologies	(1950) 0.3%	17.9%	(1950) 0.2%	20%
Physical sciences and science technologies	(1960) 12.5%	42%	(1960) 3%	30%

SOURCE: U.S. Department of Education, National Center for Education Statistics, 2007 (http://nces.ed.gov/programs/digest/d07/tables_3.asp)

Engineering has worked hard to attract women, and the numbers of women entering that field do show consistent gains. Recently, women's colleges have begun to provide programs to help women enter the various

of the same age. There is lots of evidence that boys are more impulsive and are more likely to get physically involved in a class activity (Baron-Cohen, 2003; Honigsfeld & Dunn, 2003). It may be that in a coed classroom, girls are less inclined to become actively involved because the boys are so involved. In single-sex math classes, girls reported that they were better able to learn math because their greater involvement helped them become more comfortable with the material. The boys in the same study did not find that the single-sex format made a difference in their math performance (Seitsinger, Barboza, & Hird, 1998).

This is somewhat surprising given the fact that girls have better fine-motor skills earlier than boys (Kimura, 2000), so it might seem that girls would be more willing to touch and handle materials in the classroom. One reason for girls' preference for not interacting physically with class materials comes from the belief that girls are more willing to please the teacher (Maccoby, 1998; Pomerantz, Altermatt, & Saxon, 2002), and if the teacher says, "Don't touch," girls are more likely to obey. Another reason is that boys are more impulsive (James, 2007) and may simply take over the lab exercise.

SUGGESTIONS FOR APPLYING THE THEORY TO YOUR CLASSROOM

- ✓ Encourage girls to become physically involved with the manipulatives of a class exercise. In a coed class, you can divide students into groups by gender, but if you would prefer not to, provide some guidelines for a minimum amount of interaction with the material.
 - Younger students may be more willing to become physically involved in a class exercise. Keep watch to make sure that the girls are an active part of the assignment. If girls consistently let boys take over, assign specific tasks for each child in the group.
 - For older students, be careful that a girl does not always volunteer to be the scribe as her major contribution to the group effort. The rest of the students may be perfectly happy to let her do so. All students, even those with bad handwriting, need to learn to write down results or information from research.
- ✓ Make sure that if you use manipulatives in a math class that all students are taking part, as some girls may be tempted simply to observe others. Keep a chart of student interactions, and make sure that at least once each week each female student demonstrates to you that she is able to use the manipulative being studied.
- ✓ For upper-level science courses, have a lab-practical exam as part of the grade for the course. This will show students that it is important for them to get involved in the lab exercises and will allow students who are good at these skills a place to shine.