Peer-Led Team Learning
Leader Training

The Gender Issue In Science and Engineering: Will There Ever Be Equilibrium?

Antonio Rodriguez and Oleg Survillo

The workplace of the 21st century is composed of more women in more positions than ever before. Assumptions about the workplace that workshop leaders will find themselves in should take into account a shift from a presumption of male dominance to the recognition of potential female dominance in science and engineering (S&E).

The greater participation and utilization of women in S&E fields in the United States started in the late 1970's and rapidly increased thereafter (Huang, et al., 2000). It is no longer a surprise for college students to be educated by female professors. Yet, we observed that the number of male workshop leaders often outnumbers the number of female leaders at the City College of New York (CCNY) and this "dipole moment" is reflected in most of science and engineering courses in college as well as in industry. Rates of participation of women in science and engineering are affected significantly by economic globalization and demographic factors. This research paper* is designed to provide sufficient information to help us to answer the question of whether equality between the genders will be established in science and engineering fields of study and in the workplace.

The awareness of this potential equilibrium should help to improve the workshop model, where peer leaders can support and encourage both female and male students to succeed in S&E disciplines.

The main reasons that there is underrepresentation of women in science and engineering in the United States are educational issues, with emphasis on the low rate of participation of women in the various fields of science and engineering; employment conditions in the work force; and psychological issues.

<u>Educational Issues</u>

Gender differences in choice of academic majors and future careers are apparent in the early years of college. For example, a national study of first-year students found that women of all racial and ethnic groups were less likely than men to choose to study S&E (Astin, et al., 1994). Even among those who had chosen to study S&E, fewer women than men were willing to pursue a career as an engineer or research scientist. We have indeed observed this situation in our science and engineering classes at CCNY. There are far fewer females in computer science and engineering classes than males and on average, male professors usually teach these classes. In 1996, women received 55 percent of all bachelor's degrees (Hill, 1999) and 47 percent of all bachelor's degrees awarded in science and engineering. "From 1966 to 1996, the proportion of women among S&E degree earners rose dramatically: for bachelor's degrees, it rose from 25 percent to 47 percent." However, their degrees were not evenly distributed among S&E fields (see Table I).

Table I. Women as a percentage of Science and Engineering Bachelor's by field, in 1966 and 1996		
	1966	1996
Engineering	.4	17.9
Math & Comp Sciences	33.2	33.9
Physical Sciences	14.0	37.0
Biology & Agriculture	25.0	50.2
Source: Hill (1999a), Science and Engineering Degrees: 1966-1996 (NSF 99-330) tables 11, 18, and 25		

Women are increasingly involved in the sciences, although there is a popular perception that the S&E fields are dominated by men. Consistent with the degree award data, enrollment statistics also suggest a narrowing gender gap. A recent National Science Foundation Survey of Graduate Students and Postdoctorates in Science and Engineering (Burelli 1998) indicates that, while the number of men enrolled in graduate S&E programs fell three percent from 1995 to 1996, the number of women rose one percent (these percentages hold even when the students enrolled in social sciences and psychology are not counted).

Employment Issues

In 1971, 91 percent of male scientists and engineers were working full time in occupations that were related to their training, while 71 percent of female scientists and engineers were likely to have full-time employment in S&E fields (National Academy of Sciences, 2000). Since 1973, levels of full time employment in S&E for men have decreased in all fields with an overall rate of 85 percent in 1995, while rates for women improved by nearly ten percentage points. While there is some variation across fields, by 1995 gender differences in all fields had been reduced to around 10 points. Still, this is an important difference, representing one out of ten women with a doctorate in science and engineering.

Theoretically, the gender gap in S&E achievement and attainment was a result of psychological and socio-cultural influences, which discouraged women from involvement in an area that has been traditionally dominated by men. Economic resources and material support were not a significant issue in dealing with the gender gap. The analysis presented above of the overall sample data found that a broad gender gap only narrowed to a limited extent after predictor variables were entered into the equations. In other words, those predictor variables did not account well for the lower S&E entry among women. This finding led to questions as to whether there was some cultural value that backed females' venture into S&E areas, or, alternatively, environmental factors that fostered females' intellectual orientation in terms of postsecondary program choices. Perhaps there were unique joint effects among family expectations, females' academic preparation, and their school conditions.

In an issue of a popular journal, a story by Schreiber (1993) entitled "The Search for His and Her Brains" gives us an explanation of the social conceptualization about gender differences and biological determinism. According to Anne Fausto-Sterling, Ph.D., a developmental geneticist at Brown University, quoted in the

Schreiber article, "It's easy for us to see how racial and sexual attitudes affected earlier generations of scientists, but it's harder for people to see that beliefs about sexual differences are still so strong that few scientists can move outside them."

Biological Determinism?

Women have struggled throughout much of history to gain status and parity. It is apparent that the differences between men and women have made them grow separately, seeking pathways that would benefit them in their lives and would thus have the effect of main- question on equilibrium, although answered in part with statistics, also relies heavily in its explanation on another important factor, namely the reason why women have chosen other career orientations in greater number than men have. This trend is highly noticeable in the sciences, which is our main area of study.

Who is better as a scientist or engineer? This question, on our part naïve and defiant, was a starting point to our investigation. So, by looking at various studies to prove or disprove such a query, our investigation of this question led us into discussions of processing differences. Studies in brain research have tried to explain differences with experimental data, discriminatively searching for a flaw in the structure of the female brain. Magnetic Resonance Images (MRI's) taken of male and female brains while in the process of thinking and comparing sounds showed some quite interesting results. Male and female brains behave differently while doing similar tasks yet they are both capable of doing equally well. The research implies that "nature has provided the brain with different routes to the same ability" (Wade, 2000, 132). Believing in the existence of a 'better brain' may not be a wise hypothesis.

The undertaking of such research was clearly intended to try to prove that women, not men, are deficient. The way in which the research was conducted is in itself a case of discrimination. Why not focus on male thinking and behavior and prove that it may not be flawless?

Psychological Issues

It is apparently true that in everyday life there is discrimination, so it is also obvious that the environment has presented, as stated by Vivian Gornick, "the conditions of work under which women in science have felt invisible and discounted, left out and whittled down." As expressed by a sixty-eight-year old physiologist who actively participated in college research, these 'conditions' include working with men who "never walked into my office to talk to me, who nodded to me in the hall as they nodded to the maintenance men or the cleaning women, never invited me to their conferences or their seminars or their research programs. I was the invisible woman in science" (Gornick, 1983). Such situations have been common, still affecting women today.

It is not surprising to see how women's self esteem can be harmed by such disregard. Schreiber (1993) noted, in a sidebar entitled "The Myth of the Math Gap" how changes in learning environments can help girls to perform as well as boys when social pressures on girls are eliminated.

Hypothesis: Equilibrium in the Next Generation?

As aspiring scientists, the best option that we may consider in order to prove a theory or finding will be based on the use of the scientific method. This method serves as a means of fact recollection, summary of facts or data, theory construction, performance of experiments and finally, theory acceptance or rejection. Developing our own 'theory' is also a good way of finding a reasonable answer regarding our research question. In fact, we would like to make a "contribution to successful science."

Making our 'science' successful can rely on the fact that, "for the purposes of science, all schemes of organization that allow us to make good sense of things are equally worthy." (Elgin, 1995, p. 295)

Given our initial set of data and with some analysis, we were able to draw some initial hypotheses. We were able to consider the quite obvious fact that women are definitely not participating in the sciences as much as men are. Seeing that the human brain, whether male or female and without loss of generality, can perform equally well when given the opportunity to do so, implies that intelligence or simply being 'smart' is not the only thing to consider. So, we decided to seek further.

We decided to look at a collection of statistical information. After examining the overall trends and making conjectures about what the future would be like, we questioned ourselves, 'Will there be equilibrium?' This hypothesis turned out to be our main theory. We set out to determine a reasonable answer to our theory, a reasonable answer that has some scientific basis. The data reflect the increase in the number of females involved in the sciences over the past few years. Will this rate increase be sufficient and will it reach our proposed equilibrium?

Through our study, we were able to make an estimate on the time that it would require to reach such a state of equality. The equilibrium, if any, can be calculated using the exponential growth formula, and according to the formula calculations, the number of years needed to reach equilibrium falls between 25-30 years, in other words, in the next generation. Unfortunately, our theory can only be proven when indeed this 'balanced' situation is in fact reached. So, our theory is more like an educated guess.

Ultimately, this means that the true answer to our question will have to wait for the implied result to occur and Hoversten, "Someone puts forward a hypothesis and it either sinks or swims." As in science itself, many situations can only be studied and reasoned well enough with the hope of finding a better solution in time, or with future results confirming an initial hypothesis. To accelerate the arrival of our proposed equilibrium, peer leaders should provide support and instill confidence, knowing that every workshop student can excel within the group.

Antonio Rodriguez and Oleg Survillo
Peer Leaders
City College of New York, CUNY

Editor's Note: This paper was the final project for the Leader Training Class, Spring 2002.

References

Astin, A.W., Korn, W.S., Sax, L.J., and Mahoney, M.M. (1994). *Survey of the American Freshman: National Norms.* Los Angeles, CA: Higher Education Research Institute, UCLA.

Burelli, J. (1998). *Graduate Students and Postdoctorates in Science and Engineering.* Fall 1996. NSF 98-307. Arlington, VA: National Science Foundation.

Elgin, C. Z. (1995). Unnatural Science. *The Journal of Philosophy.* 92: 289-302.

Gornick, V. (1983). *Women in Science: Recovering the Life Within.* New York: Simon and Schuster.

Hill, S.T. (1999). *Science and Engineering Degrees: 1966-1996*. NSF 99-330. Arlington, VA: National Science Foundation. Online at http://www.nsf.gov/sbe/srs/nsf99330/pdf/front.pdf.

Hoversten, P. (1998). "Scientists Smashing Holes in Mars Rock Theory." *USA Today* 14 Aug 1998: A9.

Huang, G., Taddese, N., Walter, E. & Peng, S.S. (2000). *Entry and Persistence of Women and Minorities in College Science and Engineering Education*. Washington, DC: U.S. Department of Education. National Center for Education Statistics (NCES 2000-601). Downloaded from http:nces.ed.gov/pubs2000/2000601.pdf.

National Academy of Sciences. (2000) *Who Will Do The Science of the Future?* Washington, DC: National Academy Press. Online at www.nap.edu/books/0309071852/html/R1.html.

National Resource Council Committee on Women in Science and Engineering. (1991). *Women in Science and Engineering: Increasing Their Numbers in the 1990's*. Washington, DC: National Academy Press. Pp. 7-27. Online at www.nap.edu.

Schreiber, L.A. (1993). *The Search for His and Her Brains*. Glamour, April: 234-271.

U.S. Department of Education (1997). *Women in Mathematics and Science. National Center for Education Statistics*. Downloaded from http://nces.ed.gov/pubs97/97982.html.

Wade, C. and Travris, C. (2000). *Psychology. 6th Ed*. Upper Saddle River, NJ: Prentice Hall.

Cite This Article as: Rodriguez, A., Survillo, O. (2012). The Gender Issue In Science and Engineering: Will There Ever Be Equilibrium? Peer-Led Team Learning: Leader Training. Online at http://www.pltlis.org. Originally published in *Progressions: The Peer-Led Team Learning Project Newsletter*, Volume 3, Number 3-4, Spring-Summer 2002.