The Case for Title IX Compliance in Science and Engineering

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Title IX of the Education Amendments of 1972, the statute prohibiting sex discrimination in educational institutions that receive Federal funds, protects against discrimination in science, mathematics, and engineering education. We strongly support Title IX and oppose any efforts that would weaken its effectiveness. Title IX and all other civil rights laws pertaining to education should be vigorously enforced. Since the law's enactment, girls' and women's participation in sports is a great civil rights success story,[1] having tremendous positive benefits for American society, especially boosting the entry of women into higher education.[2] The same transformation is possible in science and engineering education.

There is a talent crisis in science and engineering that constrains America's economic productivity, competitiveness, quality of life, and security.[3] Our educational system is not producing the workforce we need to continue a position of international leadership in innovation and technology. Technology is key to our growth: "as much as 85% of measured growth in U.S. income per capita was due to technological change."[4] A recent National Academy report recommends significant new investment and initiatives to produce more K-12 science and mathematics teachers and to increase the number and proportion of U.S. citizens who earn bachelor's degrees in S&E.[5] Improvement in science and mathematics teaching is needed not only to increase the number of students aiming for the S&E workforce, but also to improve science literacy, as our society enters an era of greater complexity, for example, the need to understand health, environment, genetics, and energy.

Our reliance on imported talent is high and increasing. The H1-B visa program opened opportunity for foreign professionals with high-demand skills at the rate of 115,000 per year starting in 2000, increased to 195,000 per year for 2001, 2002, 2003.[6] The National Academy recommends facilitating the entry of more international students through improved visa processing and preferential visas for doctoral-level students.[7] In 2005, students on temporary visas earned more than a third (36%) of all S&E doctorates awarded.[8] *Of the Ph.D. engineering, mathematics, computers sciences, physics, and economics graduates from US colleges and universities – the pool for our future faculty – over 50% are foreign students*.[9] Our supply of foreign students is jeopardized by increased opportunity in home countries, rising U.S. tuition, competition for students from other countries, and difficulties in obtaining U.S. visas.[10] Although most international students plan to stay in the U.S., those numbers are dropping, particularly in computer sciences and engineering,[11] as they choose to return to work in their native countries.

Other countries are increasing their rate of production of undergraduates in S&E. Where the U.S. is producing S&E undergraduates at the rate of 15%, South Korea is at 38%, France is at 47%, China at 50%, and Singapore 67%.[12] China and India have doubled their rate of production of engineers and computer scientists, and their numbers are more than

twice ours.[13] The European Commission established a special group to monitor the status of women in science, and the issue is prominent in EU Framework Programs (strategic plans for investment in science, engineering and technology).[14]

U.S. graduate programs are having trouble recruiting and graduating American students to meet the demand. "There were almost twice as many U.S. physics bachelor's degrees awarded in 1956, the last graduating class before Sputnik, than in 2004."[15] The number of degrees in computer science decreased in 2005.[16] Undergraduate enrollment in engineering is declining.[17]

The need for greater diversity in higher education and in the S&E workforce is widely recognized.[18] It is irrational, given the trends in demographics in the U.S. and the globalization of commerce and communication, to depend on one segment of the population – white males – to populate a workforce domain on which our prosperity and competitiveness depends. In many top departments in science and engineering, the faculty does not reflect the diversity of graduating Ph.D. students, showing a failure to encourage, recruit, hire, and support women and minorities entering critical fields.[19] The lack of diversity in the faculty is one of several barriers to new students, because it signals that a field is exclusive and possibly discriminatory. University students and faculty recruitment pools have diversified thanks to increased opportunity, but universities are behind in addressing the lack of diversity in the S&E faculty.

Under-utilization of Women in S&E

Large segments of our population are not participating fully in science and engineering and they could be available to fill the talent gap. Women comprise nearly half the total U.S. college-educated labor force (47% in 2005), yet they are only one-fourth of the college-educated workforce in S&E occupations (26% in 2005).[20] Participation in S&E varies by field of occupation. Women were 52% of social scientists (in 2003), but only 29% of physical scientists, 30% of computer scientists, and 11% of engineers.[21] Women are earning only 20% of bachelor's degrees in engineering and 22% in computer science[22] – the fields in most demand for U.S. economic interests.

Women are seeking college degrees in greater numbers than men – a phenomenal and controversial trend given our history in the 20th Century. "Women outnumbered men in undergraduate education since 1982 and earned 58% of all bachelor's degrees in 2005."[23] Despite increased enrollments of women in many fields, "their percentage in computer science (25%) remains unchanged since 1985 and their percentages in engineering (22%) and physics (20%) remain low.[24]

A common analysis is that women are not interested in careers, especially professional careers that require long preparation and demanding work pressures. Yet women are graduating from medical school at a rate approaching parity (47%).[25] Women are earning more than half of law degrees now.[26] Another analysis is that women are intellectually not interested in the physical sciences, because the courses are "hard," yet since 1985 women have nearly closed the gaps in environmental sciences, agricultural sciences, chemistry, and mathematics.[27]

Reasons for the Gap

Why isn't the United States tapping into under-utilized populations for the sake of competitiveness and prosperity? There are a number of reasons: tradition, discrimination, and weak legal or moral pressure to change educational practice.

Tradition has many people still believing that men and women are innately different in intellectual capacity; that women belong in nurturing roles; that when women work, they should stick to low-investment (and low-paying) jobs that involve serving people. The arguments used against giving women the vote and giving girls access to sports are similar to those used against sending women into technical fields – they don't want it, they can't, and they belong elsewhere.

Unconscious assumptions about gender – called gender schema -- are formed from birth on and lead us to over-rate men and under-rate women even when they are the same on objective measures. We expect men to be independent and reasoned while women are cooperative, expressive and caring.[28] These assumptions can lead to unequal treatment in small ways – lack of encouragement, lack of access to certain activities, redirection away from certain classes, slightly worse grades, weak recommendations, etc. Small disadvantages accrue and can explain imbalances and gaps over time, especially at higher levels of achievement.[29] Negative stereotypes play a role in differential performance on tests. The stereotyped group with heightened awareness of an alleged "deficiency" will fulfill the prophecy by obtaining lower scores on, for example, national SAT's.[30] Sex differences in quantitative skills emerge after elementary school, partly due to stereotypes.[31]

There is evidence for bias and discrimination in general and in the academic workplace in particular. The Harvard Implicit Bias Project has a web site demonstrating to anyone that most of us are biased, unconsciously, and often much to our own surprise.[32] In a study of the peer review system of the Swedish Medical Research Council for post-doctoral fellowships, female applicants had to have more credentials than men to get the same competence rating from reviewers.[33] A study of the influence of gender in the review of curricula vitae for faculty found that both men and women favored male job applicants. One study took the an actual curricula vitae, created male and female versions, and sent them for review as candidates for faculty positions. It found that both men and women preferred male job applicants.[34] Another study compared letters of recommendation for medical faculty candidates and found that the letters differed "systematically" in preference toward men, in terms of length, "doubt-raising" language, and references to status.[35]

We know that women and minorities want to join the S&E workforce. Since 1980 – or only about 25 years, the share of S&E occupations for blacks has doubled, and more than doubled for women and Hispanics.[36] Women's share of doctoral degrees in S&E overall is near parity (46% in 2005). Two frontiers are prominent: greater recruitment to engineering and computer science education, and employment and advancement through faculty ranks in most fields. Because of the tenure system and slow faculty turnover due to retirements, the opportunity for change is limited, and it can take decades to change both minds and numbers.[37]

How Title IX Can Apply

The S&E departments in many universities have shown that change is possible and feasible. Their success is documented in dozens of national reports and academic publications as "promising," "proven," or "best" practices.[38] There is no shortage of specific recommendations for action, some repeated over decades of commissions and task forces on women in science and engineering or diversity.[39] In spite of the proliferation of research and helpful guidance, some of our top universities (for example, MIT) were able to ignore or to overlook patterns of bias evident from low numbers of women and minorities on the faculty that persisted for decades while in those same decades they graduated qualified Ph.D.'s among the neglected groups.[40] Recent action plans such as that formulated at Harvard University provide excellent, current summaries of options for revising structural barriers that make working conditions better for all faculty and particularly for women.[41]

The research evidence for the benefits of diversity for learning was extensively documented in the form of *amici curiae* briefs in support of the University of Michigan, in 2003, which was challenged for giving minority students preference in two programs.[42] The ultimate goal behind the push for gender diversity is to improve education and particularly education in science and engineering that is a priority in order to produce more graduates. Many of the improvements recommended in order to attract and retain more female and minority students will improve the experience for all students. There are many studies that describe inefficient and wasteful student programs that need attention. For example, "About one-third of U.S. students intending to major in engineering switch majors before graduating."[43] The drop-out rate for women in engineering is twice that for men.[44] A number of institutions have found ways to do much better.

In 2004 the U.S. General Accounting Office issued an audit report titled Gender Issues: Women's Participation in the Sciences Has Increased, but Agencies Need to Do More to Ensure Compliance with Title IX.[45] The report recommended that NASA, the Department of Energy, and the National Science Foundation take more action in conducting compliance reviews, along with continued activity on the part of the Department of Education, Office of Civil Rights, which is responsible for Title IX compliance. The science agencies award billions of dollars in grants to institutions that are providing education in science and engineering and thus are subject to Title IX. The GAO report was initiated on the request of Senator Ron Wyden (D-OR) and Senator Barbara Boxer (D-CA) in 2003,[46] and followed on requests for major studies of the status of faculty to be conducted through the National Academy of Sciences.[47]

Leading scientists have advocated for using the pressure of compliance with Title IX to investigate and promote changes that are needed to open science and engineering education to women.[48]

Recommendations

We endorse and support recommendations formulated by the Committee on Science, Engineering, and Public Policy:[49]

1. An inter-institutional monitoring organization is needed to set standards and review Title IX compliance in science and engineering education. It would serve a function

similar to that performed by the National Collegiate Athletic Association (NCAA) for sports in education.

2. The optimal initiating organization is the American Council on Education (ACE), which can convene and build consensus among others with a focus on higher education such as the Association of American Universities and the National Association of State Universities and Land Grant Colleges. The ACE is currently an umbrella organization with 100 national member organizations.[50]

3. The monitoring organization should: set professional and equity standards, collect and disseminate education and workforce data, and provide professional development training for members that include a component on bias in evaluation. It should develop and disseminate a model "climate survey" instrument for institutional self-assessments of progress toward diversity.[51]

4. Federal agencies funding science and engineering education should establish clear guidelines and measures for compliance with Title IX and all civil rights statutes.

5. Federal agencies funding science and engineering education should take a more proactive role in assessing compliance, beyond counting the number of complaints within an institution.

6. Federal agencies funding science and engineering education should develop sanctions for noncompliance. For example, the NCAA asks a member organization not in compliance to withdraw from competition. The parallel in higher education funding might be to bar an institution from competing for federal funds for a period.[52]

In addition, we recommend:

7. All organizations whose mission is improved education should make their members aware of Title IX and its application to science, mathematics, and engineering education. This includes information campaigns, web sites, brochures, webinars, and campus-based marketing.

8. Students on campuses and alumni should be enlisted to question the status quo and to ask for local accountability. Change can come from a million conversations.

9. National surveys of the quality of student life on campus and rankings of undergraduate departments should be encouraged to incorporate diversity as an important value in educational environments – diversity among both students and faculty. Quality of campus life and quality of a promised education must also mean an environment where all students have an equal chance. Just as the year-abroad programs are meant to broaden the horizons of students, the experience of different genders and ethnicities in the classroom, in problem solving, in creative projects, and on teams is good training for future professional life.

Title IX must become as visible a buzz-word in science and engineering as it is in sports, to highlight the problem of inequity.

[1] National Collegiate Athletic Association. *Sports Sponsorship Report, 2004-2005*.
[2] Musil, Caryn McTighe (2007). Scaling the Ivory Towers. *MS Magazine*, Fall 2007, pp. 43-45.
[3] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine (2006). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, DC: National Academies Press. Also, National Academy of Engineering (2005). *Assessing the Capacity of the U.S. Engineering Research Enterprise*: Preliminary Report of the National Academy of Engineering Committee for Public View. http://www.nae.edu/NAE/engecocom.nsf/weblinks/MKEZ-68HQMA?OpenDocument . Also, National Academy of Engineering (2004). *The Engineer of 2020* http://www.nae.edu/nae/engeducom.nsf/weblinks/MCAA-5L3MNK?OpenDocument . Also, National Science Board, National Science Foundation (2004). *Broadening Participation in Science and Engineering Faculty. NSB 04-41* http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsb0441 . Also, Council on Competitiveness (2004). *Innovate America: Thriving in a World of Challenge and Change*. Interim Report 7/23/2004. http://www.compete.org/nii/interim.asp . Also, Building Engineering and Science Talent (2004). *The Talent Imperative: Diversifying America's Science and Engineering Workforce*. Downloaded January 9, 2008 from http://www.bestworkforce.org/PDFdocs/BESTTalentImperative_FullReport.pdf . Also, Building Engineering and Science Talent (2005?). *Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent.* Downloaded January 9, 2008 from http://www.bestworkforce.org/PDFdocs/Quiet_Crisis.pdf. Also, National Science Board, National Science Foundation (2003). *The Science and Engineering Workforce Realizing America's Potential*. http://www.nsf.gov/nsb/documents/2003/nsb0369/nsb0369.pdf
[4] Committee on Prospering (2006). P. 1
[5] Committee on Prospering (2006). P. 9
[6] Committee on Prospering (2006). P. 14
[7] Committee on Prospering (2006). P. 10
[8] National Science Board (2008). *Science and Engineering Indicators 2008*. Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 08-01; volume 2, NSB 08-01A). p. 2-5
[9] Ibid., p. 2-6
[10] Ibid., p. 2-19
[11] Ibid., p. 2-6
[12] Committee on Prospering (2006). P. 16
[13] Committee on Prospering (2006). P. 16
[14] See http://cordis.europa.eu/improving/women/home.htm
[15] Committee on Prospering (2006). P. 16
[16] National Science Board (2008). p. 2-5
[17] Ibid., p. 2-19
[18] U.S. Government Accountability Office (2004). *Gender Issues: Women's participation in the sciences has increased, but agencies need to do more to ensure compliance with Title IX.* Downloaded January 9, 2008 from http://www.gao.gov/new.items/d04639.pdf . Also, Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development (2000). *Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology.* Downloaded January 9, 2008 from http://www.nsf.gov/publications/pub_summ.jsp?ods_key=cawmset0409 . Also, Building Engineering and Science Talent (2004). *The Talent Imperative: Diversifying America's Science and Engineering Workforce*. Downloaded January 9, 2008 from http://www.bestworkforce.org/PDFdocs/BESTTalentImperative_FullReport.pdf .
[19] Nelson, D.J. & Rogers, D.C. (2005). *A National Analysis of Diversity in Science and Engineering Faculties at Research Universities.* Downloaded October 2, 2007 from http://cheminfo.ou.edu/~djn/diversity/briefings/Diversity%20Report%20Final.pdf Updated in http://cheminfo.chem.ou.edu/faculty/djn/diversity/Faculty_Tables_FY07/07Report.pdf

[20] National Science Board (2008). p. 3-26
[21] Ibid., p. 3-28
[22] Ibid., p. 2-5
[23] Ibid., p. 2-26
[24] Ibid., p. 2-21
[25] Association of Medical Colleges (AAMC) (2006). *Women in Academic Medicine Statistics and Medical School Benchmarking 2004-2005. Table 1.* Downloaded January 20, 2008 from http://www.aamc.org/members/wim/statistics/stats05/start.htm
[26] American Bar Association, Commission on Women in the Profession (2005). *A Current Glance at Women in the Law 2005*. Downloaded January 20, 2008 from http://www.abanet.org/women/ataglance.pdf
[27] National Science Board (2008). p. 2-26
[28] Valian, Virginia (1998). *Why So Slow? The Advancement of women*. Cambridge, MA: MIT Press.
[29] Martell, R.F., Lane, D.M., & Emrich, C. (1996). *Male-female differences: A computer simulation*. American Psychologist, 51:157-58.
[30] Steele, C.M. & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, 69, 797-811.
[31] Steele, J.R., Reisz, L., Williams, A. & Kawakami, K. (2007). Women in mathematics: examining the hidden barriers that gender stereotypes can impose. In R.J. Burke & M.C. Mattis (Eds.), *Women and Minorities in Science, Technology, Engineering and Mathematics: Upping the numbers* (pp. 159-182). Cheltenham, UK: Edward Elgar Publishing Lmtd.
[32] Harvard University (2007). *Project Implicit*. https://implicit.harvard.edu
[33] Wenneras, C. & Wold, A. (1997). Nepotism and sexism in peer-review. *Nature*, 387, 341-343.
[34] Steinpreis, R.E., Anders, K.A., and D. Ritzke (1999). The Impact of Gender on the Review of Curricula Vitae of Job Applicants and Tenure Candidates: A National empirical study. *Sex Roles: A Journal of Research,* 41(7-8), 509-528.
[35] Trix, F. and C. Psenka (2003). Exploring the Color of Glass: Letters of Recommendation for Female and Male Medical Faculty. *Discourse & Society*, 14(2), 191-220.
[36] National Science Board (2008). p. 3-27
[37] Hopkins, N. (2006). Diversification of a University Faculty: Observations on hiring women faculty in the schools of science and engineering at MIT. *MIT Faculty Newsletter*, 18 (March-April), p. 713.
[38] Whitten, Barbara et al. (2003). What works? Increasing the participation of women in undergraduate physics. *Journal of Women and Minorities in Science and Engineering*, 9(3&4). Also, Harris, B.J. et al. (2004). Gender Equity in Industrial Engineering: A Pilot study. *NWSA Journal*, 16(1), pp. 186-193.
[39] Building Engineering and Science Talent (BEST) (2004). *A Bridge for All: Higher Education Design Principles to Broaden Participation in Science Technology, Engineering and Mathematics*. Downloaded January 20, 2008 from http://www.bestworkforce.org/PDFdocs/BEST_BridgeforAll_HighEdFINAL.pdf . Also, Committee on Maximizing the Potential of Women in Academic Science and Engineering (2007). *Beyond Bias and Barriers: Fulfilling the potential of women in academic science and engineering.* Committee on Maximizing the Potential of Women in Academic Science and Engineering / Committee on Science, Engineering, and Public Policy. Available at http://www.nap.edu/catalog.php?record_id=11741
[40] Massachusetts Institute of Technology (1999). *A Study of the Women Faculty in Science at MIT*. Downloaded January 20, 2008 from http://web.mit.edu/fnl/women/Fnlwomen.htm
[41] Harvard University (2005). *Report of the Task Force on Women Faculty*. Downloaded January 20, 2008 from http://www.hno.harvard.edu/gazette/daily/2005/05/women-faculty.pdf Also, see a list of university plans at http://www.faculty.harvard.edu/01/0152.html .
[42] University of Michigan (2003). *Admissions Lawsuit*s. Downloaded January 20, 2008 from http://www.vpcomm.umich.edu/admissions/overview/
[43] M. Boylan. *Assessing Changes in Student Interest in Engineering Careers Over the Last Decade*. CASEE, National Academy of Engineering, 2004. Available at http://www.nae.edu/. Also, C. Adelman, Women and Men on the Engineering path: A Model for Analysis of Undergraduate Careers. Washington, DC: US Department of Education, 1998. Available at http://www.ed.gov .

[44] C. Adelman, Women and Men on the Engineering path: A Model for Analysis of Undergraduate Careers. Washington, DC: US Department of Education, 1998. Available at http://www.ed.gov .
[45] U.S. Government Accounting Office (2004). *GAO-04-639*. Downloaded from http://www.gao.gov/new.items/d04639.pdf
[46] Wyden, Ron (2003). Title IX and Women in Academics. *Computing Research News*, September 2003, 15(4), pp. 1, 8.
[47] Wyden, Ron (2002). *Speech before the Senate Subcommittee on Science, Technology and Space, October 3, 2002, Hearing on Title IX and Science*. Downloaded from http://wyden.senate.gov/newsroom/record.cfm?id=271926&&
[48] Rolison, Debra (2000). A Title IX Challenge. C&EN, 13 March 2000, p. 5. Available at https://pubs.acs.org with a subscription. Also, Zare, Richard N. (2006, May 15). Sex, Lies, and Title IX. *Chemical and Engineering News*, 84(20), pp. 46-49. Downloaded from http://pubs.acs.org/cen/education/84/8420education.html
[49] Committee on Maximizing the Potential of Women in Academic Science and Engineering (2007). *Beyond Bias and Barriers: Fulfilling the potential of women in academic science and engineering*. Committee of Science, Engineering, and Public Policy. Downloadable for a fee or purchase from http://www.nap.edu/catalog.php?record_id=11741
[50] Committee on Maximizing (2007). P. 232-233.
[51] Ibid. p. 234-238.
[52] Ibid. p. 240.