WASHINGTON HIGHER EDUCATION COORDINATING BOARD

Policy Brief

October 2007

Gender equity in academic programs at Washington's public four-year colleges and universities

Introduction

Far fewer female students receive degrees in the fields of science, technology, engineering, and mathematics (STEM) fields than do male students in Washington's baccalaureate-granting universities. Conversely, far fewer men than women earn degrees in health sciences fields. This policy brief explores the underlying reasons for these disparities and identifies policy options to help achieve a more equitable gender distribution in these fields.

Findings include:

- Male and female students are equally prepared to pursue postsecondary education in STEM and health science fields.
- High school students exhibit a high degree of vocational self-segregation by gender when asked to identify probable major fields, patterns that persist through their college experience.
- Women who take STEM courses as college freshmen are less likely to major in those fields than their male counterparts. Similarly, men who take courses in the pre-med/health sciences cluster are less likely to major in those subjects than are female students.
- Despite the recent growth of female doctoral graduates in STEM fields, the percentage of female faculty in these departments remains low.
- Women working in STEM fields earn a higher percentage of what men earn than they do in non-STEM fields, but wage parity has not yet been achieved in STEM fields or in health services.

Policy initiatives with the greatest potential for effectiveness are those that:

1) **Raise student awareness** of STEM and health sciences career opportunities; and
2) **Increase faculty diversity** in STEM and health sciences departments.

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Background

In December 2006, the Washington Higher Education Coordinating Board (HECB) released a report on gender equity in higher education.[1] The report examined gender equity in student services, athletics, and academic programs at Washington's five public baccalaureate universities. Board members took particular interest in the report's analysis of gender disparities in academic programs and directed staff to conduct further analysis.

Table 1

Washington institutions awarded degrees disproportionately by gender in the following fields:

Female Students	Male Students
▫ *Family and consumer sciences/human sciences*	▫ *Computer and information sciences*
▫ *Health professions and related clinical sciences*	▫ *Engineering technologies/technicians*
▫ *Education*	▫ *Engineering*
▫ *Public administration and social service professions*	▫ *Mathematics and statistics*
▫ *Psychology*	▫ *Business, management, and marketing*
▪ Visual and performing arts	▫ *Architecture and related services*
▪ Foreign languages, literatures, and linguistics	▪ Physical sciences
▪ Area, ethnic, cultural, and gender studies	▪ Parks, recreation, leisure, and fitness studies
▪ Communication, journalism & related programs	▪ History
▪ Foreign languages, literatures, and linguistics	▪ Security and protective services
	▪ Philosophy and religious studies
	▪ Social sciences

▫ *Programs in italics are highly disproportionate (variance of 20 or more percentage points from institutional mean)*.
▪ Other programs are substantially disproportionate (10-20 percentage point variance).

Source: HECB, *Gender Equity in Higher Education,* www.hecb.wa.gov/research/issues/gender.asp.

The 2006 report found that among Washington's five public baccalaureate universities[2] – 81 program areas confer 50 or more bachelor's degrees. Of those 81 major program areas, 45 (56 percent) are highly or substantially disproportionate in the awarding of degrees to male and female students – 23 programs are dominated by male students, and 22 are dominated by female students. (**Table 1** lists the program areas that exhibit disproportionate degree conferment rates.)

The HECB asked staff to examine why so many major programs exhibit disproportionate degree conferment rates and to identify policy and program options for promoting greater gender equity. The Board was particularly concerned about academic fields that are in high demand in the state's economy, including science and technology, engineering, mathematics, and health sciences fields. A set of research questions (in italics) precedes each section of this report.

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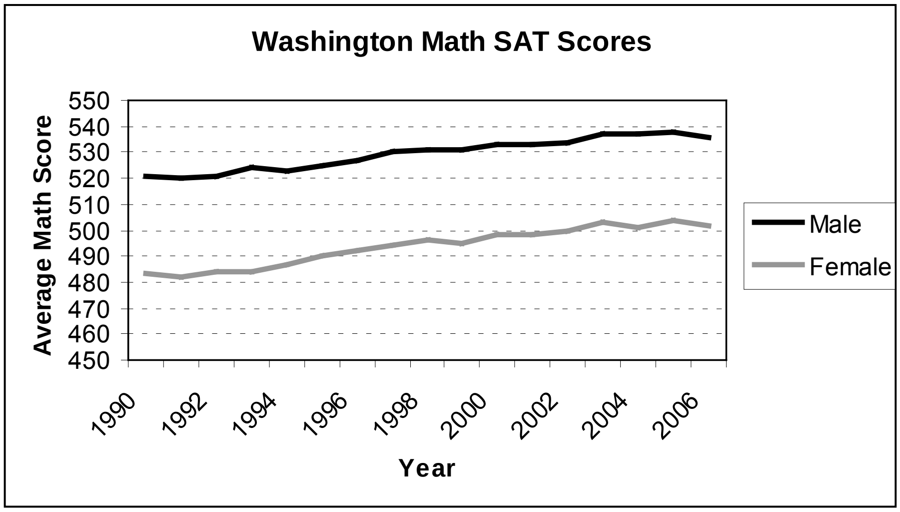
[1]Washington Higher Education Coordinating Board (2006), *Gender Equity in Higher Education*, Olympia, Washington. See: www.hecb.wa.gov/research/issues/gender.asp.
[2]The University of Washington, Washington State University, Eastern Washington University, Central Washington University and Western Washington University. The Evergreen State College was not included in the analysis because the institution reports all degrees in the same major subject area, Liberal Arts/Interdisciplinary Studies.

Preparation

Are Washington's male and female students equally prepared academically to take science, technology, engineering and math (STEM) or health sciences courses when they enter college?

Although Washington state recently defined the skills, knowledge, and abilities that constitute college readiness in science and mathematics,[3] statewide assessment information based on these new definitions has not been developed. In lieu of assessment results based on state college readiness standards, researchers often turn to standardized tests such as the science and math National Assessment of Educational Progress (NAEP) and college entrance exams – math SAT and science and math ACT scores. The college entrance exams are relevant because they zero in on the students who intend to go to college. In 2005-06, 54 percent of Washington high school graduates took the SAT and 15 percent took the ACT.

Figure 1



Source: College Board, Washington State Profile Report, (http://www.collegeboard.com/prod_downloads/about/news_info/cbsenior/yr2006/ washington-2006.pdf).

On all these standardized tests, male students score higher than female students. The test score gaps are small, but they are steady and persistent (see **Figure 1**). The test score gap exists at both the national and statewide levels. For 2005-06, the average male student score on the math SAT in Washington exceeded the average female score by 38 points (a 7.4 percent gap), the math ACT gap was 7.7 percent, the science ACT gap was 6.4 percent, and the math and science advanced placement gap was 7.3 percent.

Complicating the matter is the apparent lack of a strong correlation between aptitude for math and science in high school as expressed in standardized tests, and later student success in college courses and science and engineering careers. A study of mean college GPAs for engineering and physics majors at MIT found that gender differences in math SAT scores did not translate into differences in classroom performance.[4] Another study found that when male and female math SAT scores match, female students go on to earn higher grades in college mathematics classes.[5] Finally, a study found that less than a third of men working in STEM fields had math SAT scores above 650 (800 is the maximum score on the test).[6]

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[3] For information about the math readiness standards, go to: www.transitionmathproject.org. For the science readiness standards, go to: www.learningconnections.org/clc/hecb.htm.

[4] Gallagher, A. (1998). "Gender and Antecedents of Performance in Mathematics Testing," *Teacher College Record*, V. 100, No. 2, Winter 1998, pp. 297-314.

[5] Spelke, E.S. (2005). "Sex Differences in Intrinsic Aptitude for Mathematics and Science? A Critical Review" *American Psychologist*, Vol. 60, No. 9, December 2005, pp. 950-958.

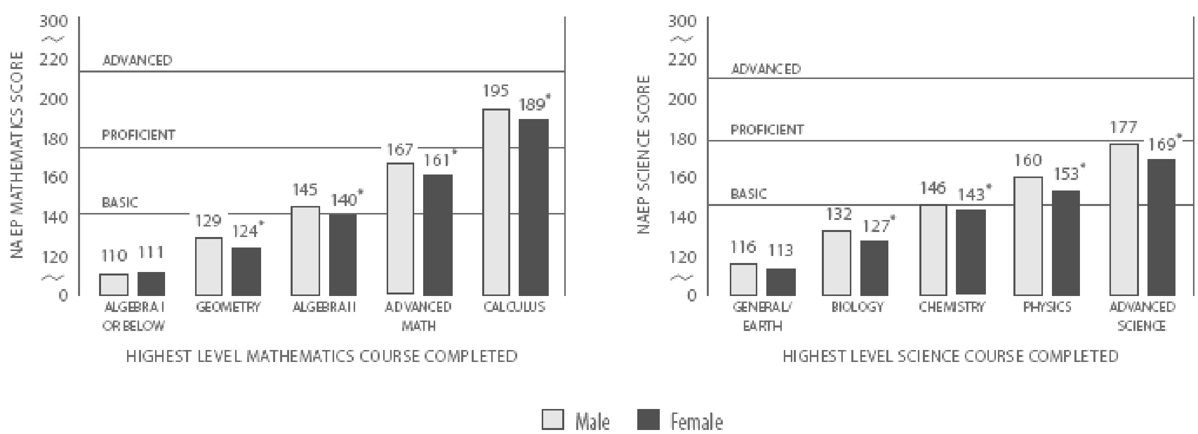
[6] National Academy of Sciences (2006), *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*. Washington, D.C.: National Academy Press.

Researchers continue to offer theories on why standardized tests underestimate female student achievement in science and math courses, and later college and career success in these fields (relative to that of male students). One theory is that the tests may be gender biased. For example, many test items show performance disparities by sex, making it possible to design a test that favors one gender or another by including items that favor that gender.[7] Another theory suggests that female students may be at a disadvantage versus their male counterparts when asked to come up with “clever and speedy” applications of mathematical skills to unfamiliar problems and circumstances. Female students may tend toward a more reflective approach to mathematical problem solving that takes more time (thereby increasing time pressures on a timed test).

This theory would be consistent with female students doing better than male students in classroom math and science exams on familiar and practiced concepts, and not as well on standardized tests. Analysis of a national sample of high school transcripts bears this out, and in fact suggests that female students may have a slight edge over their male counterparts with regard to math and science. Female high school graduates have recently surpassed male graduates in completing rigorous curricula, earning more mathematics and science credits and higher math and science GPAs.[8]

So what is revealed when researchers look at standardized test scores and control for high school courses taken and GPA? As Figure 2 indicates, even when they control for the highest math and science course completed, male students outscore female students on the NAEP test. The same is true when they control for math and science GPA.

Figure 2 NAEP Mathematics and Science Scores by Highest Course Completed and Gender



*Significantly different (p<.05) from males.

NOTE: Advanced mathematics includes courses, other than calculus, that are generally taken after algebra II (e.g., AP statistics and precalculus). Advanced science courses are courses that contain advanced content (like AP biology, IB chemistry, AP physics, etc.) or are considered second-year courses (chemistry II, advanced biology, etc.).

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2005.

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[7] Spelke, E.S. (2005). *Supra.*

[8] National Center for Education Statistics (2007). *The Nation’s Report Card, America’s High School Graduates: Results from the 2005 High School Transcript Study*. See http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007467

The 54 percent of Washington high school graduates who took the SAT exam in 2006 were asked about their course-taking behavior. This self-reported questionnaire data provides information on which math and science courses students planning to attend college have taken (or plan to take) in high school. The results are summarized in **Tables 2 and 3**.

Table 2

Mathematics course-taking patterns
Washington SAT-takers, 2006

	Test-Takers		Percent by Gender	
Years of Study	Number	Percent	Male	Female
More than 4 years	3,408	12%	50%	50%
4 years	16,461	57%	46%	54%
3 years	7,545	26%	42%	58%
2 years	1,139	4%	44%	56%
1 year	105	0%	44%	56%
1/2 year or less	65	0%	48%	52%
No response	5,427			
Course Work				
Algebra	26,275	92%	45%	55%
Geometry	25,502	90%	45%	55%
Precalculus	17,457	61%	46%	54%
Calculus	16,400	58%	47%	53%
Other Math Courses	8,842	31%	50%	50%
Computer Math	6,731	24%	42%	58%
AP/Honors Courses	7,708	27%	47%	53%

Note: 54 percent of all test-takers were female.
Source: The College Board, *State Profile Report: Washington, 2006* .

Table 3

Natural Sciences course-taking patterns
Washington SAT-takers, 2006

	Test-Takers		Percent by Gender	
Years of Study	Number	Percent	Male	Female
More than 4 years	1,578	6%	46%	54%
4 years	11,294	40%	46%	54%
3 years	10,167	36%	43%	57%
2 years	4,530	16%	47%	53%
1 year	689	2%	51%	49%
1/2 year or less	239	1%	45%	55%
No response	5,653			
Course Work				
Biology	26,690	94%	44%	56%
Chemistry	22,893	80%	45%	55%
Physics	13,390	47%	51%	49%
Geology, Earth, or Space Science	10,951	38%	45%	55%
Other Sciences	12,635	44%	42%	58%
AP/Honors Courses	6,109	21%	45%	55%

Note: 54 percent of all test-takers were female.
Source: The College Board, *State Profile Report: Washington, 2006* .

These tables indicate that female students are taking upper-level science and math courses (with the exception of physics) at or near their representation in the test-taking population (54 percent of Washington SAT-takers are female), including AP/honors courses. Average grade point averages for mathematics, self-reported by male and female test-takers, are equal (3.2) and are slightly higher for female students for natural sciences (3.4 for female test-takers and 3.3 for male test-takers).[9]

The two main measures of math and science college readiness yield contradictory information on gender equity. Females in Washington state and nationally appear to score consistently and slightly lower than their male counterparts on standardized assessments of math and science aptitude. But when math and science high school course-taking behavior and grades are analyzed, female students appear to have a slight edge over their male counterparts. Because common practice in college admissions is to consider both test scores and high school transcripts, the two may balance each other out.

Conclusion: Male and female high school graduates in Washington are about equally prepared to complete college-level math and science courses.

[9] The College Board (2006), *State Profile Report: Washington 2006.* See http://www.collegeboard.com/prod_downloads/about/news_info/cbsenior/yr2006/washington-2006.pdf.

Interest

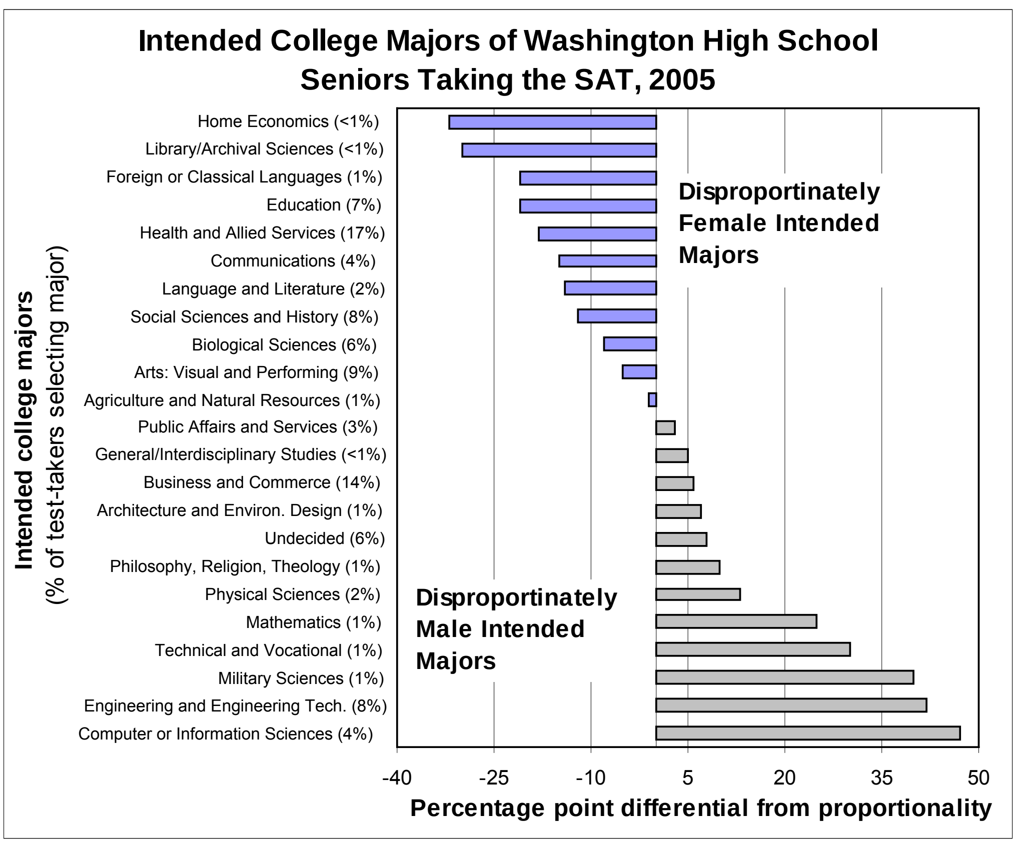
Are male and female lower-division students equally likely to take STEM and health sciences courses? Why do students who take these introductory courses choose to major in these fields?

Despite parity in the academic preparation of male and female students for college-level work in the STEM and health sciences fields, students seem to begin the self-segregation process before getting to college. In 2004, a national study found that about 26 percent of female college freshmen intended to major in science and engineering fields, compared to 41 percent of freshman males[10]. Conversely, male freshmen were predisposed to major in every field of science and engineering except the biological and social sciences.

A look at Washington SAT-takers in 2005 shows that early on, college-bound high school students have begun making gender-related academic and career choices, with male students preferring certain fields and female students preferring others. As **Figure 3** indicates, only about a third of intended major fields show roughly proportional gender representation (less than 10 percentage point deviation).

Figure 3 shows that by the senior year of high school, when most test-takers sit for the SAT, intended college majors are highly skewed by gender for many fields of study. The percentages following each major are the percentage of all test-takers who selected the intended major on the questionnaire. The length of the bars indicates the percentage point deviation from proportionality: 44 percent of all test takers indicating an intended major were male; 56 percent were female – so the bars represent the percentage point deviation from those benchmarks.

Figure 3



Source: The College Board, State Profile Report: Washington 2005.

[10] Based on data from the Higher Education Research Institute at UCLA, *Survey of American Freshmen*, as presented in National Science Foundation (2004), *Women, Minorities, and Persons with Disabilities in Science and Engineering, op. cit.*

Table 4 shows the distribution for the fields of study in high demand by Washington employers. The STEM fields – computer science, engineering, mathematics, physical and biological sciences – are grouped in a single category. Nearly half of students taking the SAT indicated interest in majoring in one of the three high-demand areas of study, but their interest was highly skewed by gender.

Table 4

Intention of Washington SAT-takers to major in high-demand fields, 2005

	Test-Takers		Percent	
Intended Field of Study	Number	Percent	Male	Female
STEM Fields	5,168	21%	70%	30%
Health and Allied Services	4,220	17%	26%	74%
Education	1,806	7%	23%	77%

Source: The College Board, State Profile Report: Washington 2005.

Conclusion: Convincing more female students to pursue the STEM fields and more male students to pursue health services and education may be an effective strategy for meeting employer demand for qualified workers in these fields.

Persistence

Are male and female students in Washington who take introductory courses in STEM and health sciences equally likely to persist and attain degrees in these fields? Have persistence rates changed over time?

National studies of student persistence in STEM fields by gender present a mixed picture that varies from study to study and for different fields within STEM. Engineering programs show higher rates of persistence for male students than for female students. This is particularly true for high-achieving students. One study found that only 29 percent of top undergraduate women remained in engineering programs, compared to 82 percent of top undergraduate men[11].

Variables that affect general levels of persistence seem to affect women disproportionately. These include the presence of appropriate role models, student knowledge about engineering, and the student's willingness/ability to work long and stressful hours while managing other competing time demands. Additional demographic barriers exist. For example, women students represent 60 percent of all students in the lowest income quartile; 62 percent of all students 40 and older; 62 percent of married or separated students with children or dependents; and 69 percent of single-parent students[12].

Finally, the structure of the science and engineering curriculum itself may inhibit students from testing the waters in a field and from persisting in that field. On many campuses, students are not presented with a clear picture of the field of engineering and its applications until far into the curriculum; often not until the second or third year of study. Women and under-represented minorities are less likely to be exposed to engineering as a profession prior to taking their first courses in the field, and may find the curriculum uninviting[13] because it fails to provide context about the profession and its employment possibilities.

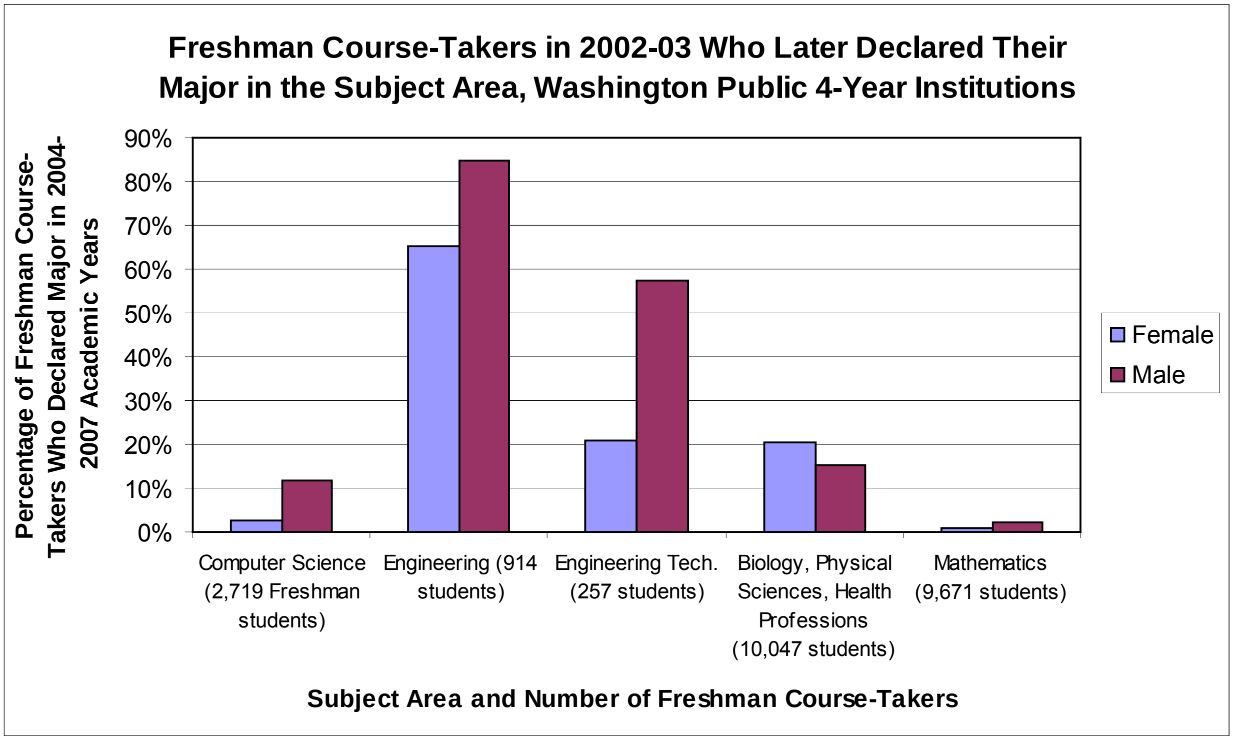
[11] National Research Council of the National Academies (2006). *To Recruit and Advance: Women Students and Faculty in Science and Engineering*, pages 46-50.

[12] *ibid*, page 51.

[13] National Research Council of the National Academies (2006). *Supra,* page 53.

The HECB staff conducted an analysis of persistence rates by gender at Washington's public four-year institutions using the state's Public Centralized Higher Education Enrollment System (PCHEES) database. A cohort of new freshman students taking STEM and health sciences courses in 2002-03 was identified and the system used to compare the courses they took as freshman with their eventual majors. The results broken out by gender are in **Figure 4**.
(Note: The Evergreen State College was not included in the analysis because all students major in the same Liberal Arts and Sciences academic field of study.)

Figure 4



Source: HECB analysis using PCHEES state data reporting system.

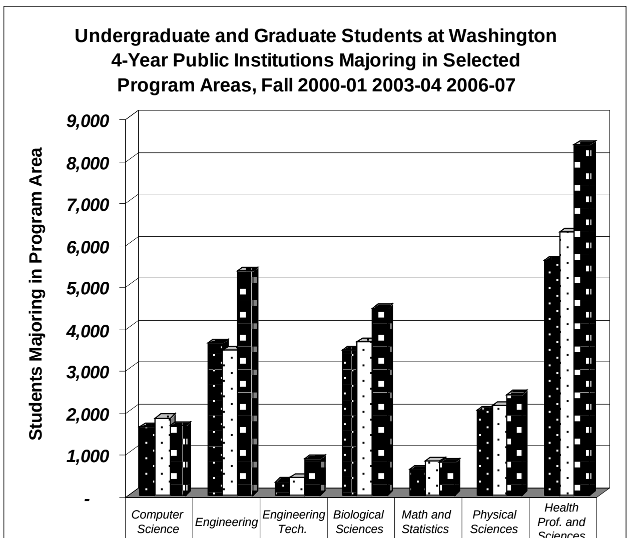
Many students who take math and computer science courses as freshmen do not intend to major in those subjects, but instead take them to support their studies in other fields or to fulfill a distribution requirement. Therefore, the percentage of those who later choose to major in these subject areas is low. Biology, Physical Sciences, and Health Professions were grouped because nurses, pre-med students, and other health professionals typically take biology and chemistry as freshmen. This is the only cluster of programs with a greater percentage of female students declaring majors. Again, this research shows more female than male students majoring in the biological sciences and the health professions (including nursing).

Male students who took computer science, engineering, engineering technology, and mathematics courses as freshmen were more likely than their female counterparts to later select those fields as majors. The chart indicates that most students (male and female) tend not to take engineering courses, even as freshmen, unless they intend to major in the subject. Based on the chart, gender inequality in student persistence is highest for computer science and engineering technology.

In recent years, the Washington State Legislature has provided funding to expand programs in the STEM and health sciences fields as part of a larger objective to meet high-demand employment needs. HECB staff recently examined whether this increased capacity has helped produce greater gender equity in the STEM and health sciences fields. **Figure 5a** shows growth in the number of students majoring in these fields, partially attributable to this increased investment. **Figure 5b** shows the percentage of women enrolled in these high demand programs. The percentage of women enrolled increased in only three of seven program areas: Engineering Technology, Physical Sciences, and Health Professions and Sciences.

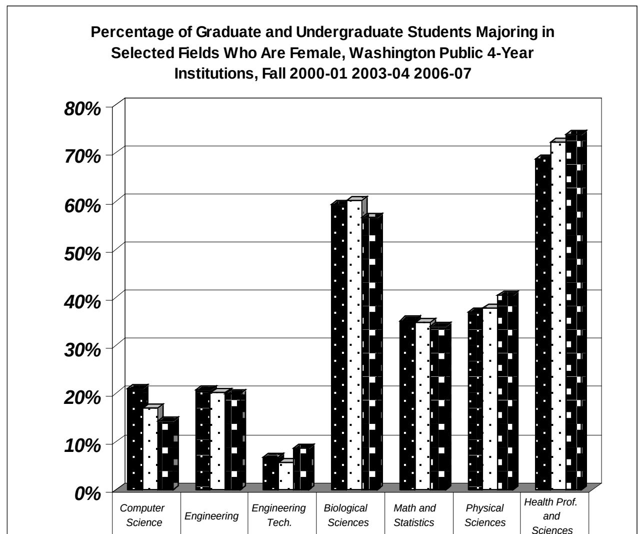
Conclusion: Simply expanding capacity will not achieve greater gender equity in STEM and health sciences fields. Strategies are needed to recruit students who have not traditionally shown interest in these fields.

Figure 5a



	Computer Science	Engineering	Engineering Tech.	Biological Sciences	Math and Statistics	Physical Sciences	Health Prof. and Sciences
2000-01	1,625	3,607	308	3,453	606	2,008	5,586
2003-04	1,825	3,447	412	3,647	808	2,112	6,266
2006-07	1,645	5,331	850	4,444	767	2,386	8,333

Figure 5b



	Computer Science	Engineering	Engineering Tech.	Biological Sciences	Math and Statistics	Physical Sciences	Health Prof. and Sciences
2000-01	21%	21%	7%	59%	35%	37%	69%
2003-04	17%	20%	6%	60%	35%	38%	72%
2006-07	14%	20%	9%	57%	34%	40%	74%

Source: HECB analysis using PCHEES state data reporting system.

Role Models

Do STEM and health sciences students persist at higher rates when they take courses taught by faculty of the same gender? What is the gender breakdown for faculty in STEM and health sciences fields? How have these percentages changed recently? What factors influence the recruitment of faculty in these fields (capacity issues, doctorate degree conferment rates, progression toward full professorship)?

Studies indicate that high school preparation, ability and effort are not the key determinates of persistence in STEM fields. Rather, it is the educational climate of science and engineering departments that seems to matter most[14]. These climate issues are most important early in a student's experience, before the student has declared a major. Once science and engineering students have declared, they are equally likely to complete the major (nationally, about 60 percent for both male and female students).

[14] National Academy of Sciences (2006). *Supra*, p. 3-13.

Many female students appear to refrain from selecting science and engineering as fields of study because they acquire a strong sense of role incongruity – a perceived difference between the stereotypical characteristics of their gender (and by extension, of themselves) and the attributes thought to be required for success in the field.[15]

Male and female students also are attracted to science and engineering for different reasons. Women are almost twice as likely as men to have chosen science or engineering through the influence of a role model. Men are twice as likely as women to cite their skills in math and science as a primary reason for selecting a science or engineering major.[16]

Studies of students who fail to persist also reveal gender differences. Female students cite as reasons for leaving STEM fields their belief they will get a better education in another major, poor teaching, and poor career options. Male students cite course overload, loss of confidence, financial problems, and issues with competition.[17] A 1997 University of Washington study noted that advising and a supportive community are important factors in the retention of female science, engineering, and mathematics majors.[18]

Given these issues, it would follow that providing female STEM students with more and better role models and advising would improve the educational climate and increase persistence rates. There is strong scientific evidence to suggest that the presence of a female instructor can reduce the tendency of female students to develop stereotypic beliefs.

A 2004 University of Massachusetts study by Dasgupta and Asgari[19] showed that women in male-dominated science and math classes at a coed college exhibited greater levels of stereotypic beliefs than those who attended the same courses at a women's college. Importantly, this effect was mediated when the professor at the coed institution was female. If female student pre-conceptions about gender-appropriate careers and leadership roles can be mediated in a coeducational environment by exposure to women in leadership positions, presumably the same is true for men in reverse.

The percentage of female faculty in STEM fields is low – ranging from 10 to 30 percent nationally across the science and engineering disciplines. The number is lowest in engineering, where nationwide, female faculty make up just 10 percent of all tenured and tenure track faculty. At the University of Washington, the state's largest institution, the female faculty ratios are similar to the national averages, although they are slightly better in engineering. See **Table 5**. The percentage of women instructional faculty (in all subject areas and including non-tenure track faculty) is 41 percent across the six public institutions, ranging from 39 percent at the University of Washington to 49 percent at The Evergreen State College[20]

[15] i*bid., p. 3-14.*
[16] i*bid., p. 3-14.*
[17] i*bid., p. 3-14.*
[18] SG Brainard and L Carlin (1997). A Longitudinal Study of Undergraduate Women in Engineering and Science. http://fie.engrng.pitt.edu/fie97/papers/1252.pdf.
[19] N. Dasgupta and S. Asgari, "Seeing Is Believing: Exposure to Counterstereotypic Women Leaders and Its Effect on the Malleability of Automatic Gender Stereotyping." *Journal of Experimental Social Psychology*, Vol. 40, Issue 5, pp. 642-658.
[20] Information is based on HECB analysis based on 2006-07 Common Data Set information provided by the institutions.

Table 5

University of Washington
Tenured and Tenure-Track Faculty in Selected Colleges and Departments, October 2006

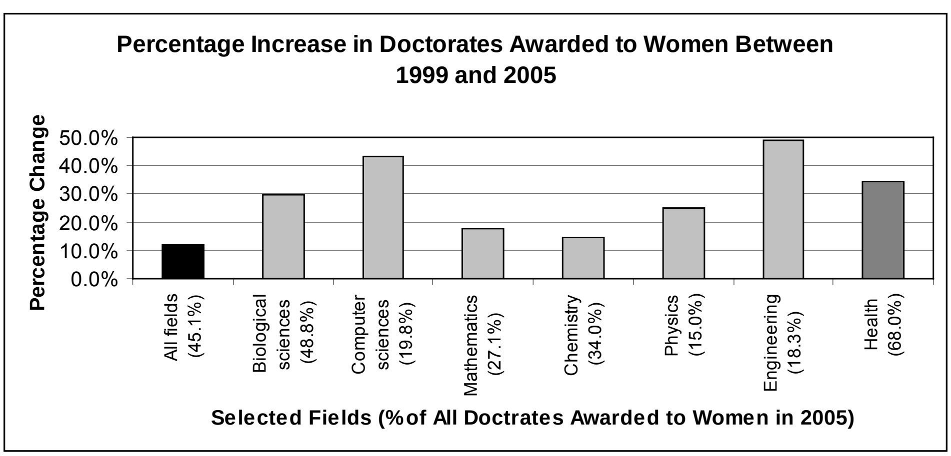
College/Department	Total	% Female	College/Department	Total	% Female
College of Engineering	*208*	*16%*	*College of Arts and Sciences*	*793*	*34%*
Industrial Engineering	9	44%	Biology	36	31%
Civil and Environmental Eng.	33	21%	Astronomy	11	27%
Material Science and Eng.	10	20%	Statistics	20	25%
Bioengineering	10	20%	Atmospheric Sciences	16	19%
Electrical Engineering	38	16%	Mathematics	50	14%
Chemical Engineering	13	15%	Applied Mathematics	9	11%
Computer Science and Eng.	43	9%	Earth and Space Science	22	9%
Mechanical Engineering	25	8%	Physics	44	9%
Aeronautics and Astronautics	18	6%	Chemistry	40	8%
School of Nursing	*75*	*92%*			
School of Public Health	*119*	*36%*			
School of Dentistry	*57*	*32%*	**Total UW-Seattle**	**3,051**	**32%**
School of Medicine	*1,287*	*28%*	**Total UW-Bothell**	**64**	**44%**
School of Pharmacy	*35*	*26%*	**Total UW-Tacoma**	**107**	**51%**

Source: UW Affirmative Action Reports, http://www.washington.edu/admin/eoo/AA_Reports.html

Recruiting more women into faculty positions is made more difficult by the low percentages of women who reach the doctorate level in STEM fields (and conversely, men in health sciences fields). However, in all areas except health sciences, there have been dramatic improvements in the number of doctorates awarded to women in the last few years, as indicated in **Figure 6**. The percentage increase in doctorates awarded to women between 1996 and 2005 in STEM fields exceeded the overall percentage increase in doctorates awarded to women in all fields. In health sciences, over-representation of women doctorates increased during the period, making it more difficult to recruit men to some professorship positions, like nursing.

Conclusion: It would seem appropriate for institutions to set a benchmark target for recruitment of new faculty that at least matched (if not exceeded) the gender distribution of doctorates awarded in the field. For example, a statistical disparity such as the one between the UW chemistry department (8 percent women tenure/tenure track faculty) and a 34 percent national doctoral award rate to women may signal a need for review and potential modification of hiring procedures and practices.

Figure 6



Source: NSF Division of Science Resources Statistics, Survey of Earned Doctorates.

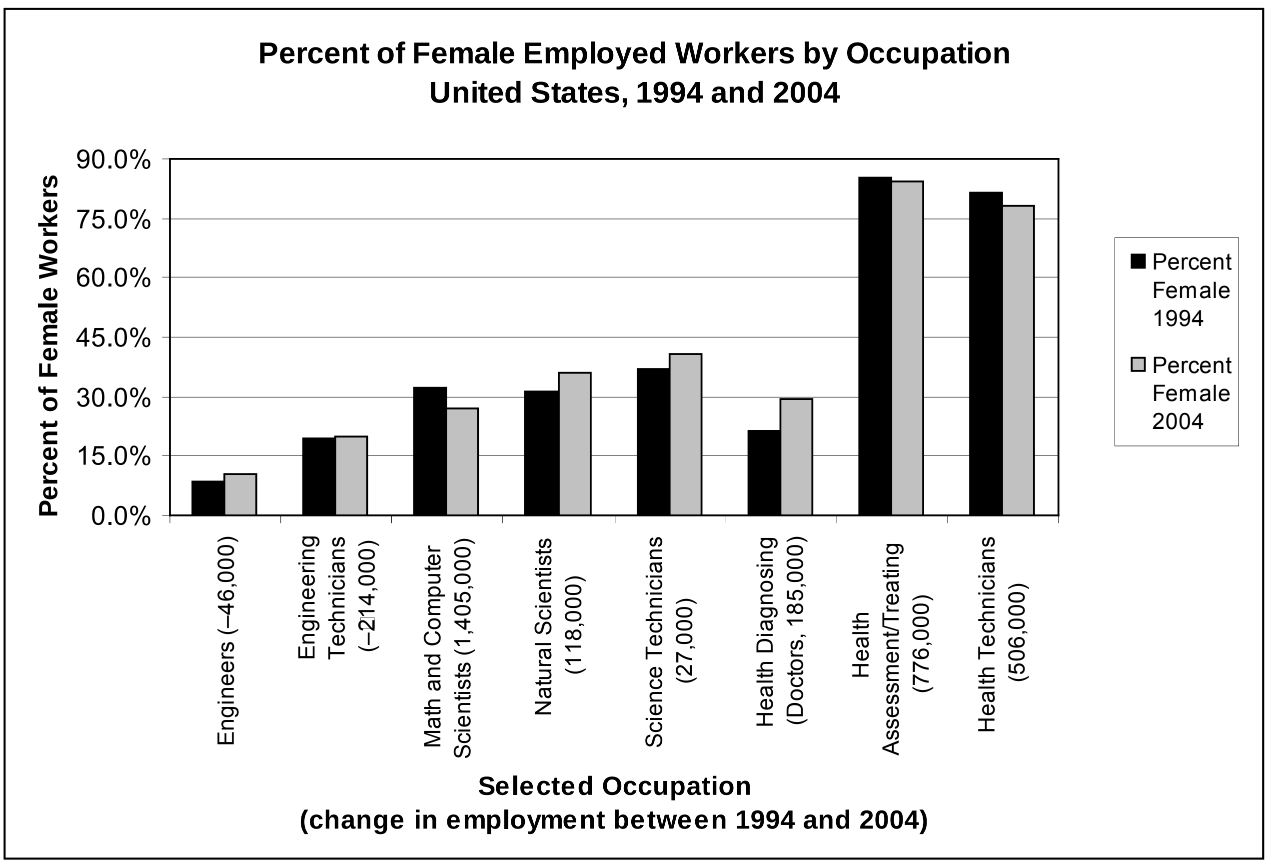
Outcomes

Are male and female graduates from Washington's STEM and Health Sciences programs equally likely to work in their field following graduation? Will they receive similar earnings? Will they continue their studies to achieve an advanced degree in their field?

In **Figure 7**, national statistics indicate the percentage of female professionals and managers working in the STEM fields and health diagnosing occupations is lower than that of men, as well as the overall percentage of female managers and professionals in all fields. The opposite is true in some of the health sciences professions, where female nurses, therapists, and health technicians outnumber men.

The figure also shows national-level changes in employed workers for selected occupational categories between 1994 and 2004, as well as changes in the percentage of female workers in each category over the period. The graph shows growth in all fields except engineering and engineering technicians over the 10-year period. Gains were made toward greater gender equity in each occupational category except for math and computer scientists – the category that experienced the largest total gain in employment. The largest percentage gain was for female workers in the health-diagnosing occupations.

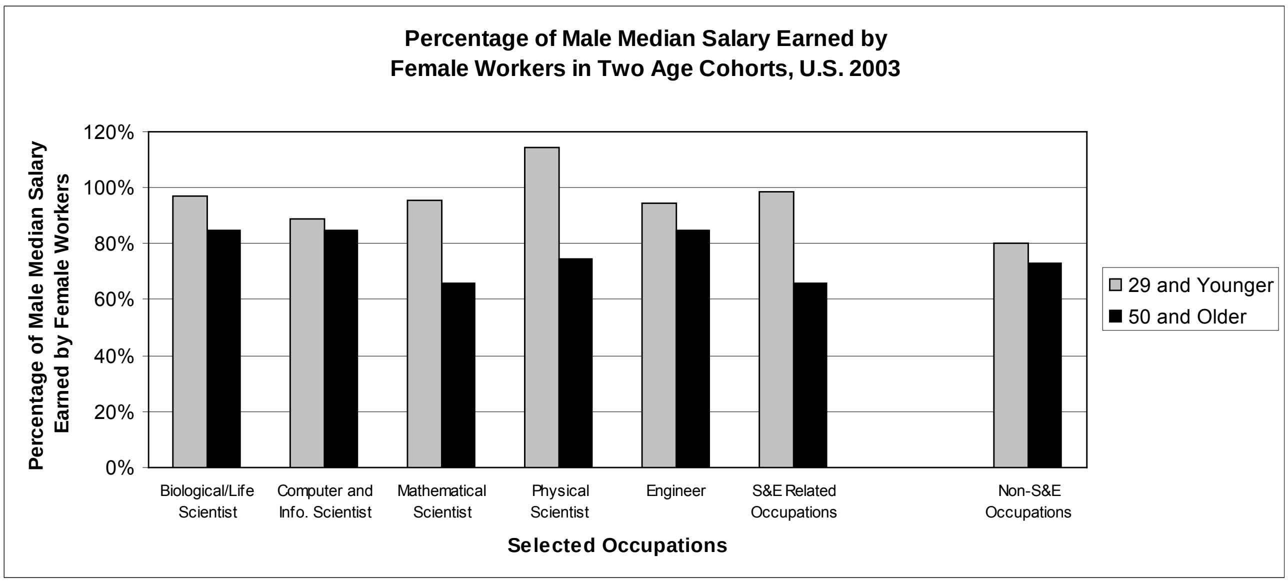
Figure 7



Source: NSF Division of Resources Statistics, from BLS Current Population Survey data.

Figure 8 compares median female and male salaries for selected occupations. The grey bars indicate workers under age 29 and the black bars are for workers aged 50 and older. In each instance, younger female workers are showing greater wage parity with their male counterparts than older workers. This indicates either progress in wage parity for younger (recently hired) female workers or fewer opportunities for women to advance to higher paying jobs (the "glass ceiling"). Both of these may be occurring simultaneously. Also of note is that wage parity with male counterparts in the 29-and-under age bracket is higher for all of the science and engineering occupations than for non-S&E occupations. This indicates that S&E jobs show greater gender pay equity than non-S&E jobs, at least for younger workers.

Figure 8



Source: NSF Division of Resources Statistics, Scientists and Engineers Statistical Data System.

The wage parity picture in the health sciences is similar, even in occupations such as nursing and diagnostic support technicians that are dominated by female workers. According to the latest BLS Current Population Survey data, female registered nurses earn 90 cents for every dollar male nurses earn (90 percent of all registered nurses are female), and for physicians and surgeons (42 percent of all doctors are female) it is 72 cents on the dollar.[21]

HECB staff reviewed 2006 alumni survey data from the University of Washington and found that engineering, public health, and nursing baccalaureate students all earned more during their first year after college than other UW graduates, and those increased earnings were retained by engineering graduates in 5- and 10-year follow-up surveys. Contrary to the national data, women engineering respondents reported higher earnings than male respondents. Natural science majors had earnings levels and gender disparities that tended to track more closely to the overall university average.

[21] Bureau of Labor Statistics, *Current Population Survey*, http://stats.bls.gov/cps/cpsaat39.pdf.

Policy Options

What successful policies and programs have other states implemented to improve gender proportionality of students and faculty? What strategies have been proven effective at the institutional level that can be replicated statewide?

From the discussion above, we can draw the following conclusions to help inform policy options for increasing gender equity in academic programs:

- Male and female students are equally prepared to pursue postsecondary education in STEM and health science fields, even though there are relatively small and persistent differences by gender in test scores and course-taking behavior.
- However, even before getting to college, high school students exhibit a high degree of vocational self-segregation by gender when asked to identify probable major fields – patterns that persist throughout their college experience.
- Women who take STEM courses as freshmen are less likely to major in those fields than their male counterparts. Similarly, men who take courses in the pre-med/health sciences cluster are less likely to major in those subjects than are female students. Persistence rates vary by gender.
- Despite the recent growth of female doctoral graduates in STEM fields, the percentage of female faculty in these departments remains low.
- Women working in STEM fields earn a higher percentage of what men earn than they do in non-STEM fields, but wage parity has not yet been achieved in STEM fields or in health services. Wage disparity by gender seems to be highest for older workers, possibly due to the “glass ceiling” effect. The existence of this effect in our state is supported by UW wage survey data that shows wage disparities by gender for program graduates that often increase between the first, fifth, and tenth year after graduation.

These research results suggest that appropriate policy and program areas of focus for new initiatives in Washington state would be to:

I. Increase awareness of high school students (targeting under-represented gender students) to career opportunities in the STEM and health sciences fields, and providing these students with opportunities to interact with gender-minority role models working in these fields.

II. Improve the welcoming experience of gender-minority students who express interest in the STEM and health sciences fields by enrolling in those courses as freshmen, in an effort to raise persistence rates and the number of gender-minority students that major in these fields.

III. Provide support and assistance to STEM and health sciences departments in their efforts to hire gender-minority faculty and faculty of color, and securing institution-wide commitment to achieving aggressive hiring targets.

Most of the program and policy initiatives designed to encourage greater gender equity in the STEM or health sciences fields have been at the institutional level, or by partnerships between community organizations and K-12 schools and school districts. There are few examples of statewide policies or program initiatives undertaken by state higher education boards, executive officers, or at the state university system level.

I. Career Awareness

There are many Washington State programs that encourage young girls in middle and high school to consider careers in STEM fields. In fact, **Table 6** lists the 27 community-based programs found in the National Girls Collaborative Project database. It is important to note this is not an exhaustive list and that the programs vary greatly in design and intensity. Some are one-day workshops, others are summer programs (typically one to three weeks), and others are year-round and intensive.

The near-absence of Eastern Washington programs from the database (only three are listed) suggests these opportunities may not be widespread throughout the state. Most of these programs involve partnerships with middle and high schools, and several involve community and technical colleges and four-year institutions. However, program administrators are quick to note the difficulty of getting these experiential learning initiatives mainstreamed into the middle and high school curriculum, as well as the problem of achieving sufficient program scale to achieve a broad impact.

Table 6

Washington Programs Raising Girls' Awareness of STEM Careers

Program	Organization	City
Salish Sea Expeditions - Sea Investigators	Salish Sea Expeditions	Bainbridge Island
WWU Engineering Technology	Engineering Technology	Bellingham
Northeast Vocational Area Cooperative (NEVAC)	NorthEast Vocational Area Cooperative	Bothell
TechREACH	Puget Sound Center for Teaching, Learning and Technology	Bothell
Junior Recognition Scholars	Stanwood-Camano Branch AAUW	Camano Island
Girls Go Tech	Girl Scouts -- Pacific Peaks Council	DuPont
Scholar Recognition Program-Edmonds AAUW	American Association of University Women	Edmonds
Lakewood Computer Clubhouse	Lakewood Computer Clubhouse	Lakewood
MESA: Yakima/Tri-Cities	Yakima Valley Tri-Cities MESA	Richland
BioQuest	BioQuest	Seattle
Discovery Corps	Pacific Science Center	Seattle
Girl Scouts - Totem Council	Girl Scouts - Totem Council	Seattle
Inspiring Youth Through Technological Creativity	Red Llama	Seattle
MESA - Seattle	Seattle MESA	Seattle
Passages Northwest	Passages Northwest	Seattle
Reel Grrls	Reel Grrls	Seattle
Seattle Expanding Your Horizons	SMARTgirls	Seattle
Seattle Girls' School	Seattle Girls' School	Seattle
Society of Women Engineers-Pacific NW Section	Society of Women Engineers	Seattle
TechNet Program	Associated Recreation Council	Seattle
University of Washington Women's Initiative (UWWI)	University of Washington Women's Initiative	Seattle
Washington Aerospace Scholars	Washington Aerospace Scholars/The Museum of Flight	Seattle
Women Fly!	The Museum of Flight	Seattle
Girls on Ice	Girls on Ice (North Cascades Institute)	Sedro-Woolley
WSU Spokane CityLab	WSU Spokane CityLab	Spokane
AAUW-WA High School Scholars	Puyallup Valley Branch American Association of University Women	Tacoma
Great Explorations: A Math and Science Adventure	Great Explorations in Education	Walla Walla

Source: Northwest Girls Collaborative Project database, http://www.pugetsoundcenter.org/ngcp/directory/index.cfm

Conclusion: A state policy initiative to provide support for career awareness programs and to integrate them into school districts' academic programs could be modeled after the Massachusetts STEM Pipeline Fund. They have put $6.5 million in general fund resources into the program since 2003, providing grants of up to $350,000 for each project proposed by seven regional PreK-16 Networks. The grants support teacher professional development and teacher mentoring, curriculum development, science fairs, career fairs, science academies, summer science camps, and many other important activities designed to increase interest in STEM fields.

II. Improving Student Persistence

The data presented in **Figure 4**, show that female students in Washington are less likely to major in computer science, engineering, or mathematics than their male counterparts—even after they take a course in these subjects as freshmen. The same is true, to a lesser degree, for male students taking courses in the pre-med/health sciences cluster. Although the latter is a more recent phenomenon, due in part to extraordinary efforts by the medical education profession to make careers in medicine, especially doctors, a more attractive and viable choice for female students.[22] Many institutions are working to extend some of the procedural, program and cultural changes that have occurred in medical education to the STEM fields to make them equally welcoming and supportive for female students.

One example is Carnegie Mellon University's *Women in Computer Science Program,* which succeeded in raising female enrollment from 7 percent in 1995 to 40 percent in 2000, but despite continued efforts has fallen back to about 28 percent (still much higher than the Research I average of 15 percent). Activities included professional development training for high school AP computer science teachers in C^{++} and gender equity issues, modification of admissions criteria to de-emphasize prior programming experience, and development of a supportive community that included a new Women@CS Advisory Council.

The National Research Council identifies the following strategies for retaining female students in science and engineering programs: signal the importance of women; build K-12 bridging programs at the undergraduate level; improve advising; establish mentoring programs; change the pedagogical approach; increase engagement with students; and increase professional socialization.[23]

Conclusion*:* It is easy to see from this list that student retention strategies need to be built primarily at the institutional level, based on the institution's analysis of when and where they are losing students and what support strategies are most needed and appropriate. From a statewide policy perspective, merely asking institutions to develop a student retention plan to promote gender equity may be a good place to start.

[22] According to the Association of American Medical Colleges, the percentage of female medical school graduates has risen from 36 percent to 49 percent in the last 15 years. In 2005, 34 percent of full-time faculty at the University Of Washington School Of Medicine were women, exceeding the national average by 2 percentage points. However, there remain gender gaps at the UW and nationally with regard to rates of female tenured faculty and full professorships. See http://www.aamc.org/members/wim/statistics/stats06/start.htm.

[23] National Research Council of the National Academies (2006), *supra.*, p. 113.

III. Increasing Faculty Diversity

Students need role models to help them envision their career opportunities. Nothing can be more encouraging than having someone say to a student that they were once where they are now, and that they found a path to a fulfilling and rewarding career. This is why it is so important to have women faculty in the STEM fields and men teaching in the health science fields, especially nursing. The data presented above show that institutions across the country, including in Washington State, continue to struggle to attract, retain, and promote women faculty in the STEM fields and men in some health fields, despite recent improvements in the doctoral hiring pool.

Departments and institutions have established many successful programs to promote a more welcoming and supportive environment for faculty of all racial, ethnic, and gender groups. Activities include bringing in speakers on the topic; creating special recognition and awards for work in this area; developing diversity committees; assessing institutional patterns and practices; creating support networks and societies; providing workshops for search committee chairs and department chairs on diversity; revising hiring procedures and credential assessment rubrics; and providing support for dependent care. Most of the work has been done at the institutional or even the department level, where solutions can be customized within a given institutional context.

Recognizing that institutional culture must be changed at the institutional level, the National Science Foundation (NSF) created the ADVANCE program in 2001. The program provides grants to institutions assessment and developing plans to increase participation and advancement of women scientists and engineers. Funding is available for partnerships engaged in adaptation, implementation, and dissemination of best practices. The program also provides opportunities for research fellowships for women scientists.

Since 2001, the University of Washington has received nearly $5 million from the program to support a range of activities both on and off campus through the Center for Institutional Change (CIC) in the College of Engineering (see: www.engr.washington.edu/advance/). The CIC activities involve 21 departments in the Colleges of Engineering and Arts and Sciences, including the monitoring of women faculty hiring and advancement in science and engineering; awards and recognition to women scientists; a transitional support program to promote faculty retention; a visiting scholars program, leadership workshops; mentoring programs; and cultural change/policy transformation advocacy within the institution. In addition, the CIC has received NSF support for national dissemination of best practices, and offered a well-attended national leadership workshop for department chairs and deans from across the country in July 2007.

Conclusion: One policy option available to Washington is to create centers like the UW CIC at each public four-year institution. Essentially, Washington could create its own state version of the NSF ADVANCE program. The UW could provide technical assistance to the other five public institutions on self-assessment, strategy selection and implementation to promote cultural change. Private and neighboring state institutions could “buy in” to the network if they were interested in receiving technical assistance.

Selected References

The College Board (2005). *State Profile Report: Washington*. New York: The College Board.

Crandall, S.R. and Surabhi, J. (2007) "New Directions in Workforce Development: Do They Lead to Gains for Women?," *New England Journal of Public Policy,* Vol. 22, No. 1 and 2, pp. 81-98.

Freeman, C.E. (2004). *Trends in Educational Equity of Girls & Women: 2004* (NCES 2005-016). U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

Gallagher, A. (1998). "Gender and Antecedents of Performance in Mathematics Testing," *Teacher College Record*, V. 100, No. 2, Winter 1998, pp. 297-314.

Higher Education Coordinating Board (2006), *Gender Equity in Higher Education.* Olympia, Washington: Washington Higher Education Coordinating Board.

King, J.E. (2006). *Gender Equity in Higher Education: 2006.* American Council on Education, Center for Policy Analysis. Washington, D.C.: American Council on Education.

National Academy of Sciences (2006). *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*. Washington, D.C.: National Academy Press.

National Center for Education Statistics (2007). *The Nation's Report Card, America's High School Graduates: Results from the 2005 High School Transcript Study* (NCES 2007-467). U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

National Research Council of the National Academies (2006). *To Recruit and Advance: Women Students and Faculty in Science and Engineering.* Washington, D.C.: National Academy Press.

National Science Foundation, Division of Science Resources Statistics (2004). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2004.* NSF 04-317. Arlington, Virginia: NSF.

Spelke, E.S. (2005). "Sex Differences in Intrinsic Aptitude for Mathematics and Science? A Critical Review" *American Psychologist*, Vol. 60, No. 9, December 2005, pp. 950-958.