Studying Women and Science:

Why Women's Lower Rate of Participation in Science, Technology, Engineering, and Mathematics Courses Isn't a Problem for the Government to Solve

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Executive Summary

In 2007, the National Academy of Sciences released a report*, Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, which examined the causes of the different rates of participation among women and men in science, technology, engineering, and mathematic disciplines (STEM).[1] The report explored several potential factors that might contribute to fewer women than men pursuing STEM degrees, but concluded that discrimination was the central impediment to women's progress in these fields. The report called for greater government action and oversight to reverse this trend. The media have reported these findings, and many policymakers have embraced the report and explored legislation to codify the report's recommendations.

Yet policymakers and the public should not simply accept the report's conclusion that discrimination is the primary cause of enrollment differences and should consider the potential pitfalls of greater government involvement in students' decisions about what field to pursue. Innate differences in aptitudes, temperament, and interest likely play a role in leading fewer women than men to pursue and commit to STEM disciplines. Attempts to steer students toward one area of study to achieve a politically correct gender balance would ignore students' true preferences, potentially leaving them worse off.

Greater government intervention to approach parity in enrollment in STEM fields could also have a discriminatory impact on men. While policymakers and bureaucrats attempting to institute policies to encourage institutional change would undoubtedly claim not to be creating a "quota" or encouraging the creation of different expectations for male and female students, the experience with the use of Title IX in the athletic arena should serve as a warning to the public. Title IX has encouraged schools to embrace a quota mentality in college athletics, leading many schools to eliminate men's teams in order to reduce the number of male athletes so that men's and women's participation rates are more equal. If this approach is applied to academic subjects, it could adversely impact students and scholarship.

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Even those who champion women's interests alone should be concerned about the potential for Title IX's application to academia. After all, women now account for six in ten undergraduate students, and earn the overwhelming majority of degrees in biology, psychology, and much of the humanities. If Title IX is applied to STEM, it would be reasonable to assume that Title IX also would have to be applied to other academic areas. As a result, women may find themselves discouraged from pursuing disciplines that, for a host of reasons, they have traditionally found most attractive.

To the extent that there are barriers to women pursuing STEM, including discrimination against women and stereotypes that deter women from pursuing these fields, individual institutions are best suited to counteract these problems. Numerous non-profit organizations reach out to young women to encourage them to pursue degrees in STEM fields. Individual schools are attempting to reach out to prospective female students as well as find ways to make STEM departments more hospitable to female students. These are the best ways to alleviate social pressures without undermining the independence of the academy.

Introduction

In 2007, Representative Eddie Bernice Johnson (D-TX) introduced the "Gender Bias Elimination Act," (H.R. 3514). This legislation would authorize agencies to spend millions of taxpayer dollars to fund workshops and training programs aimed at increasing women's representation in STEM fields. On October 17th, 2007, the Subcommittee on Research and Science Education in the U.S. House of Representatives Committee on Science and Technology held a hearing entitled "Women in Academic Science and Engineering." The hearing examined the "institutional and cultural barriers" to women's success in science and engineering. Stories questioning why women's progress is so slow in STEM fields regularly appear in the media.[2]

Why is there so much concern that women are less likely than men to study and maintain careers in STEM fields? After all, the discrepancy in the participation rates between the genders is just as skewed in other fields—such as psychology and education (which women dominate)—but those are rarely discussed.

Why is there so much concern that women are less likely than men to study and maintain careers in STEM fields?

There are likely several reasons that the participation rates in science and technology garner so much attention.

First, since in decades past discrimination deterred women from participating in these fields, we are keenly aware of this potential injustice. Discrimination surely plays a role in some departments today, though the extent of its impact is subject to much debate. The specter of past discrimination and our desire to rectify its impact contribute to concern about this issue.

Second, science and technological fields tend to lead to prestigious, high-paying careers. Those frustrated that women's average earnings continue to lag behind men's know that a key to closing the so-called wage gap is encouraging women to pursue high-paying professions like those in STEM fields.

Finally, technological advances improve our quality of life. We depend on scientists to seek cures for life-threatening illnesses, and find ways to make energy more affordable, communication easier, and travel safer. If talented individuals are being discouraged from entering these fields, we may all be worse off because of it.

Certainly it is worth considering the underlying cause of the different participation rates between men and women in STEM fields. Yet in doing so, it is also important to recognize that there may be many legitimate reasons for this discrepancy. Different levels of participation are not in themselves problems so long as they reflect individuals' true preferences and talents, and are not the result of discrimination or other factors that prevent talented students from pursuing STEM fields.

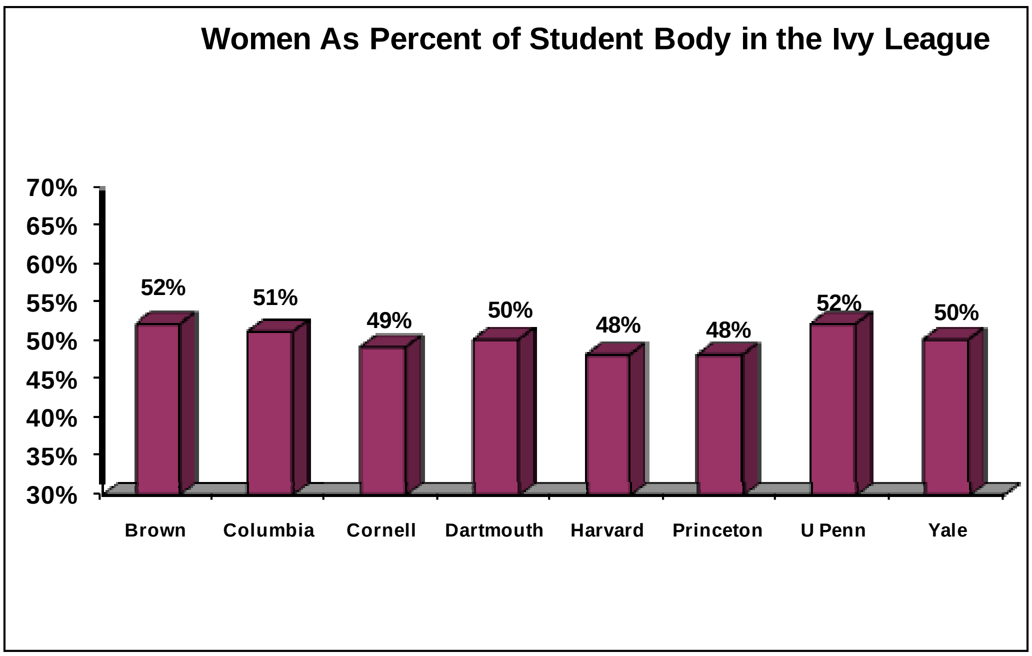
Therefore, there is no reason that we should expect or attempt to manufacture a certain rate of participation by either sex. Achieving parity in participation, or a participation rate that precisely mirrors college enrollment, for example, would be an arbitrary goal and one that could lower, instead of boost, individual fulfillment.

This paper begins by examining women's participation rates in a variety of disciplines. It then explores potential reasons that women might be less likely than men to study and pursue careers in particular fields. It considers the role the government plays, and ought to play, in preventing discrimination and encouraging participation among women in any academic discipline. Finally, this paper will examine how private entities are themselves attempting to encourage greater female participation in STEM fields.

Participation Rates in Academic Disciplines: Where the Girls Aren't

Given the makeup of today's college campuses, it is amazing to think that just a generation ago women were the minority in academia. In 1970, women accounted for just 42 percent of undergraduate students, but by 2005 the number of women on campus had grown to 56 percent of the total.[3] This growth has occurred throughout the university system, including our most prestigious institutions. As shown in Figure 1, women account for more than half of the student body at many of the country's most prestigious schools, such as Brown University, Columbia University, and the University of Pennsylvania, and are at near parity throughout the rest of the Ivy League. Women have even made strides in our nation's most prestigious technical schools, accounting for 51 percent of science undergraduates at the Massachusetts Institute of Technology and 35 percent of its engineering undergraduates.[4]

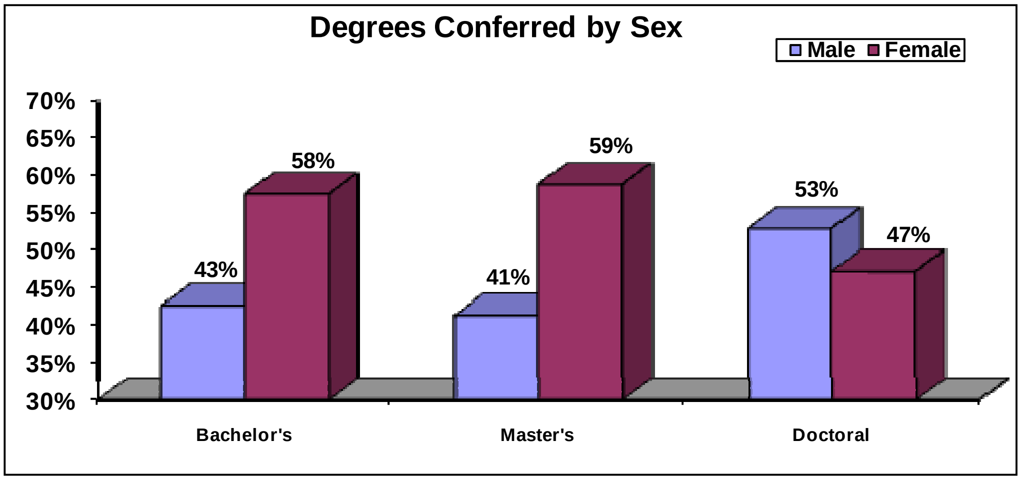
Figure 1



Source: Information from college websites.

As shown in Figure 2, women are not only earning the majority of bachelor's degrees but also the majority of master's degrees and nearly half of all doctoral degrees.

Figure 2



Source: U.S. Department of Education, National Center for Education Statistics, (2005). Available at: http://nces.ed.gov/fastfacts/display.asp?id=72.

Yet although women are attending college in greater numbers than men, women often make different decisions about what to study while there. As shown in Figure 3, women dominate some areas of study: women earn more than three quarters of the degrees awarded in education and psychology, and six in ten degrees in biological sciences. However, there are still disciplines where men heavily outnumber women. Women earn just 20 percent of the degrees awarded in engineering and 28 percent of the degrees awarded in computer sciences.

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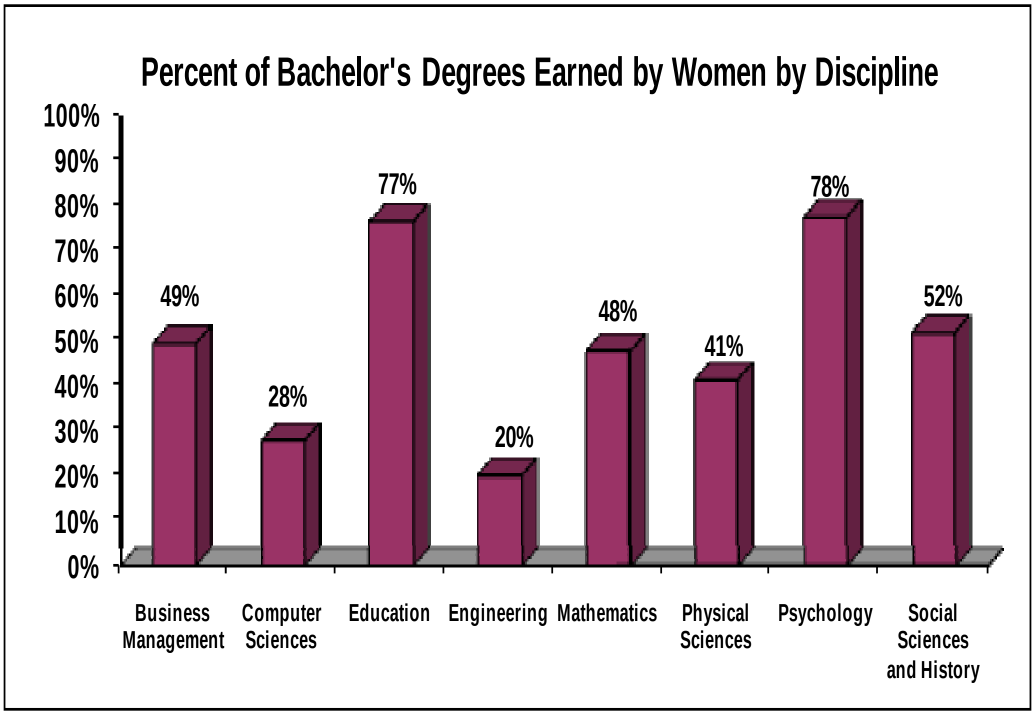
Figure 3

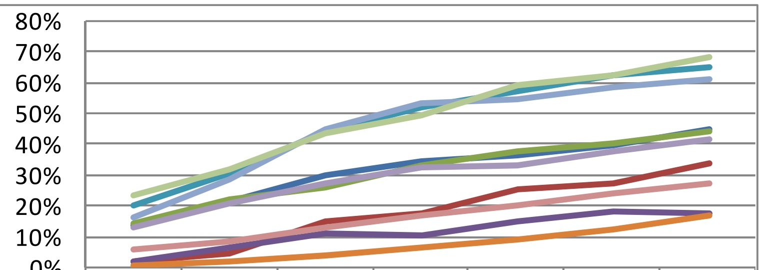


Source: National Center for Education Statistics, U.S. Department of Education, *Trends in Education Equity of Girls & Women: 2004*, November 2004, p. 78, Table 29. (Data for 2000-2001)

While these numbers demonstrate that women still lag behind men in some areas, it is important to note that even in these areas women have made considerable progress in terms of representation in recent decades. Consider the highest level of educational attainment: the doctoral degree. Women's share of doctoral degrees grew from 13 percent in 1970 to 45 percent in 2001, and this includes considerable progress in sciences and engineering. As shown in Figure 4, in 1970, women earned just 2 percent of the doctoral degrees awarded in computer and information science and just 1 percent in engineering. In 2001, women earned 18 percent and 17 percent, respectively. Certainly, female PhDs in these fields are significantly outnumbered by men, but women as a whole have made considerable progress in the past generation.

Figure 4

Percentage of Doctoral Degrees Conferred on Women



	1969-70	1974-75	1979-80	1984-85	1989-90	1994-95	2000-01
All	13%	21%	30%	34%	36%	39%	45%
Business Management	2%	4%	15%	17%	25%	27%	34%
Biological Science/Life Sciences	14%	22%	26%	33%	38%	40%	44%
Computer and Information Sciences	2%	7%	11%	10%	15%	18%	18%
Education	20%	30%	44%	52%	57%	62%	65%
Engineering	1%	2%	4%	6%	9%	12%	17%
Health Professions and Related Sciences	16%	29%	45%	53%	54%	58%	61%
Physical Sciences and Science Technologies	5%	8%	12%	16%	19%	24%	27%
Psychology	23%	32%	43%	50%	59%	63%	68%
Social Sciences and History	13%	21%	27%	32%	33%	38%	41%

Source: National Center for Education Statistics, U.S. Department of Education, *Trends in Education Equity of Girls & Women: 2004*, November 2004, p. 82, Figure 31.

Although Figure 4 shows how women have made progress across the board, increasing their representation in all disciplines, progress has been much faster in some areas than in others. For example, in psychology, women went from earning 23 percent of PhDs in 1970 to 68 percent in 2001, while in the biological sciences, women grew from earning 14 percent to 44 percent over the same time period.

Overall, what this picture shows is that while women have made gains in all academic areas in terms of rate of participation, men and women continue to make different choices about what to study and what degrees to pursue.

Factors That May Contribute to Women's Participation Rates in Science

Why do fewer women than men choose to enter fields like engineering and computer science? There are likely many reasons.

Consider the many factors that students take into account when deciding what coursework and majors to pursue. What subjects have they found most interesting in the past? In what subjects did they exhibit their greatest strengths during high school and in previous courses? What are the time demands of the courses? Some students take a long-term view, and consider the types of careers associated with a given academic discipline, while others focus on short-term considerations like class schedules, exam loads, and what their peers are taking.

Ultimately, what to study is an individual choice, but there are some factors that may make it more likely that women, in aggregate, make different choices than men.

Differences in Aptitude and Learning Styles

In January 2005, Harvard University's president, Lawrence Summers, speculated that innate differences in aptitude may contribute to the underrepresentation of women in the upper echelons of the fields of math and science. These remarks were roundly denounced by the feminist movement, and Summers eventually gave up his post at Harvard, in part because of this controversy. Yet this line of inquiry should not be off limits when considering why fewer women than men gravitate to certain academic disciplines.

Ultimately, what to study is an individual choice, but there are some factors that may make it more likely that women, in aggregate, make different choices than men.

It isn't unreasonable to think that innate differences in aptitude could be a factor in decisions about what to study and occupational choice. As Professor Kingsley R. Browne notes in the article "Women in Science: Biological Factors Should Not Be Ignored," it is commonly accepted that biology plays a role in gender breakdown in some occupations, and he uses an extreme example: the National Football League. Yet he makes the case that it isn't just in areas of physical strength that biology comes in to play; biology is also a factor in cognition and temperament.[5]

Male and female brains are physically different. In *The Female Brain*, Dr. Louann Brizendine describes how new tools (such as positron-emission tomography [PET] and functional magnetic resonance imaging [fMRI] scans) have illuminated numerous sex differences in brain structure and function with significant implications:

> As a result, scientists have documented an astonishing array of structural, chemical, genetic, hormonal, and functional brain differences between men and women. We've learned that men and women have different brain sensitivities to stress and conflict. They use different brain areas and circuits to solve problems, process language, experience, and store the same strong emotions. The female and male brains process stimuli, hear, see, "sense," and gauge what others are feeling in different ways.[6]

Brizendine notes that these differences do not mean that men and women are unable to complete the same task or that one sex has a superior aptitude, but highlights that men's and women's brains are fundamentally different tools that use different approaches to problems:

> Our distinct female and male brain operating systems are mostly compatible and adept, but they perform and accomplish the same goals and tasks using different circuits. In a German study, researchers conducted brain scans of men and women while they mentally rotated abstract, three-dimensional shapes. There were no performance differences between the men and women, but there were significant, sex-specific differences in the brain circuits they activated to complete the task. Women triggered brain pathways linked to visual identification and spent more time than men picturing the objects in their minds. This fact merely meant that it took women longer to get to the same answer. It also showed that females perform all the cognitive functions males perform—they just do so by using different brain circuits.[7]

Yet other researchers conclude the different brain structures ultimately do impact aptitude.* Based on analysis of what areas of the brain are employed for different tasks, researchers have identified different strengths in male and female brains on average that affect the performance of certain tasks:

> To the extent that these areas are larger in males than in females, a male advantage is predicted in (a) the tendency to rely on spatial representations for solving mathematical problems, (b) intuitive knowledge of certain features of geometry, and (c) ease of learning mathematics when it is presented in a spatial format. Alternatively, given the advantage of females in language domains, a female bias in the tendency to represent mathematical problems in a verbal format is predicted and, as discussed earlier, is found for solving the types of problems on standardized mathematical-abilities tests such as the GRE (Gallagher et al., 2002).

* If it weren't for the politically charged nature of this topic, it would seem unnecessary to provide the obvious disclaimer that all discussions of aptitude and male and female performance differences refer to men and women on average or in general as a group. This does not affect expectations for any single man or woman.

> Moreover, a male advantage in engineering and science tasks that involve object manipulation or generating complex 3-D images is predicted, as is a male advantage for integrating mathematical knowledge into spatially based science and engineering tasks, to the extent the intraparietal and adjacent regions are engaged with these tasks.[8]

Indeed, numerous tests have found the predicted results: men on average outperform women on measures of spatial ability, often by a significant degree;[9] women tend to show superior verbal acumen, particularly on assessments that include writing samples.[10]

In addition to having generally different cognitive strengths, men and women as groups have different levels of variability, which may also play a role in the observed differences in occupational outcomes.

Differences between men and women in average performances tend to be relatively small, but these averages mask that men are over-represented at both the bottom and top of the distribution chain. As Browne notes: "For example, although no sex difference appears on most intelligence tests, which are normed to an average IQ of 100 and designed to yield equal means for males and females, males outnumber females by approximately 20% in the above-140 group and by an even greater amount among those below 70."[11]

Those who oppose any suggestion that innate ability could play a role in STEM participation dismiss these findings as irrelevant. In the National Science Foundation's *Beyond Bias* report, the authors suggest that most studies of cognitive sex differences focus on measures that predict success in high school and college, but that do not necessarily correlate with success as scientists and engineers,[12] and dispute the idea that variability could contribute to participation differences since it rests on a presumption that only those at the very upper end of the performance distribution pursue careers in STEM.[13] For example, the authors note: "among youth scoring in the top 1% of mathematics ability as adolescents, men were almost twice as likely as women to obtain degrees in the physical sciences and engineering. Lack of innate mathematics ability could not explain this difference."[14]

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Yet Browne reminds us that there is a great deal of variability within the top 1%, which could help explain this fact. Researchers found significant differences between those in the top and bottom quarters of the top 1% of outcomes such as earning a degree in science, including that those in the top quarter were four times more likely to earn PhDs in math or science.[15]

Browne states it emphatically:

> It is simply erroneous to assert, as 79 signatories to a letter to *Science Magazine* did, that "there is little to no evidence that those scoring at the very top of the range in standardized tests are likely to have more successful careers in the sciences." On the contrary, as Wai, Lubinski and Benbow put it, these data "falsify the idea that after a certain point more ability does not matter" and show that "[m]ore ability always seems to matter.[16]

The National Science Foundation report attempts to dismiss any serious consideration of the role of sex differences by claiming that public discussion of sex differences has focused on "highly selective" research that emphasizes a small number of measures that show sex differences and de-emphasizes evidence in which sex differences are small or non-existent.[17] They conclude: "Studies of brain structure and function, of hormonal modulation of performance, of human cognitive development, and of human evolution have not revealed significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women in these fields."[18]

Indeed, researchers generally are cautious about concluding that evidence of sex differences explains differences in outcomes. For example, an article written by six professors that endeavors to provide a "consensus statement that is based on the best available scientific evidence" about the reasons for sex differences in careers in science and mathematics provides copious evidence of biology's role in men's and women's different aptitudes. The professors cite different measures of innate ability, levels of variability, and studies on brain function and structure, all of which suggest significant differences between men and women that would predict a male advantage in STEM-related disciplines. Yet, in the summary, the professors are careful to avoid discounting how other factors play a role:

> We review the brain basis for sex differences in science and mathematics, describe consistent effects, and identify numerous possible correlates. Experience alters brain structures and functioning, so causal statements about brain difference and success in math and science are circular. A wide range of sociocultural forces contribute to sex differences in mathematics and science achievement and ability—including the effects of family, neighborhood, peer, and school influences; training and experience; and cultural practices. We conclude that early experience, biological factors, educational policy, and cultural context affect the number of women and men who pursue advanced math and that these effects add and interact in complex ways. There are no single or simple answers to the complex questions about sex differences in science and mathematics.[19]

Certainly there is no single answer to why fewer women pursue STEM disciplines, but that doesn't justify dismissing the role that biological factors play.

It is also worth noting that differences in performance between men and women appear around the world. Counterexamples are seized upon by those who want to dismiss biology's role. For example, in the *Beyond Bias* report, as the authors begin their discussion of the role that socialization plays in shaping our aptitudes and interests, they emphasize how "those influences and their results can vary markedly among cultures," citing Iceland, where "adolescent girls outscore boys in mathematical reasoning."[20] Yet, more often than not, these examples end up bolstering the point they were supposed to refute.

Professor Browne exposes the shallowness of attempts to disprove worldwide trends with a single anecdote and how even these outliers tend to contain evidence that corroborates the original finding:

> In the context of sex differences in mathematical ability, some seize on international comparisons to suggest that sex differences cannot be biological because they vary from country to country. The current poster child for this school of thought is Iceland.
>
> …Certainly, it is an interesting fact that Iceland, a country with a population only slightly smaller than that of metropolitan Green Bay, Wisconsin, is alone among the 41 countries participating in the Program for International Student Assessment (PISA) in which girls outperform boys in mathematics. It is a slender reed upon which to build a claim that biological influences have been disproven, however, just as one should not conclude that sexual dimorphism in height has no biological roots because the sex differences in stature varies from culture to culture.
>
> …Finally, Iceland does not deviate from the usual pattern as much as it may appear, since despite a substantial mean difference between male and female performance on the PISA—and a gross disproportion of boys at the bottom level—the sex difference is negligible at the very highest level of performance. Moreover, on the Third International Mathematics and Science Study (TIMSS), Icelandic boys scored higher than girls on mathematical literacy in the final year of secondary school. An additional similarity between Iceland and the rest of the world is the fact that although 61% of university students in Iceland are women, women account for only one-third of Iceland's science students.[21]

It is also worth noting that differences in performance between men and women are replicated around the world.

Of course, social factors and biases, which are also present around the world, could play a role in these outcomes, but certainly the pervasiveness of these differences suggests that innate factors likely play a role as well.

It's Not a Question of Better or Worse

Those who recoil from the idea that men's and women's brains function differently seem to presume that the implication will be that one sex's brain will be innately inferior to the other and will thus be used as a pretext for discrimination. Yet the suggestion that men and women have different aptitudes and ways of learning has important benign implications. For example, it may not be that women are less capable of learning a particular scientific discipline, but conventional teaching methods in a discipline may be less suited to take advantage of women's strengths.

Physician and psychologist Leonard Sax argues that ignorance of—or an unwillingness to acknowledge—biological differences such as brain structure *contributes* to outcomes such as the different participation rates in math and science. He urges the public to embrace a recognition of the differences between male and female brains so that the focus is on how best to use each:

> The bottom line is that the brain is just organized *differently* in females and males. The tired argument about which sex is more intelligent or which sex has the "better" brain is about as meaningful as arguing about which utensil is "better," a knife or a spoon. … the differences between what girls and boys can do are not large. But the differences in how they do it can be very large indeed. For example…you can teach the same math course in different ways. You can make math appealing to girls by teaching it one way, or you can make it appealing to boys by teaching it in another way. Girls and boys can both learn math equally well if you understand those gender differences.[22]

Our one-size-fits-all public school system, which arranges children by age irrespective of sex or ability, fails to tailor teaching styles to account for these gender differences.

Our one-size-fits-all public school system, which arranges children by age irrespective of sex or ability, fails to tailor teaching styles to account for these gender differences. Sax concludes: "Gender-blind education leads paradoxically to a strengthening of gender stereotypes, with the result that fewer girls take courses in physics, computer science, trigonometry, and calculus." Our school system needs to be restructured to encourage teachers to consider how to make subjects appealing and to take advantage of the strengths in both boys and girls. Sax argues that doing so would make language arts more appealing to boys and math and science more appealing to girls: "There are no differences in what girls and boys can learn. But there are big differences in the best ways to teach them."[23]

"There are no differences in what girls and boys can learn. But there are big differences in the best ways to teach them."

Similarly Browne's research provides another potential explanation for how biology may play a role that would not in any way suggest female inferiority:

> One reason that mathematically talented women tend to be found in disciplines other than math and science is not that their opportunities are narrower by comparison to men, but rather that they are broader. Men who are high in mathematical ability tend to have much higher mathematical ability relative to verbal ability, while women high in mathematical ability tend also to be high in verbal ability. Thus, women with high mathematical ability are considerably more likely than men with high mathematical ability to pursue study in fields that require high verbal ability, such as in the humanities, rather than math or science.[24]

This finding—that women with high mathematical aptitudes are also skilled in other areas, unlike men—certainly wouldn't explain the totality of sex differences but would offer a further rationale for how other environmental factors may come into play. If women with high scientific ability have the option of pursuing other disciplines, such as humanities, and view these disciplines as providing a better fit with their lifestyle desires, better mentor relationships, and less sexism, then they are more likely to take those options than if they had relatively lower skills in other areas.

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Differences in Temperament

Let's assume that the many differences in how men and women process information and approach problems have no impact on aptitude. Differences in innate makeup could still play a major role in the decisions men and women make about what academic disciplines to pursue. Temperament and interest also affect how people choose to spend their time and focus their energies. And, as Professor Browne summarizes, scientific studies back up what most people identify in their everyday experiences about differences between men and women in regard to temperament, and these differences relate to decisions that men and women make about their occupations and training:

> Apart from cognitive differences, the sexes also differ in temperament and personality. On most measures of direct competitiveness, for example, males score higher than females. …The sexes also vary in risk preference, with males exhibiting a greater preference for both physical and nonphysical risks. ...Females also tend to exhibit more nurturing behavior than males, both inside and outside the family. …These temperamental differences are reflected in occupational interests. Sex differences are consistently found on measures of occupational interest such as Strong Interest Inventory and the Self-Directed Search, which measure occupationally relevant aspects of personality.[25]

Dr. Louann Brizendine, for example, dismisses the role that innate aptitude plays in the different disciplines that attract men and women and instead believes differences in temperament and interest are at the root:

> We now know that when girls and boys first hit their teen years, the difference in their mathematical and scientific capacity is nonexistent. … But as estrogen floods the female brain, females start to focus intensely on their emotions and on communication… At the point when boys and girls begin deciding the trajectories of their careers, girls start to lose interest in pursuits that require more solitary work and fewer interactions with others, while boys can easily retreat alone to their rooms for hours of computer time.[26]

She describes experiences of her patients and fellow scientists who have struggled with their desires to pursue these areas of interest with their needs for social interaction and time with family:

> From an early age, my patient Gina had an extraordinary aptitude for math. She became an engineer but the twenty-eight year old was struggling with her desire to be in a more people-oriented career and one that would allow her to have a family life, too… This is not an unusual conflict for women. My friend the scientist Cori Bargmann told me that many of her smartest girlfriends dropped science to go into fields that they felt were more social. These are value decisions that are actually shaped by hormonal effects on the female brain compelling connection and communication.[27]

Many recoil from stereotypes that presume that women are more nurturing than men and that men are more competitive, but these stereotypes have grounding in scientific research.

To add another anecdote, a brilliant friend of mine intended to major in molecular biology as an undergraduate, but became frustrated with the long, isolating hours during an intensive lab course. She wanted a major that provided greater social interaction and had other interests and skills to choose from. She switched to political science, was awarded a Fulbright scholarship, and later attended an elite law school. Could this young woman have been an excellent scientist? Undoubtedly, but since she found the lifestyle associated with academic science unappealing and had other interests and aptitudes, she choose to focus elsewhere. These are just anecdotes, of course, but they are emblematic of the different choices that men and women commonly make and that most everyone recognizes from his or her own experience.

Many recoil from stereotypes that presume that women are more nurturing than men and that men are more competitive, but these stereotypes have grounding in scientific research. Dr. Brizendine describes the different paths of development brains take in utero: fetal brains look the same until eight weeks old when a surge of testosterone suppresses the growth of the communication center in the male brain. That is one reason why women on average end up being more talkative then men.[28]

Differences in focus are evident very early in life. After birth, baby girls focus more on faces than baby boys do; as Dr. Brizendine puts it, girls are "born interested in emotional expression."[29] Even when babies are a year old, there is evidence that girls are more interested in their mothers' approval than boys are;[30] studies suggest that from birth on girls are better at giving and receiving empathy.[31]

Women's greater interest and aptitude for understanding emotions and interaction with other people could be one reason that even women who are interested in science tend to gravitate toward areas that offer greater social interaction (such as psychology) than to disciplines that have a reputation as being more isolated (such as engineering).

Women's greater desire for feedback is not just evident in infancy and childhood, but continues throughout a woman's life. Studies show that women's self-esteem is more directly influenced by the amount and nature of the feedback they receive than men's is.[32] Studies also suggest that men and women have different reactions to competition. Men seek out competition from an early age while women seek more collaborative endeavors. Studies suggest that greater competition increases motivation for men, but not for women.[33]

Studies also suggest that men and women have different reactions to competition. Men seek out competition from an early age while women seek more collaborative endeavors.

It is easy to see how these differences could manifest themselves during course selection. STEM subjects involve less back and forth with professors than seminar -heavy humanities courses. Many contend that grading tends to be harder in quantitative subjects, like math and science, than in more subjective humanities classes.[34] Just the perception that a class or major is particularly challenging could itself contribute to gender disparities. Men may be attracted to the challenging course, while more risk-averse women avoid the potential for a bad grade and the stressfully competitive environment.[35]

Evidence of different temperament and preferences is often discounted as a by-product of discrimination. Those who seek to minimize biology's role tend to argue that it is socialization—the different ways that we treat boys and girls from their infancies—that leads to different behaviors, including women's greater propensity to nurture and seek out more social interaction.

While socialization almost certainly plays a role in our behaviors, evidence suggests that these differences are at least in part hardwired into us. Not only are masculine and feminine characteristics present throughout the world (in both Western and non-Western societies), but they are even present in other mammals:

> The greater dominance-seeking, risk-taking, and aggressiveness seen in male humans is the usual pattern among mammals…Greater spatial ability

> among males is found in a number of mammalian species, including rats, voles, and rhesus monkeys, a pattern thought to be an evolutionary consequence of the greater ranges typically traveled by males. Greater nurturance among females is the rule on mammals, of course. Sex-differentiated toy preferences, which are so commonly attributed to differential socialization, are exhibited even by young monkeys. These patterns are difficult to explain based upon social expectations.[36]

Regardless of whether these temperamental differences are the result of biology or socialization, they play a role in determining how people spend their time and what they choose to study. The authors of the *Beyond Bias* report and some policymakers suggest reforming the disciplines themselves to make them more appealing to women (such as through greater emphasis on mentoring programs and more collaborative processes).

It is possible that such efforts could make these subjects more appealing to women. Yet, assuming that these attributes are at least in part germane to the subject matter itself (that chemical engineering is less social and less of an outlet for nurturing than education or psychology), it is likely that differences in enrollment levels will remain.

Those who discount the role of innate differences and individual preferences in men and women's different participation rates in STEM disciplines tend to believe that the primary cause is discrimination.

Interests and Work-life Priorities

A future paper will consider in more detail how the pressures of family life influence women's decisions about whether—and for how long—to dedicate themselves to STEM fields. While our society is increasingly open to men and women creating a variety of arrangements for caring for dependents (the number of stay-at-home fathers grew from 98,000 in 2003 to 143,000 in 2006),[37] women, including those who work full-time outside the home, still assume the lion's share of responsibility for childrearing.

For many young women, careers in STEM fields likely appear—and in fact are—less amenable to balancing family life compared to other disciplines. There are likely many ways that these fields can change to make careers more hospitable to women (and men who want to spend more time on outside interests, including their families), yet at present it is certainly likely that these considerations contribute to the different participation levels among men and women in STEM fields.

Discrimination

Those who discount the role of innate differences and individual preferences in men and women's different participation rates in STEM disciplines tend to believe that the primary cause is discrimination. Cultural factors, such as the challenges STEM careers present for primary caregivers, are also identified as having an impact, but are in themselves viewed as an outcome of the way our society continues to pigeonhole women and discourage their full participation in arenas like STEM disciplines. As the authors of *Beyond Bias* sum up:

> The present situation of women in scientific and engineering professions clearly results from the interplay of many individual, institutional, social, and cultural factors. Research shows that the measured cognitive and performance differences between men and women are small and in many cases nonexistent. There is no demonstrated connection between these small differences and performance or success in science and engineering professions. Furthermore, measurements of mathematics- and science-related skills are strongly affected by cultural factors, and the effects of these factors can be eliminated by appropriate mitigation strategies, such as those used to reduce the effects of stereotype threat.
>
> Because sex differences in cognitive and neurological functions do not account for women's underrepresentation in academic science and engineering, efforts to maximize the potential of the best scientists and engineers should focus on understanding and mitigating cultural biases and institutional structures that affect the participation of women.[38]

The section "Subtle, Implicit, or Unexamined Bias" highlights that even though explicit discrimination is overwhelmingly condemned, prejudiced attitudes remain. This lingering prejudice can lead to "unconscious and subtle forms of discrimination." This section singles out "differential mass-media portrayals and *de facto* segregation in education and occupations" and explains that "all manifestation of subtle prejudice constitute barriers to full equal treatment."[39]

There has been a great deal of research on the existence and extent of implicit bias. For example, laboratory tests have been conducted that measure people's unconscious reactions to images (Implicit Association Test) and the ease with which they associate various qualities with different groups (for example, white associated with good and black with bad).[40] Such tests have often yielded results showing widespread bias. Yet these tests have failed to make the link that laboratory evidence of bias translates into discriminatory behavior in the real world. In spite of the lack of research that confirms that these tests really are evidence of bias and that this bias affects behavior, some seek to change the legal landscape and adopt policies predicated on the need to root out or mitigate these behaviors. As one study's authors warn: "Our fear is that the stage has been set for an epistemic disaster of minor-epic proportions. Throughout this Article, we have seen how rarely IAR researchers temper their enthusiasm for ferreting out unconscious prejudice with offsetting concerns about the dangers of making false accusations of prejudice."[41]

While the link between evidence of bias and discriminatory behavior may not have been made, as the authors of *Beyond Bias* detail, the effect of bias on victims of discrimination is evident in studies focused on the "stereotype threat." The "stereotype threat effect" refers to the finding that women perform worse on aptitude tests when stereotypes are emphasized than when no suggestion is made: "Taken together, the findings show that activation of negative stereotypes can have a detrimental effect on women's interest and performance in domains relevant to success in academic science and engineering."[42]

Yet while research demonstrates that the stereotype threat can play a role in laboratory settings, it is less clear how this manifests in the real world. Scholars at the University of Minnesota sought to test the applicability of laboratory findings to applied settings by examining the relationship between test scores and outcome criteria.[43] Their research failed to show the stereotype threat effect having an influence in the applied setting, leading the researchers to consider potential reasons that the stereotype threat would be salient in the laboratory setting and not in the real world:

> …A second possibility is that stereotype threat is experienced in both laboratory and applied testing environments but that the effect can be overcome through increased effort and focus when motivation to succeed is high. Thus, in the atmosphere of the laboratory, minority students may have no real motivation to overcome the effects of stereotype threat, and the stereotype threat effect will be observed. The situation may be quite different in high-stakes testing environments. In many of these situations, including the SAT testing situation investigated here, motivation to succeed is arguably high. In such situations, test takers may exert more effort to increase their focus as a response to the significance of the testing occasion. This increased effort and enhanced focus may enable the test taker to overcome the inhibitory influences of the stereotype threat effect.[44]

Yet while research demonstrates that the stereotype threat can play a role in laboratory settings, it is less clear how this manifests in the real world.

These authors do not suggest that the stereotype threat effect theory is wholly invalid, but simply caution "in making premature generalizations to such applied settings."[45] Certainly more research is needed to explore the extent of the stereotype threat's effects in a variety of settings. One question worth considering is, why, if the stereotype threat plays a major role in a group's performance, women (and other groups who have been shown to be affected by the stereotype threat) have been able to overcome the effect of the stereotype threat in some fields and not in others.

This question is worth considering in relation to unexamined discrimination as a whole. Are mathematics and engineering departments much more awash in unexamined bias and stereotypes than biology departments and the business world? There may be more female role models in the latter disciplines today, but consider the rate of change since 1970. In 1970, business management and engineering and computer science awarded less than 2 percent of PhDs to women. By 2001, women received one in three business management PhDs but less than one in five PhDs in engineering and computer science. Progress has been made in both areas, but not at the same rate.

Similarly, women have broken into and achieved near parity in other professions that were once dominated by men. For example, women now earn nearly half of the law degrees awarded compared to just 5 percent in 1970.[46] It is unclear why women would have been able to overcome the stereotype threat or other subtle forms of bias in disciplines such as these while the same barriers in engineering and computer science departments would be so much more difficult to overcome.

In addition to being cautious about conclusions about the prevalence and impact of "hidden barriers," researchers and policymakers should consider the difficulties and potential problems associated with policies created in response to these assumptions.

Beyond Bias's authors confidently claim that "measurements of mathematics- and science-related skills are strongly affected by cultural factors, and the effects of these factors can be eliminated by appropriate mitigation strategies, such as those used to reduce stereotype threat." Yet the authors also acknowledge the difficulty of identifying, let alone rooting out or "mitigating," subtle forms of discrimination.[47]

The proposals to counteract or mitigate this type of "subtle" or "unexamined" discrimination are often broad, with far-reaching implications. As *Beyond Bias* states, "legal scholars have begun to use the term unexamined to describe such discriminatory behavior, arguing that it shifts the burden of proof and acknowledges that such behavior can be changed."[48] Shifting the burden of proof implies that it would no longer be incumbent upon the plaintiff to prove harm, but that the institution itself would have to be able to prove an absence of discrimination—even this difficult-to-identify or document form of discrimination, "unexamined" bias.

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Beyond Bias provides clues as to how an institution can go about eradicating bias and prove that it has done so. The authors write authoritatively: "The main effect of subtle prejudice seems to be to favor the in group rather than to directly disadvantage the out group." They don't elaborate on how this is known, but it seems instead a means to open the door to policies meant to counteract the "advantage" of groups (presumably white males and possibly Asians) who benefit from unexamined bias.

The authors of *Beyond Bias* claim to know what it takes to counteract the forces of this indefinable, but fully culpable, phenomenon: proactive recruiting, teambuilding programs, mentoring, regular evaluations, and family-friendly policies.[50] Yet clearly the authors and policymakers who have attempted to transform these recommendations into legislation recognize that these efforts may not be sufficient. The Gender Bias Elimination Act, for example, while providing grants for programmatic efforts like workshops and recruitment, would also encourage greater government oversight and enforcement of anti-discrimination laws.

According to *Beyond Bias*, the absence of discrimination will not be evidenced merely by the presence of such proactive recruitment and sensitivity training efforts. The elimination of bias will be known by the outcomes it creates, namely "changes in the representation of women and minorities in the student body". In other words, an institution will know that they have eradicated bias when their numbers change. Exactly what number colleges have to reach isn't specified, but allusions to Title IX as an enforcement mechanism and the experience with Title IX in athletics may be a road map for what students can expect for academia.

Title IX: The Law and its Limits

Title IX of the Education Amendments of 1972 prohibits discrimination on the basis of sex in educational programs or activities in all entities that receive federal funds—given that essentially all postsecondary schools receive federal funds (for example, by accepting students using federal financial aid), Title IX applies to the entire college and university system.[51] Title IX applies to all aspects of education; however, thus far, the law has been primarily associated with college athletics.

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Records of the debate surrounding the law's creation show that Congress did not intend to create a quota system through Title IX. Yet the policy interpretation and implementation of the law have created a climate that encourages institutions to embrace the mentality of the quota system. Educational institutions have three mechanisms through which they can demonstrate Title IX compliance:

1. Showing that intercollegiate participation opportunities for male and female students are provided in numbers substantially proportionate to their respective enrollments; or,
2. Showing a history and continued practice of program expansion in response to the interest and abilities of the "underrepresented" sex; or,
3. Demonstrating that the interests and abilities of members of the "underrepresented" sex have been fully and effectively accommodated by the school's program.[52]

Litigation that followed demonstrated that even schools that could provide evidence of meeting the third or second test were vulnerable to an unfavorable result. This left universities with only one way to insulate themselves against Title IX litigation, and that is by complying with the first test and meeting the proportionality requirement.

Schools have two options to try to make the numbers work: they can either try to increase female participation or reduce the number of male athletes. Many have struggled to attract greater female participation. When Brown University was faced with a Title IX lawsuit, there were 93 positions on female varsity teams that were unfilled—had students occupied those spots, Brown's participation rate gap would have been nearly erased. Yet that didn't matter when it came to complying with Title IX. Many universities across the country have taken the other route and attempted to reach parity by cutting men's athletic teams. In total, thousands of men's teams have been cut, decimating many collegiate sports, including men's gymnastics and wrestling.[55]

In 2005, the Department of Education issued clarifying guidance for how to adequately measure student interest in athletics (for example, through carefully conducted student surveys) in hopes of giving universities an alternative method for insulating themselves from Title IX complaints. But the idea of surveys was denounced by feminist activists and has not been embraced by the university community.[56] Even since this guidance was offered, schools have continued to focus on the proportionality goal. For example, in the fall of 2006, James Madison University eliminated seven men's teams along with three women's teams in an effort to comply with Title IX. The school's athletic roster was already more than half female, but since their student body was more than 60 percent female, university officials said they felt the need to make this change to comply with the law.[57]

Some have suggested that Title IX could be similarly used in the academic arena. For example, an article focusing on proposed legislation, the Gender Bias Elimination Act, reported that according to advocates of the bill, it is also intended "to provide a foundation for future Title IX lawsuits against the universities."[58] Reportedly, Department of Education officials have indeed begun investigating academic departments for evidence of gender-based inequities, having conducted an evaluation of Columbia University's physics department in 2007.[59]

While the problems associated with Title IX's enforcement in athletics should give proponents pause, there are additional reasons why the current Title IX regime's application to the academic arena is likely to create numerous additional problems.

Limits for Boosting Enrollment of the Underrepresented Sex

There are important differences between academics and the athletic arena. For instance, in athletics, it is common for men and women to be assigned to different teams. Boys cannot join the girls' soccer team; girls (with few exceptions) do not play men's football. This is based on the understanding that there are physical differences that affect athletic ability: on average, men are stronger and can run faster than women, which would give men an edge in many sports and discourage female athletic participation.

Because of this accepted discrimination, a school could discourage female athletic participation by failing to support women's sports teams. If a school offered solely men's swimming, track, football, tennis, soccer, wrestling, and crew, it would be clear that they were effectively discriminating against women by failing to offer them opportunities to participate in athletics. To encourage greater athletic participation among women, schools could create women-only teams. This practice obviously entails costs (which is why schools often take the easier route of eliminating male teams), but it is a clear method to increase the number of female athletes. It would be more difficult if all athletic teams were mixed-sex, since creating new teams could exacerbate the discrepancy.

Academia is a different situation since, with the exception of single-sex schools, classes are offered to all comers. There would be no justification for a school offering physics classes exclusively to one sex and having no such opportunities for the other. This means that adding students from the desired group—or discouraging students from the undesired group—to reach proportionality would be a more difficult process.

Universities eager to avoid Title IX litigation have slashed men's athletic teams in order to reach the desired mix of male and female athletes, but schools won't have that option for academics. Current proposals to boost the number of women in STEM disciplines have focused on outreach programs, workshops, and diversity training within universities. Yet if those don't do the trick, what other measures might universities resort to in order to increase the portion of women in these courses? It seems possible that universities may have to resort to some very heavy-handed tactics—tactics far beyond an "implicit bias" against men—to achieve parity in STEM fields.

Even the concept's feminist backers should be concerned about such a potential regime since while the focus of discussions about applying Title IX to the academic arena has been on women in STEM fields, there is no reason that this should be so. Women earn nearly eight in ten degrees in education and psychology. At what point will it become untenable to invest solely in efforts to change the gender makeup of STEM fields while ignoring equally lopsided fields that favor women?

Those who seek aggressive Title IX enforcement and who would argue that the only way to know that hidden biases have been compensated for is through the outcome in enrollment haven't defined exactly what would constitute "changes in the representation of women and minorities in the student body". Would colleges be protected from legal challenges only if the number in a target discipline (like STEM) mirrored the gender balance of the student body (as is the case in athletics)? That would require that on many campuses six of ten engineering students would have to be female.

This reality—that women today greatly outnumber men on campus in general—also will present an uncomfortable challenge if we enter a government-monitored academic numbers game. Why would it make sense to have enrollment in each discipline reflect enrollment when enrollment numbers are unrepresentative of the population as a whole?

The potential for costly litigation can quickly turn well-intentioned policy and a desire for diversity into a numbers game and unseemly quota system. If Title IX is aggressively applied to academia, schools may begin seeking ways to steer students to and away from disciplines in order to achieve a politically correct classroom mix. That's hardly a step toward true fairness and equality, as schools and the government officials selectively focus on some cases and subject areas instead of others, and could be counterproductive in terms of encouraging greater efficiency and happiness.

The potential for costly litigation can quickly turn well-intentioned policy and a desire for diversity into a numbers game and unseemly quota system.

Responses by professors who have already been interviewed as part of a government review highlight some of the potential problems. One professor from Columbia University called her interview by government officials "a complete waste of time" and said that she wanted to tell her interviewer to "leave me alone, and let me get my work done."[60] Indeed, the money invested in these conferences and in examining departments for hidden bias is money that could have been used elsewhere. Some universities may think that there is a need for such an investment, but if this money is used solely to satisfy politically correct overseers, then it is surely an unfortunate misuse of limited funds.

INDEPENDENT
WOMEN'S FORUM

Another female professor from Florida State University responded to the article "Can Equality In Sports Be Repeated in the Lab?" by expressing her great concern about the potential of forcing universities to achieve a certain gender-balance or face punishment. She saw such an effort as undermining the legitimacy of the women who do focus on and excel at STEM disciplines. She writes:

> Science…requires a high intellect, interest, opportunity, and a solid education. Lack of the latter two [has] restrained females of past generations, but the gender gap in education and opportunity is closing. Affirmative action may serve to broaden the pool of female scientists, but it will also weaken it—lower requirements naturally mean lower quality. As a result, the old preconception of male intellectual superiority will be reinforced, the status of women in science be reduced, and we will be back to the system that we are apparently fighting. I speak for many satisfied and successful (and therefore quieter) female scientists when I say, "Don't marginalize us![61]

In addition to devaluing those women who truly are interested in and suited for study and careers in STEM fields, efforts to artificially encourage women to pursue this discipline would likely disserve many women. If women are not truly interested in STEM or if they desire an area of study or a career that provides a different environment, then they are unlikely to thrive or achieve as much in STEM as they would have in their area of greater interest.

Non-governmental Efforts to Increase Female Participation in STEM Disciplines

The threat of litigation and aggressive government oversight of the gender makeup on campus is the wrong way to encourage more women to pursue STEM disciplines. Fortunately, numerous private organizations, corporations, and individual colleges and universities offer programs and initiatives to encourage girls and young women to pursue study and careers in STEM disciplines.

For example, the Society of Women Engineers offers hundreds of programs to elementary and high school girls and college-age women that fund everything from computer labs and videos to formal science clubs and mentoring programs. The organization provides scholarships for college women preparing for careers in engineering and computer science. In 2007, the 130 scholarships that were awarded had an estimated value of $400,000. The organization gives yearly awards to "outstanding career guidance programs for collegiate and professional member sections," thus attempting to encourage others to provide support for aspiring female engineers. Their quarterly magazine (*Magazine of the Society of Women Engineers*) highlights the achievements of female engineers in addition to covering issues such as career guidance. In addition to the national foundation, individual chapters on college campuses across the country work to support their students. The Society of Women Engineers receives funding for these efforts from non-profit charitable groups such as the Ford Foundation and corporate sponsors' foundations, including ExxonMobil, The Ford Motor Company, Chrysler, Wal-Mart, Verizon, Dow Chemical, and Halliburton, to name but a few.

One of the notable attributes of the Society of Women Engineers is its multifaceted approach to encouraging women to pursue engineering. They recognize that there is not one factor discouraging women from pursuing these fields and that different women may need different kinds of support. The organization's lengthy list of corporate sponsors suggests that corporations themselves recognize the benefits of encouraging talented individuals to pursue these disciplines.

Individual universities engage in their own efforts to attract and retain female STEM students. Texas Tech University has initiated a program to reach out to students as young as kindergarten, particularly those who would be first-generation college students, to "expose them" to college. In addition to programs reaching out to both boys and girls, Texas Tech's efforts include "Science: It's a Girl Thing," a residential camp for girls, grades in fifth through eleventh grade, which seeks to "dispel myths and misconceptions about science and careers in science".[64]

Women at the Massachusetts Institute of Technology have created their own student-led program, Women's Initiative, to encourage middle and high school girls to pursue engineering and computer science. MIT women travel around the country to excite students about engineering concepts, bring the subject to life by demonstrating projects they have worked on, and provide information on the experience of being an engineering student. The program is supported by individuals as well as corporations such as Cisco, Oracle, and Amazon.com.[65]

Problems with Government Efforts

The National Science Foundation (NSF), an agency of the U.S. government with a budget of nearly $6 billion, primarily supports basic research in science and engineering. However, the NSF also has a program to encourage more participation of women in math and science. As the National Science Foundation describes this effort:

> One of the National Science Foundation's (NSF) key strategic goals is to cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens. … The goal of the ADVANCE program is to develop systemic approaches to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce.[66]

To accomplish this goal, the NSF provides millions of dollars in grants to individual initiatives and programs across the country. Undoubtedly, some of the programs funded accomplish positive things, such as encouraging the recruitment and retention of valuable faculty, yet other grants seem of dubious value and showcase the problems associated with government involvement in the minutiae of academic life.

For example, the University of Colorado at Boulder received more than $3.5 million as an "Institutional Transformation Award" from the National Science Foundation for its "Leadership Education for Advancement Program" (LEAP). According to the abstract on the National Science Foundation's website, LEAP endeavors to improve "the level of managerial and leadership skills possessed by the faculty" to help "reduce the stresses commonly associated with achieving tenure" and ultimately to "accelerate the promotion rate of women faculty by increasing retention rates and making their environment more supportive."[67]

It is unclear why taxpayers, and not the university itself, should foot the bill for this effort.

It certainly may be worthwhile for the University of Colorado to train faculty about and consider policies that would make staff more satisfied with their positions. However, the University of Colorado at Boulder has an endowment estimated at $720 million.[68] It is unclear why taxpayers, and not the university itself, should foot the bill for this effort.

CUNY Hunter College received nearly $4 million for a program "to improve the institutional practices and culture that affect the hiring, retention, promotion, salary, and professional development of women in the natural and social sciences." The focus of this program is to identify and find ways to measure "hidden and subtle" indicators of gender equity. Once these indicators were identified, the program would seek to correct for this unintentional bias by educating "administrators and other evaluators, via workshops and training manuals, about inadvertent gender biases in evaluating and recognizing scientists' contributions and strategies for equalizing men's and women's ability to advance." The final goal listed in the program abstract is "to develop interventions to advance junior and mid-level women scientists via a sponsorship program."[69]

In other words, these millions of dollars are to be used so that the gender-obsessed can comb through science departments in search of any evidence of bias, then hold workshops to indoctrinate faculty in political correctness, and—assuming those workshops and the pressure placed on administrators aren't enough to yield the results in terms of pushing the proper number of women up the ladder—implement other "interventions" to increase women's prominence in the department. This hardly seems as though it is in the interest of science. It may be one thing for the university to elect to use their money on such an exercise, but it hardly seems like the best use of taxpayer money.

There are numerous such examples: Utah State University received nearly $3 million to "reduce assumptions and stereotypes" and change university personnel policies;[70] Virginia Tech received nearly $3.6 million for a program, which among other things provides for retreats and workshops for faculty; the University of Montana received $3.5 million for their initiatives, including the appointment of a "Special Assistant to the Provost for Comprehensive Equity."

Students should be encouraged to consider their range of possibilities and then to focus where their talents and interests lead them.

Undoubtedly, some of these initiatives had positive results. Yet the focus of the programs seems wholly on achieving a preconceived notion of "gender equity" that can only be truly recognized by the outcome of more equal representation, rather than on actually promoting the study of science. Programs that are in the best interest of the university, students, and the public in general would be focused on encouraging the most robust, useful academic inquiry. Students should be encouraged to consider their range of possibilities and then to focus where their talents and interests lead them. Where barriers exist that discourage students from using these talents, they should be torn down. However, these programs seem to go much further in attempting to not just take down barriers but to create artificially insulate pathways to entice the desired group (in this case women) to pursue this particular area of study.

Corporations may in part be motivated by a desire to curry political favor or create an image of corporate responsibility when they give money to programs to support women in science, but it seems that their primary interest is to actually increase the pool of talent in the fields that are so vital to their future. It seems unlikely that these "institutional transformation" programs would receive much support from private entities. Yet that isn't a reason that taxpayers should fund the programs. After all, these universities typically have ample resources at their disposal if they believe that this is a good use of their funds. If the value of these programs is so dubious that universities cannot raise money from private entities and are unwilling to use their own resources, then it seems proper to conclude that they aren't worth the taxpayers' money either.

The good news is that there are private entities that are funding valuable outreach efforts, and if the National Science Foundation wasn't also involved in funding programs, the private sector would likely contribute more. To the extent that the current system yields a suboptimal outcome in terms of use of human capital, then it is in the interest of many parties to change that outcome. The private sector—not the government—is best suited to identify the best methods of addressing these problems without creating unnecessary waste.

Conclusion

Many factors contribute to the different areas of study that men and women pursue. While discrimination and societal expectations may contribute to fewer women than men focusing on STEM disciplines, differences in temperament, innate aptitude, and interests also play a role.

Universities benefit from encouraging all students to pursue the areas of study that best match their talents and interests. To the extent that unnecessary barriers prevent individuals from doing so, the universities should seek ways to improve the system so that their students can best realize their potential. However, schools' efforts should not be geared to meeting a politically correct balance in each discipline area.

Private entities, both non-profit groups and for-profit corporations, recognize the desirability of ensuring that women are encouraged to consider studying and pursuing careers in STEM fields. These efforts, not aggressive governmental action, are most likely to yield the appropriate results of encouraging exploration and opening opportunities to all without coercion or creating artificial incentives that will ultimately be counter-productive for individuals, the universities, and academic inquiry.

Notes

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[4]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 1.
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[8]Diane F. Halpern, Camilla P. Benbow, David C. Geary, Ruben C. Gur, Janet Shibley Hyde, and Morton Ann Gernsbacker, "The Science of Sex Differences in Science and Mathematics," *Psychological Science in the Public Interest*, Vol. 8—Number 1, 2007, p. 29.
[9]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, pp. 513-514.
[10]Diane F. Halpern, Camilla P. Benbow, David C. Geary, Ruben C. Gur, Janet Shibley Hyde, and Morton Ann Gernsbacker, p. 1.
[11]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, p. 511.
[12]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 25.
[13]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 32.
[14]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 35.
[15]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, p. 514.
[16]Ibid.
[17]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 24.
[18]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 25.
[19]Diane F. Halpern, Camilla P. Benbow, David C. Geary, Ruben C. Gur, Janet Shibley Hyde, and Morton Ann Gernsbacker, p. 1.
[20]*Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, p. 41.
[21]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, p. 519.
[22]Leonard Sax, *Why Gender Matters: What Parents and Teachers Need to Know about the Emerging Science of Sex Differences*, Doubleday, New York, 2005, p. 33.
[23]*Why Gender Matters: What Parents and Teachers Need to Know about the Emerging Science of Sex Differences*, p. 99.

[24]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, p. 515.
[25]Kingsley R. Browne, "Women in Science: Biological Factors Should Not Be Ignored," *Cardozo Women's Law Journal*, Vol. 11, 2005, p. 516.
[26]*The Female Brain*, p. 7.
[27]*The Female Brain*, p. 8.
[28]*The Female Brain*, p. 14.
[29]*The Female Brain*, p. 15.
[30]*The Female Brain*, p. 16.
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