

College of Western Idaho

# Equality in STEM

America's Blind Spot

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## **Abstract**

The lack of diversity in STEM occupations and academics is a detriment to the advancement of scientific thought. The state of gender equality in STEM fields in America was examined. A brief history of significant female contributions to scientific advancement is listed to demonstrate the aptitude and brilliance of which women are capable. Cognitive differences between the information processing of men versus women was contrasted, leading to evidence suggesting an inherent difference in interests present along the gender line. The concept of stereotype threat is a negative factor in generating interest in science and math among young girls, but using different teaching approaches can minimize the effect. Women are prejudiced against at the university level of academics and in industry, a concept known as “unconscious bias”. The prejudice of unconscious bias is causing large numbers of women to leave research positions. The current steps taken to prevent discrimination are not enough. The future of American science and math will be more diverse with transparency in academic standards and a restructuring of early child education.

## Equality in STEM: America's Blind Spot

A major problem threatens to undermine America's Science, Technology, Engineering, and Mathematics fields (STEM). The problem is a lack of diversity. Scientists believe that a robust discussion between differing viewpoints is vital to the advancement of science (Reece, et al 24). The discussion between scientists has been the basis of scientific advancement throughout history. From the Stone Age to the Bronze Age, and from the Industrial Age to the Space Age, the level of human understanding and how to use that knowledge through technology defined these eras. The major breakthroughs leading to these developments were through the hard work of brilliant minds with an insatiable curiosity to develop their understanding. These developments build on each other through the advancements of ideas through lifetimes of work. Where would the level of our communications technology be without the insight into relativity that Albert Einstein brought with his studies? Telegraphs may be the standard of communication still. How much time would have been needed to make the breakthrough if Einstein had been born a woman and from an early age believed she could not work in theoretical physics? Our world would look unrecognizably different. But if science is truly in favor of a robust diversity to advance scientific thought, why are there so few women in these fields?

According to the Bureau of Labor Statistics, women compose 47% of the total work force in America, but only 26.1% of computer and mathematical occupations, and 14.1% of the workforce in architecture and engineering fields (34-35). These numbers are up from the 1970s (see figure 1), but the disparities in these numbers indicate that a discussion from multiple viewpoints is not possible in STEM because half of the world population constitutes a fraction of the work force. Women are capable of insight and achievement in science and is demonstrated by the history of female accomplishment in science. In order to maximize the potential for

advancing human civilization to the next stage of scientific understanding and discovery, America must correct the disparity of gender equality in STEM fields. The steps to take to correct the disparity are: acknowledging the history of female contributions to scientific inquiry, understanding the biological differences between male and female cognition, applying techniques to foster interest in science for young girls, and addressing biases present in current academic and scientific fields.

The results of discoveries by women are found throughout the history of academia, though a cursory look into the history of scientific achievement reveals a long list of males being credited for these discoveries. The lack of diversity in the history books may contribute to the feeling that science is more geared to the faculties of the male mind. Yet many historical instances of female achievement that led to advancement can be found, with the lack of properly attributed credit being the real problem. There have been several female recipients of the Nobel Prize in history, but they all have a factor in common: as stated in *The Madame Curie Complex*, “...when we look at the women who won Nobel Prizes before 1970—the Curies, Maria Mayer, Gerty Cori, and Dorothy Crowfoot Hodgkin—we see that their close proximity to elite male scientists was a factor in their science-winning distinction,” (Jardins 163). A few cases of acknowledgment of female contributions are found in history, but they are often relegated to being assistive roles for the men of science, or ignored outright. Most exemplifying is the case of Rosalind Franklin. Her work in x-ray crystallography led to the acceleration of Watson and Cricks’ construction of the DNA model, through insight gleaned from the viewing of Franklin’s data and photos without her knowledge. Had she published her findings sooner, she would almost certainly have been one of the recipients of the Nobel Prize claimed by Watson, Crick, and Wilkins. Franklin did not expect to be circumvented by her colleagues. The sexist

environment of Kings College where she worked in proximity to the Crick and Watson team was nothing like the freedom of expression Franklin had experienced during her studies in Paris, and she was an outcast in the new environment of London (Jardins 180-195). Gender disparity is echoed in several cases documented in an article on *National Geographic*, the first being Jocelyn Bell Burnell, who discovered pulsars in 1967. Burnell's work in analyzing the radio signals resulted in a Nobel Prize—for Anthony Hewish, her supervisor, and Martin Ryle. Yet another instance is that of Chien-Shiung Wu, the woman who helped disprove the law of parity and assisted in the development of the atom bomb. Her experiments with cobalt-60 led directly to the 1957 Nobel Prize, but not for her. Tsung-Dao Lee and Chen Ning Yang, the two theoretical physicists who approached Wu for her help, claimed that prize (J. Lee). Both of these cases, along with that of Rosalind Franklin, illustrate how women have been marginalized in history even with their demonstrative capacity for brilliance time and again.

A logical question for the discrimination of women in science is: are there any biological justifications for the low numbers? The answer is a qualified yes. In studies of young children and infants, a gender-based difference in aptitudes appears to be in the skills of *systemizing* and of *empathizing*. As Baron-Cohen states, “. . . ‘systemizing’ is the drive to analyze the variables in a system to derive the underlying rules that govern its behavior” (11). Children appear to prefer toys that engage diverge along the difference in their interests. Boys are more prone to roughhouse and play with toy cars and LEGO bricks to build with (toys that can be systemized) and girls prefer activities that include socialization. Girls seem to be more comfortable with eye contact at early ages. While the empathizing can be attributed to how children are raised to behave according to their gender, it appears not to be the only factor. Evidence suggests an inherent interest in systemizing is seen in males as young as one-day old, in male babies

spending more time watching a mechanical model, while female babies would spend their time watching a human face (18). While the test demonstrates an inherent interest that divides along gender lines, the test also measures no actual aptitude. Critics can use the information to reinforce their position that women do not belong in scientific fields, but a gap in the interest levels of women is explained by the tendency of people to follow their aptitude to guide their interests, entering fields in which they are most skilled.

Do the results of Baron-Cohen's studies mean that STEM is correlating appropriately to human physiology? Not according to a study by David Tzuriel and Gila Egozi. A key part of the systemizing described by Baron-Cohen is spatial ability. The ability that most differentiated between the sexes was mental rotation, or the ability to "...maintain a three-dimensional object in working memory while simultaneously transforming it..." (Tzuriel 1418). The study of first graders sought evidence whether gender differences on age-appropriate mental rotation tasks existed, and to what degree training of visuospatial skills had to reduce gender differences. The results of the \ experimental training showed the performance gap narrowed significantly while the control group did not. The percentage of improvement from pre- and post-training showed the girl group improving much more than the boys (1423). These findings show that by addressing the inherent difference in male and female cognition, the advantage in systemizing that is shown by males is reduced. The girls can succeed as much as the boys with the right encouragement and training. Female success is shown again in similar studies of a group of American biology teachers who had been "...particularly successful in encouraging children to study science—including the girls." These teachers were more likely to include hands-on training that could have emphasized spatial skills, and in doing so, "sex differences virtually disappeared" (Birke 320). The biological differences in the sexes can easily be mitigated with the

right approach, so policy changes incorporating these new tactics are key to increasing the amount of women in STEM fields. If girls are not discouraged from science, they can develop the cognitive skills to succeed. Noted astrophysicist and science popularizer Neil deGrasse Tyson related stories of his rise in academia as a minority when asked during an interview about the role of biological differences in the lack of women in science. Tyson said:

I have never been female. But I have been black my whole life . . . What is the blood on the tracks that I happened to survive that others did not? Simply because of the forces of society that prevent it at every turn . . . So my life experience tells me that when you do not find blacks in the sciences, when you do not find women in the sciences, I know that these forces are real, and I had to survive them to get where I am today. So before we start talking about genetic differences, you have got to come up with a system where there is equal opportunity. Then we can have that conversation. (Center For Inquiry)

And equal opportunity is the crux of the issue. The information in the research is not intended to state that women must be promoted to faculty in universities, or that they necessarily need to be hired over other qualified applicants. The case is women interested in these STEM fields must be given equal opportunity to learn and excel. The problem with the equality and empowerment is that an unconscious bias exists that must be dealt with to provide a level playing field.

How does “unconscious bias” affect women in STEM? By eroding the trust needed to build scientific knowledge. The human race now has enough knowledge that verifying and testing every component of empirical evidence is now impossible. Scientists and researchers must rely on each other’s “division of cognitive labor” and trust of one’s colleagues is “the only alternative to either ignorance or stagnation” (Rolin 202). Trust is not easily earned when unconscious bias is integrated into the minds of many people, even those who would be for the

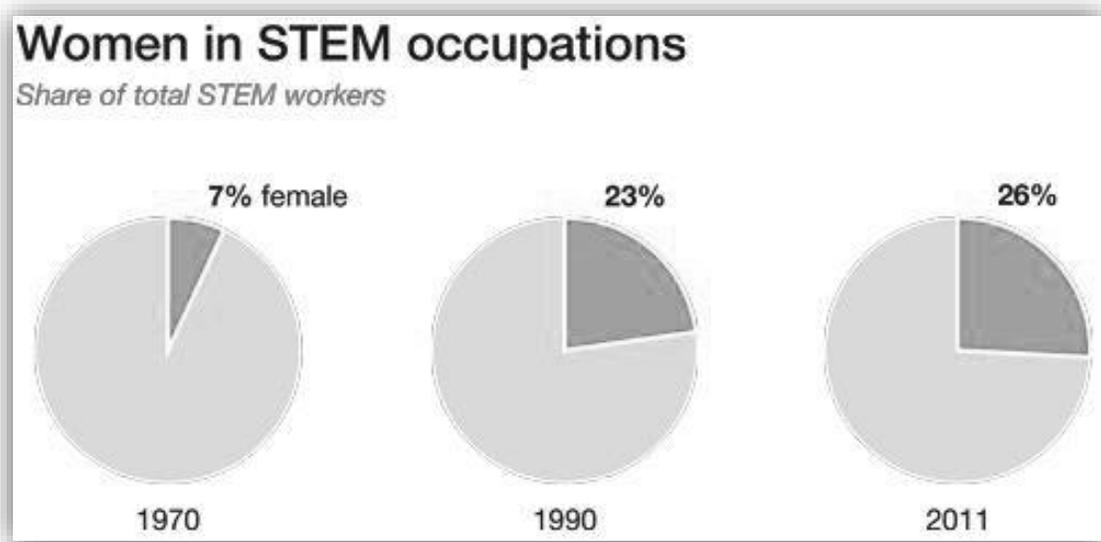
diminishing of the gender gap. According to research by the American Association of University Women, implicit bias contributes the negative effect in academia and the work place, “even among people who support gender equity” (Hill, et al 28). manifests as a polite refusal to acknowledge the thoughts and contributions of female colleagues, as shown in the environment of Boise State University. Dr. Janelle Wharry is an assistant professor of material science, and she recounted instances of dismissal in her interactions with colleagues:

There is definitely an unconscious bias in my department . . . there are several female faculty and several male faculty, and a when females voice an opinion about something, the overall [response] is, ‘Okay, thanks for sharing... Hey, guys: what do you think about [the problem]?’ Instead of actually listening to what we have to say . . . [male colleagues seem to say to the females] you probably don’t know what you are talking about, so what do the males think.

But whether conscious or not, the negative behavior is setting back the rights of women, and the progress of potential scientific breakthroughs. According to Dr. Wharry, the attitudes of the incumbents in academia are persistently regressive even though they are required to take training and awareness programs to curtail gender minimization. Gender bias can negatively affect evaluation by superiors, leading to talent that is undervalued and denied access to crucial resources, and leads to disheartenment about careers in science that lead to eventual drop outs (Cozzens 351). Many women in research change fields in less than a decade of work in academia, and while assistant professorships are equalizing, women still “[do not attain] full professorships or upper administration positions as often as men” (Easterly and Ricard 62). The disheartening quickest fix to the discrimination of women in scientific publications is to use initials instead of first names to mask gender when reviewed for tenure opportunity or

promotion. The percentage of women accepted for publication increased when the manuscripts were evaluated under a double blind review (Easterly and Ricard 68). Gender discrimination is real in STEM, and one of the leading causes of women leaving research and academic careers.

The presence of a force of oppression in STEM fields is real. An environment of dismissal is rampant even though empirical evidence of women's aptitude in science and reasoning is plentiful. Everyone in STEM must address unconscious bias from colleagues to superiors for the human rights issues of gender equality. The way to correction is by acknowledging the role of female scientists throughout history and framing them as positive role models, by a re-evaluation of how science is taught to young children to minimize stereotype threat and allow all those interested in science to feel free to pursue those careers, and to educate the people in power at university and industry environments, along with establishing clear guidelines to advancement and publication that are independent of the applicant. If these goals are accomplished, humanity will thrive in a brave new world of gender empowerment, knowing that the *idea* is king (or queen!) and not the chromosome pairing of the thinker. Insight into chromosome pairing is better understood thanks to the diligent work ethic and scientific acumen of a woman named Rosalind Franklin. Know her name and spread her story, and let the future women in STEM know their ideas will not be discounted.



**Figure 1: *Small Growth*.** Despite modest increases since 1970, there is a long way to go for equality in STEM. Source: US Census Bureau.

### Works Cited

- Baron-Cohen, Simon. "Why So Few Women in Math and Science?" *The Science on Women in Science*. Ed. Christina Hoff Sommers. Washington, DC: AEI, 2009. 7-23. Print.
- Birke, Lynda. "In Pursuit of Difference: Scientific Studies of Women and Men." Ed. Muriel Lederman and Ingrid Bartsch. *The Gender and Science Reader*. London: Routledge, 2001. 309-22. Print.
- Bureau of Labor Statistics, US Department of Labor. *Women in the Labor Force: A Databook*. Washington, DC: US Government Printing Office, 2014. Web. 15 Feb. 2015.
- Center For Inquiry. "Panel Discussion: Dawkins, Tyson, Druyan, Stenger, Grothe." Online video clip. *YouTube*. 21 Jul. 2009. Web. 15 Feb. 2015.
- Cozzens, Susan E. "Gender Issues in US Science and Technology Policy: Equality of What?" *Science and Engineering Ethics*. 14:345-356 (2008). *ERIC*. Web. 08 Feb. 2015
- Easterly, Debra M., and Cynthia S. Ricard. "Conscious Efforts To End Unconscious Bias: Why Women Leave Academic Research." *Journal of Research Administration* 42.1 (2011): 61-73. *ERIC*. Web. 27 Jan. 2015.
- Hill, Catherine, et al. "Why So Few? Women in Science, Technology, Engineering, and Mathematics." *AAUW* (2010): *ERIC*. Web. 27 Jan. 2015.
- Jardins, Julie. *The Madame Curie Complex: The Hidden History of Women in Science*. New York: Feminist Press at the CUNY, 2010. Print.
- Lee, Jane J. "6 Women Scientists Who Were Snubbed Due to Sexism." *National Geographic*. National Geographic Society, 19 May 2013. Web. 08 Feb. 2015
- Reece, Jane B., and Lisa A. Urry. *Symbiosis: The Pearson Custom Library for the Biological Sciences Based on Campbell Biology*. Second ed. Print.

Rolin, Kristina. "Gender Equality in Science: A Philosophical Perspective." *Higher Education in Europe*. XXV.2 (2000): 201-5. Web. 01 Feb. 2015.

Tzuriel, David, and Gila Egozi. "Gender Differences In Spatial Ability Of Young Children: The Effects Of Training And Processing Strategies." *Child Development* 81.5 (2010): 1417-1430. *Academic Search Complete*. Web. 8 Feb. 2015.

Wharry, Janelle. Personal Interview. 17 Feb. 2015.

## Bibliography

- Baron-Cohen, Simon. "Why So Few Women in Math and Science?" *The Science on Women in Science*. Ed. Christina Hoff Sommers. Washington, DC: AEI, 2009. 7-23. Print.
- Birke, Lynda. "In Pursuit of Difference: Scientific Studies of Women and Men." Ed. Muriel Lederman and Ingrid Bartsch. *The Gender and Science Reader*. London: Routledge, 2001. 309-22. Print.
- Bureau of Labor Statistics, U.S. Department of Labor. *Women in the Labor Force: A Databook*. Report 1052. Washington, DC: US Government Printing Office, 2014. Web. 15 Feb. 2015.
- Center For Inquiry. "Panel Discussion: Dawkins, Tyson, Druyan, Stenger, Grothe." Online video clip. *YouTube*. 21 Jul. 2009. Web. 15 Feb. 2015.
- Cozzens, Susan E. "Gender Issues in US Science and Technology Policy: Equality of What?" *Science and Engineering Ethics*. 14:345-356 (2008)
- Easterly, Debra M., and Cynthia S. Ricard. "Conscious Efforts To End Unconscious Bias: Why Women Leave Academic Research." *Journal of Research Administration* 42.1 (2011): 61-73. *ERIC*. Web. 27 Jan. 2015.
- Hill, Catherine, et al. "Where The Girls Are: The Facts About Gender Equity in Education." *American Association Of University Women* (2008): *ERIC*. Web. 27 Jan. 2015.
- . "Why So Few? Women in Science, Technology, Engineering, and Mathematics." *American Association Of University Women* (2010): *ERIC*. Web. 27 Jan. 2015.
- Jardins, Julie. *The Madame Curie Complex: The Hidden History of Women in Science*. New York: Feminist Press at the CUNY, 2010. Print.

- Jones, Jenny. "Closing the Gender Gap". *Civil Engineering*. 80.7 (2010): 60-63. *ERIC*. Web. 04 Feb. 2015.
- Kalayci, Nurdan and Fahriye Hayirsever, "An Analysis of Citizenship and Democracy Education Text Book in the Context of Gender Equality and Determining Students' Perceptions on Gender Equality." *Educational Sciences: Theory & Practice*. 14(3): 1065-1072 (2014).
- Lee, Jane J., "6 Women Scientists Who Were Snubbed Due to Sexism." *National Geographic*. National Geographic Society, 19 May 2013. Web. 08 Feb. 2015
- McCullough, Laura. "Women's Leadership In Science, Technology, Engineering And Mathematics: Barriers To Participation." *Forum On Public Policy Online*. 2011.2 (2011): *ERIC*. Web. 27 Jan. 2015.
- McNeely, Connie L., and Sorina Vlaicu. "Exploring Institutional Hiring Trends of Women in the U.S. STEM Professoriate." *Review of Policy Research* 27.6 (2010): 781-793. *Business Source Premier*. Web. 27 Jan. 2015.
- Rawat, Preeti S. "Patriarchal Beliefs, Women's Empowerment, and General Well-being." *Vikalpa: The Journal for Decision Makers* 39-2, (43-55).
- Reece, Jane B., and Lisa A. Urry. *Symbiosis: The Pearson Custom Library for the Biological Sciences Based on Campbell Biology*. Second ed. 26. Print.
- Rolin, Kristina. "Gender Equality in Science: A Philosophical Perspective." *Higher Education in Europe*. XXV.2 (2000): 201-205. Web. 01 Feb. 2015.
- Seal, Lizzie. "Pussy Riot and feminist cultural criminology: a new 'Feminism in Dissent'?. *Contemporary Justice Review* 16.2 (2013): 293-303. *CWI Library Database*. Web. 04 Feb. 2015.

- “Sisters of the Sun.” *Cosmos: A Spacetime Odyssey*. Writ. Ann Druyan and Steven Soter. Dir. Brannon Braga. FOX. 27 Apr. 2014. *Netflix*. Web. 01 Feb 2015.
- Shankar, Vedantam. “Why Aren’t More Girls Attracted to Physics?” *Morning Edition (NPR)* (2013): *Newspaper Source Plus*. Web. 27 Jan. 2015.
- Tzuriel, David, and Gila Egozi. "Gender Differences In Spatial Ability Of Young Children: The Effects Of Training And Processing Strategies." *Child Development* 81.5 (2010): 1417-1430. *Academic Search Complete*. Web. 8 Feb. 2015.
- UNESCO. *UNESCO’s Promise: Gender equality – a Global Priority*. Paris, France: The Division for Gender Equality, 2014. Web. 04 Feb. 2015.
- Wharry, Janelle. Personal Interview. 17 Feb. 2015.
- Zielinski, Sarah. “Ten Historic Female Scientists You Should Know.” *Smithsonian*. Smithsonian.com, 19 Sep. 2011. Web. 08 Feb. 2015.