Exploring Diversity

Gender Stereotypes in Science Education: Issues and Implications

Jamael Sadallah

Dr. Suzanne MacDonald

5100:604 – 801

April 17, 2011

Abstract

Today, America faces a disheartening imbalance of males and females in the science, technology, engineering and mathematics (STEM) fields, with sometimes as little as 20% female representation in particular subjects, and the numbers only decline when considering higher graduate degrees (Hill, Corbet, and Rose, 2010). There are obvious differences in the way males and females act and think, but there is ongoing debate about whether these gender differences are innate or culturally absorbed. In truth, these differences are likely both physiological and environmental. Though many gender differences are seemingly harmless, some can be rather detrimental. Nevertheless, an underrepresentation of females in the STEM fields can be dangerous both to our economy and to our own families (Hill et al., 2010). Although the physiological differences of boys and girls cannot be changed, we can manipulate the learning environment to be more female-friendly in the STEM fields, hopefully encouraging the advancement of women and the use of their heads and hands in research and design.

Introduction

I chose this topic out of a combination of intrigue and concern for the Science, Technology, Engineering, and Mathematics (STEM) fields. I knew that females were grossly underrepresented in these fields and wanted to know why and if it was of concern. I come from a science background and have seen first-hand the imbalance of men and women. I never found it to be a problem, I just felt as though I was different and therefore stood out. I thought that standing out would help me get a job or a position in graduate school in the future, so I was never really concerned about the blatant gap in numbers. I did actually get a job in a science/engineering field and quickly realized how large the gap was when I was the only female engineer in the company's entire United States branch. When I began my path in education a few months ago, I started to question these underlying reasons for the STEM gender gap and what implications they have for our students. Why do we have so many men in STEM fields? Are educators unintentionally scaring girls away from the sciences? What are the consequences of this incredible achievement gap? And most importantly, can we fix them?

Discussion

What seems to be the problem?

Although the male/female gap in STEM has been closing over the last few decades, we still face inequity in representation and median salary. According to a 2007 survey conducted by the Massachusetts Institute of Technology (MIT), women faculty do not initially notice a gender bias at the beginning of their career. They seem to get paid comparable to the new male faculty and they seem to gain the same amount of respect from their superiors and coworkers. However, tenured senior female faculty claim that as they become more successful in their careers, the bias becomes much more apparent and measurable. This same group of faculty said that they too

experienced equity early in their careers, but it soon withered and the gap between men and women only grew with time (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007).

Another incident in 1996 at MIT shows us once again that this inequity exists even just in subtlety. A group of female faculty charged the university with sex discrimination, seemingly out of nowhere. The charge came as a surprise to the university, but once the female faculty had made their case, it forced MIT to reconsider how it treated its science faculty. They had pointed out that there were 22 women to 252 male science faculty members. In addition, the women were paid considerably less, were given less lab space and less research assistants than the men of equal position and experience. MIT quickly made some changes, but just like our middle school and high school teachers, they had created a sexist environment without even realizing it (Vilhauer, 2004).

The problem with underrepresentation is much more significant than feeling left out or unpicked for the team. Without the specific viewpoints and considerations of female minds in STEM fields, the consequences can and have already proven to be devastating. The detrimental effects of a gross lack of females in engineering occurred when the early generation of voice recognition software had debuted. The technology was designed by male engineers and therefore calibrated with a typical man's voice. It was unable to recognize the higher pitches in a woman's voice and literally left 50% of our population forgotten and "unheard." Similarly, air bag technology had been designed to protect a person with the physique of a grown man. Countless preventable deaths of women and children occurred from this lack of consideration. Had women been on the design team, they could have addressed these fatal issues before it was too late for some (Hill et al., 2010).

How did it get this bad?

Strides have been made to close the achievement gap over the years, but clearly some underlying issues are still not being addressed. Manning (1998) suggested that whatever is turning girls away from science is happening in early high school. Test scores in 1998 of 4th, 8th, and 12th grade students showed that girls' and boys' science scores on standardized tests were comparable in 4th and 8th grade. However, the 12th grade scores showed a considerable gap, with girls falling tremendously behind the boys in science. As much as we would like to think that the situation has gotten better over the years, Nosek et al. (2009) looked at the same set of data a decade later and noticed that this time, the gap occurs in the 8th grade scores.

Admittedly, female scientists do not have to be born in 8th grade. Many females in STEM choose their field in college. This suddenly brings responsibility to the university science professors, now with the request to recruit new female scientists where the educational system has already failed. In my own experience, university professors are actually very good at this. A friend of mine told me that she always appreciated science, but was never encouraged by her middle school and high school teachers to pursue it. They all told her she would be great in some kind of creative field like Art or English. It was not until her first visit to college, a Geology professor showed her around and told her about what a career in Geology was like. She chose to study Geology her first semester in college, and is now attending graduate school for a Masters in Science in Structural Geology (_____, personal communication, April 3, 2011). However, it should not be the university's responsibility to salvage the female population in STEM. Recognition of ability and achievement is only one of many steps. The issue of self-worth and self-achievement should really be addressed in secondary school.

There are three possible problems suggested by Manning (1998) with how we handle science classes in middle school and high school. The first is that we tend to water down our science curriculum compared to other classes. Instead of teaching science as an entity, science is taught as fact memorization with little acknowledgement of how one topic relates to the next. The second problem is that science teachers try to make every student into a scientist. As a scientist, I can understand this mentality. Unfortunately, it is an unreasonable expectation and thus, changing the objective to "make students appreciate the importance of science" may be an appropriate solution. The third problem high school and middle school science classes face is that often the teachers are unfamiliar with their audience. They are either uncomfortable with the material being taught and therefore interact less with the students in fear of exposure, or they cannot successfully communicate the information in a way that the students understand it.

Although a large community of scientists believe that gender differences, especially those regarding science education are cultural, or environmentally learned, there are still others that believe that these differences are purely biological, even evolutionary. Data from PET and MRI scans show that males have more blood flow into the parts of the brain that control spatial reasoning. Similarly, females have more blood flow into the areas that control language and sensory reasoning (Gurian, 2010). This physiological difference in brain anatomy can be interpreted as evolutionary, dating back to when humans were hunters and gatherers. According to anthropological studies, males and females were much closer in size (muscle mass, height, body fat, etc.) than they are today. Men were hunters, an aggressive, active, and spatially demanding occupation. Meanwhile, the women were gatherers and caregivers, an occupation demanding keen sensory awareness and communication skills. These demands were reinforced over time and have become part of our evolutionary DNA. However, although these differences

are inherent and natural, it does not mean that they cannot be overcome (Gurian, 2010). It is still our responsibility as educators to give each student the opportunity to achieve, and reinforcing that "boys are better at math" is enough to affect the girls' performances on math and engineering exams (Nosek et al., 2009).

Can we reverse the damage?

When analyzing the research results of the cultural versus biological debate of gender differences in the classroom, most researchers will agree that in fact, both sides need to be taken into consideration when developing an escape route. As hard evidence suggests that humans have a tendency to excel in certain subjects based on their gender, small variability can translate to huge gaps in test scores with negligence (Linn & Hyde, 1989). Teachers unintentionally feed the message that "science is not feminine" to their students, and as environmental sponges, the students behave in a way that fulfills these expectations (Kahle, Parker, Rennie, & Riley, 1993). Two similar studies were done in the early 1990s in Australia and the United States that observed science teachers in the classroom. Although every teacher claimed that he/she did not favor neither girls nor boys in their classrooms, each one showed signs of male favoritism. In skills-only workshops, sexism became apparent in subtle acts like offering assistance to groups of girls more often than groups of boys, and initiation of more interaction about the subject matter with the groups of boys (Kahle, et al., 1993). Just like the MIT case, many teachers do not even realize that they are contributing to the problem.

Research shows that reversing the damage of the monster we have created is much more difficult than anticipated. The problem has been apparent for decades and although we have made considerable progress, the damage not only requires repair, but also maintenance. In an interview with a high school science teacher, I learned that the problem is much bigger than just

science test scores. In fact, this teacher says that boys seem to be more interested in science than girls, but girls tend to get better grades. He attributes this to complete apathy in high school boys and struggles with finding appropriate measures to motivate these students (____, personal communication, April 6, 2011).

To create a healthy classroom environment for all of our students, we need to use culturally responsive teaching. Culturally responsive teaching recognizes the role that each student's real life encounters contribute to the classroom and overall learning experience (Kroeger & Bauer, 2004). By responding with this method, we can better relate curriculum to our students and better understand how they might receive it. To apply this concept specifically to science education, we need to recognize the role that women play in the history of science to better promote female participation in STEM fields. Textbooks often overlook female contributions in science and therefore, straying from the textbook may be necessary. For instance, before women were viewed as equals in society, women scientists and writers were forced to publish their work under a male pseudonym or even pass off their work to men for publication (Gollnick & Chinn, 2009). Even the simplest of lessons may require some extra research by the teacher to uncover a woman's work, but perhaps this extra effort is just what we need to turn this problem around.

Conclusion

Research shows that although many gender differences are evolutionary and inherent, cognitive differences are minor but exaggerated by environmental reinforcement. Teachers often unintentionally contribute to the problem of sexist favoritism in science classrooms. Proof of this gender bias manifests itself in test scores that show a tremendous achievement gap in girls when compared to their male peers. However, the need for female representation and equity in

the STEM fields is much more significant than the fact that “we just need more women.” History has shown that without female representation and perspectives in STEM, the consequences are detrimental, and even in some cases fatal. Not only does our educational system need to change perceptions about girls in science, but also the STEM industries contribute to female inequity in pay and resources. Admittedly, the working industry has made some improvements over the years, but unfortunately our schools still have considerable work to do in preparing more females in STEM. This achievement gap is still apparent after decades of awareness and is disheartening that the problem continues to persist.

References

Committee on Maximizing the Potential of Women in Academic Science and Engineering. (2007). Viewpoint 5: removing bias in academic science and engineering will narrow gender barriers. In Miller, K. (Ed.) (2010). *The achievement gap* (pp. 201-209). Farmington Hills, MI: Greenhaven Pr.

Gollnick, D.M., & Chinn, P.C. (2009). *Multicultural education in a pluralistic society*. Columbus, OH: Prentice Hall.

Gurian, M., & Stevens, K. (2010). *Boys and girls learn differently! a guide for teachers and parents*. San Francisco, CA: Jossey-Bass.

Hill, C., Corbett, C., & Rose, A. (2010). *Why so few?: women in science, technology, engineering, and mathematics*. Washington, D.C.: AAUW.

Kahle, J.B., Parker, L.H., Rennie, L.J., Rily, D. (1993). Gender differences in science education: building a model. *Educational Psychologist,* 28 (4), 379-404.

Kroeger, S.D., & Bauer, A.M. (2004). *Exploring diversity: a video case approach*. Columbus, OH: Prentice Hall.

Linn, M.C., & Hyde, J.S. (1989). Gender, mathematics, and science. *Educational Researcher,* 18 (8), 17-19, 22-27.

Manning, M. L. (1998). Gender differences in young adolescents' mathematics and science achievement. *Childhood Education*, 74 (3), 168-171.

Nosek, B.A., Smyth, F.L., Sriram, N., Lindner, N.M., Devos, T., Ayala, A., Bar-Anan, Y., Bergh, R., Cai, H., Gonsalkorale, K., Kesebir, S., Maliszewski, N., Neto, F., Olli, E., Park., J., Schnabel, K., Shiomura, K., Tulbure, B.T., Wiers, R.W., Somogyi, M., Akrami, N., Ekehammar, B., Vianello, M., Banaji, M.R., Greewald, A.G. (2009). National differences

in gender – science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences*, 106 (26), 10593-10597.

Vilhauer, S. (2004). *The science glass ceiling: academic women scientists and the struggle to succeed*. New York, NY: Psychology Press.

The Plan

I think that the best way to increase science participation in girls is to get them more involved and excited about the subject. Research has shown that subtlety is the best approach in dealing with female participation in science education. High school is where girls start to feel alienated in the sciences and choose to focus on other subjects. This means that high school is the window of opportunity to engage all students, especially female students in STEM. My plan is to be the faculty advisor for a high school science club. As a woman, I hope to inspire and encourage other young women to join the science club, get more involved in their school, and learn about how exciting science can be.

I did not join science club when I was in high school because I felt like it was a place for boys to hang out and blow stuff up. Unfortunately, that is what most science clubs are like. I would like to do activities that would interest girls as well, not just talk about gross creatures, blow things up, and make robots. I might want to do activities like growing crystals, making homemade ice cream out of salt, water and milk, or using household items as acid/base indicators in my science club. Of course, blowing things up has always been a favorite pastime of scientists, so we may still do some classic experiments involving rockets and volcanoes. I just want to make sure that girls will enjoy science and will not be deterred from getting involved like they have in the past.

My goal is to recruit more girls into the sciences, not to discourage boys from what they already love. I hope that an element of diversity will attract everyone and celebrate everyone's interests and experiences. I also hope to be a positive role model for girls that are interested in STEM and act as a mentor to guide them through high school. I can relate to these young

women personally because I grew up always enjoying science, but unable to connect with other girls my age also interested in science.

I hope that my science club will accomplish three things. First, I want it to attract *all* students, boys and girls, through the activities we do and the methods for doing them. Second, I want it to be a safe haven for all students, so they feel comfortable and can trust that science club is a place to have fun and enjoy themselves. And lastly, I hope science club members will form a camaraderie that I experienced as an undergraduate at Kent State University. These three elements should be a successful formula for contributing to closing the gap between male and female science interests and test scores.