Effective Strategies to Increase Girls' Success in STEM Education

Nicole Sowers partnered with the San Francisco Department on the Status of Women to complete this project in partial fulfillment of the requirements of the Master of Public Policy program at Mills College. The judgments and conclusions are solely those of the author and are not necessarily endorsed by the SF DOSW or Mills College.

Significance

During the next five years, the United States' demand for science, technology, engineering and math (STEM) workers is expected to increase at twice the rate of all other occupations (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). A strong STEM workforce is necessary to expand the nation's innovative capacity and economic competitiveness. As technology continues to advance at a rapid rate, STEM skills, and computer science skills in particular, are becoming increasing relevant across other disciplines.

All students in the United States need a robust STEM education to prepare them for 21st century success. Unfortunately, our schools are currently falling short of equipping students with the STEM skills they need. A 2007 study found that 80% of K–5th grade Bay Area teachers responsible for teaching science in their classrooms reported spending 60 minutes or less per week on science, with 16% of teachers spending no time at all on science (Dorph, Goldstein, Lee, Lepori, Schneider, & Venkatesan, 2007).

Status of Women in STEM Nationwide

Though women comprised 48% of the 140,638,000 total U.S. workers and 43% of the full time workforce in 2009, they filled only 24% of the 7,430,000 STEM jobs (Beede et al, 2011; DeNavas-Walt, Proctor, & Smith, 2010). This is in spite of the fact that women's share of the college-educated workforce has increased over the past decade. Between 2000 and 2009, women's share of all college-educated workers increased from 46 to 49 percent while their share of the STEM workforce remained constant at 24%. Thus, women's underrepresentation in STEM fields is not an issue of lower educational attainment or lesser workforce participation.

In recent years, women are much less likely than men to major in STEM at the college level. In computer science specifically, there has been a dramatic decline: women earned 37.1% of bachelor's degrees in computer science in 1984, but that proportion dropped to only 18.2% in 2010 (National Science Foundation, 2013; Camp, 2001).

STEM Course Enrollment by Gender in SFUSD

Figure 1: Non-AP Computer Course Enrollment by Gender in SFUSD and California, 2011-2012

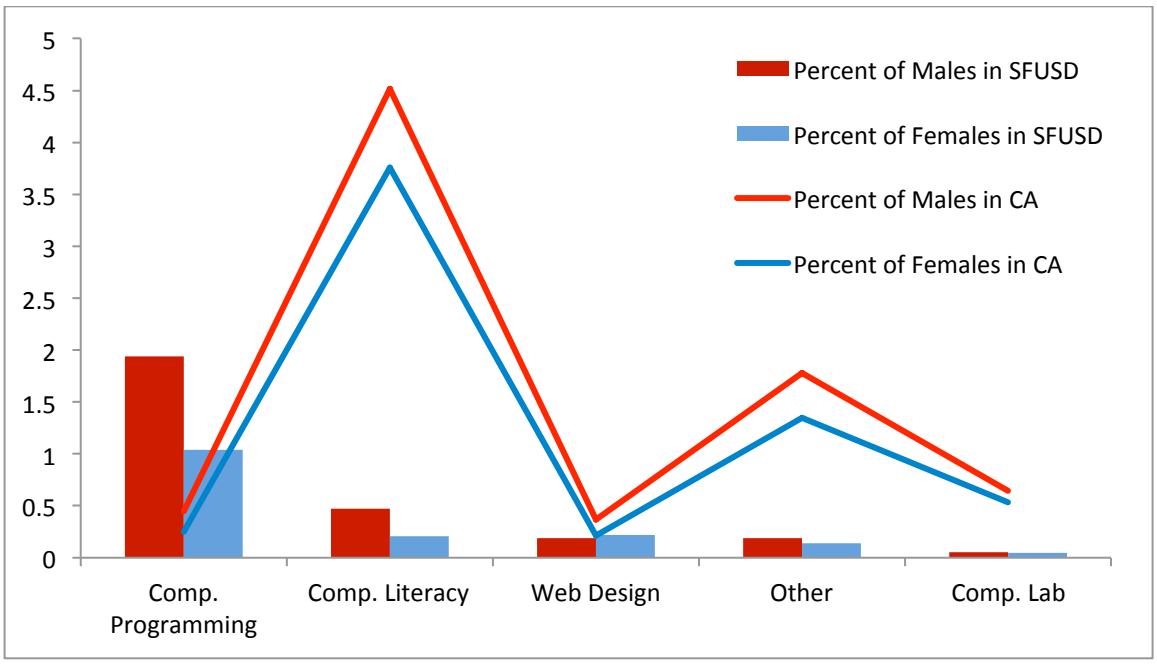

Figure 2: Non-AP Math Course Enrollment by Gender in SFUSD and California, 2011-2012

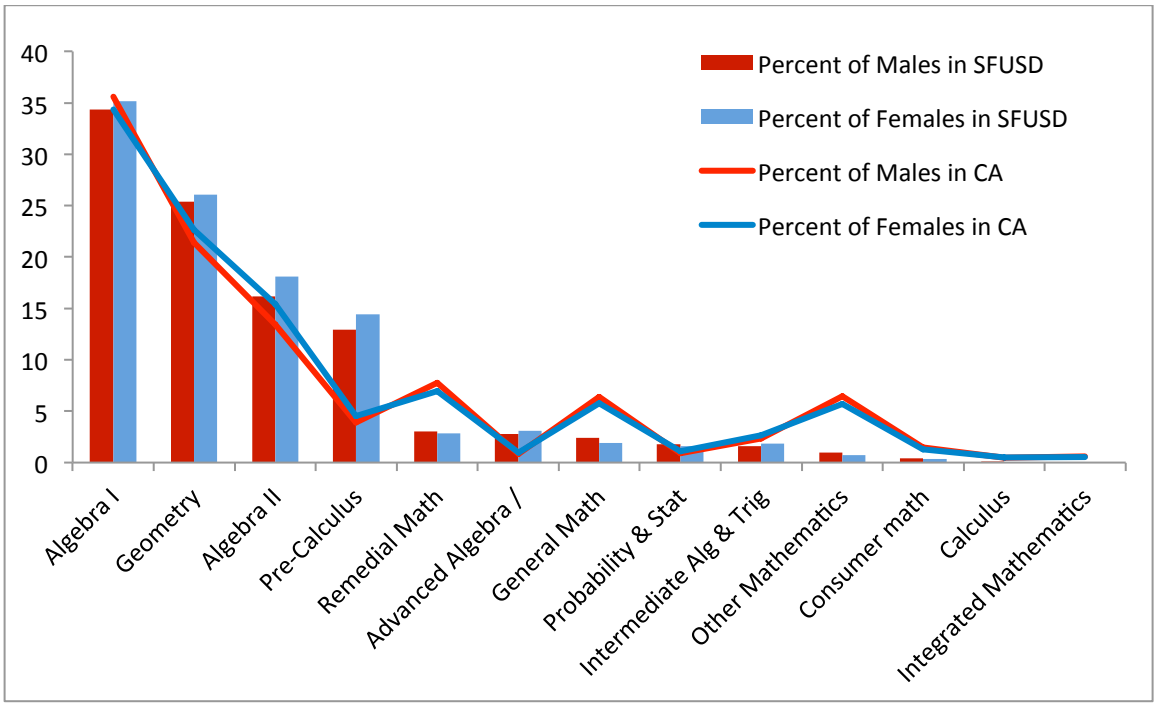

Figure 3: Non-AP Science Course Enrollment by Gender in SFUSD and California, 2011-2012

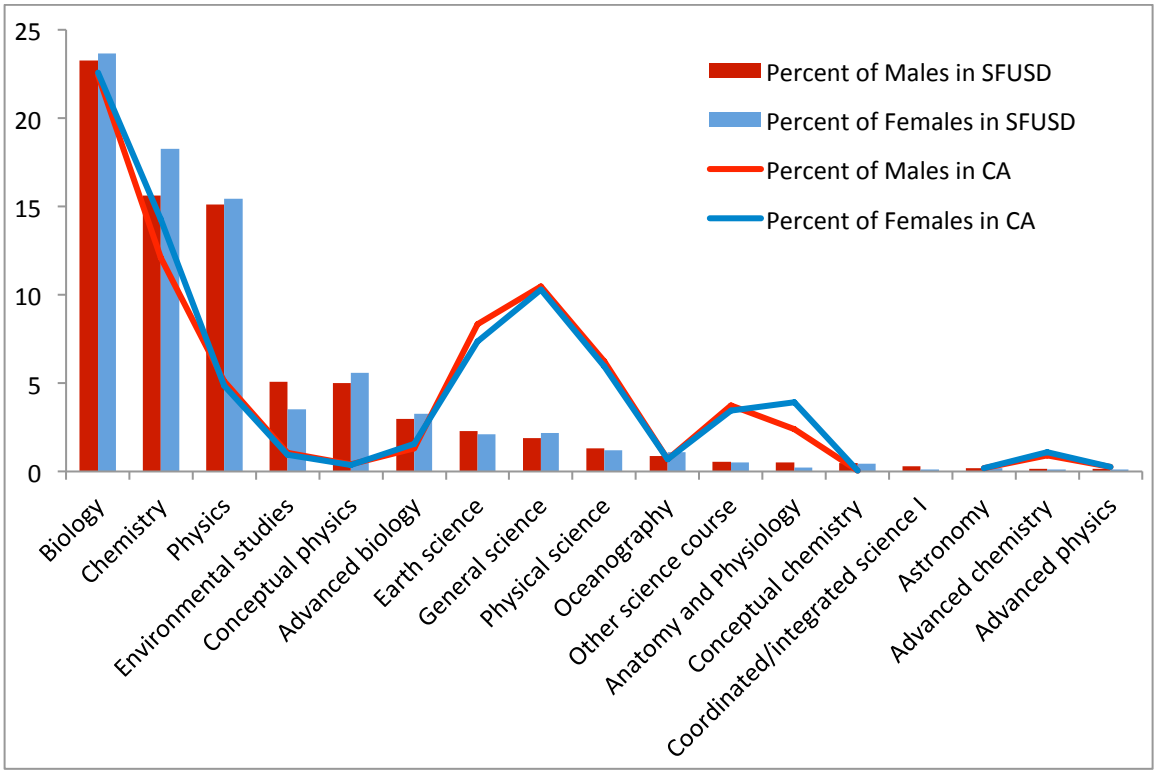

Figure 4: AP Course Enrollment by Gender in SFUSD and California, 2011-2012

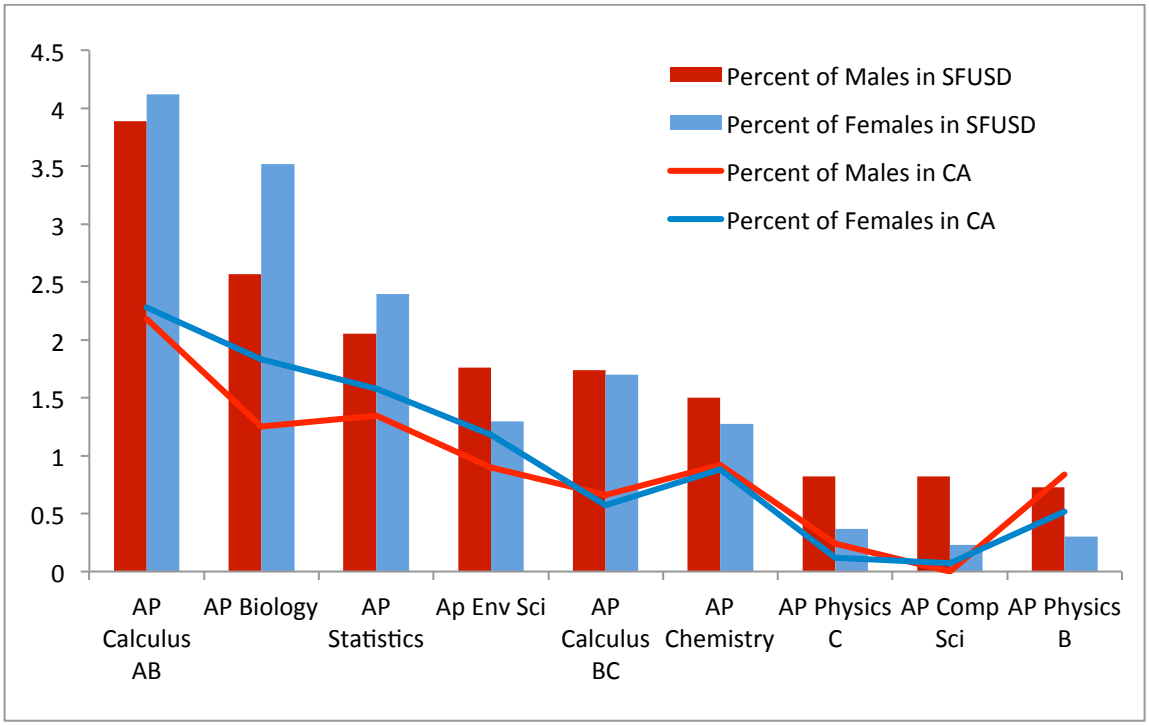

Table 1: Female Enrollment in Upper Level STEM Courses in SFUSD by Ethnic Group, 2007-2008

	Intermediate Algebra	Advanced Math	1st Year Chemistry	1st Year Physics	Total 9-12 Enrollment
American Indian	4 (10%)	3 (7%)	5 (12%)	7 (17%)	41
Asian	1,181 (27%)	1,165 (27%)	1,109 (25%)	741 (17%)	4,365
Pacific Islander	13 (15%)	7 (8%)	13 (15%)	5 (6%)	87
Filipino	107 (19%)	137 (7%)	344 (18%)	165 (9%)	576
Latina	362 (19%)	137 (7%)	344 (18%)	165 (9%)	1,934
African American	199 (16%)	57 (5%)	155 (12%)	77 (6%)	1,262
White	198 (24%)	131 (16%)	181 (21%)	159 (19%)	844
Multiple/No Response	56 (21%)	60 (22%)	69 (25%)	54 (20%)	273

Focus Group Findings

Ms. Sowers conducted four one-on-one interviews and a single focus group with four women, all of whom are currently pursuing STEM majors in college. The volunteer-based sample included women majoring in math, chemistry, physics, and geography. Major themes from the interviews and focus group include the following:

Theme 1: Improved Course Content

In crafting course content to engage girls, the women emphasized the importance of teacher choices about what examples to use. Participants recommended that teachers use examples that resonate with both males and females. One woman said that

> "there are all these examples about cars…why not something else that's more interesting, about the natural world? There are plenty of things in physics that apply – like how a bird is able to fly through the sky. All these things that are not so male. Everybody has an experience with these things."

Theme 2: Female Teachers and Role Models

A major theme that emerged from the interviews and focus group was the importance of female role models. Several women mentioned that their mothers worked in STEM, and these participants credited that early exposure as a major influence on their decision to later pursue a STEM major. Others stated that they appreciated the presence of female teachers, with one saying that "I think having women teachers definitely helps a lot. I feel like they describe things in a way that's less lofty and more accessible…**I think everybody, not just the women, benefit[s] from that teaching style**."

Theme 3: Make a Difference

A major unifying characteristic among participants was their desire to make a difference in the world through their work in STEM. **Rather than pursuing a STEM occupation for prestige or high pay, the women shared a motivation to change other people's lives for the better**. For example, one woman's interest in STEM by her passion for environmental issues and climate change, while another sought to pursue medical research after losing her mother to cancer.

Theme 4: Lack of Female Classmates

The women reported that most of their courses are male-dominated in enrollment. This is especially true as the classes get more advanced – one woman noted that classes that are serve as general education requirements for non-STEM majors tend to have higher female-enrollment, while other STEM courses are often almost exclusively male.

Some women reported feeling put down by male classmates, with one stating that "**some guys make it very clear that they think you're not smart**." Some women feel as though their performance must be far above average in order to receive the same amount of respect as their male counterparts. Additionally, one woman reported that male classmates are more supportive of one another while more competitive with females.

Theme 5: Spatial Reasoning

One woman reported being under confident in her spatial reasoning skills. She believes that she has less strength in this area than some of her male classmates and felt placed at a disadvantage in the STEM classroom as a result. The woman also expressed that she would likely take advantage of a spatial reasoning workshop to improve those skills if it were available.

Theme 6: Careers

Participants emphasized that a lack of awareness of career options is a major barrier to women's participation in STEM. One stated that **career information "absolutely needs to be part of education"** so that both male and female students are better aware of the possibilities that are available to them.

Key Advantages and Disadvantages of 3 Existing Programs

Ms. Sowers conducted interviews with the directors of three STEM programs and evaluated each model according to the criteria of program quality, cost-effectiveness, equity, collaboration, scalability, and duplication.

San Mateo County Office of Education STEM Center

The San Mateo County Office of Education (SMCOE) opened a high-tech STEM Center on August 24th, 2012. The Center's primary function is to offer professional development opportunities for instructors. These professional development sessions include training on incorporating STEM into PreK-3 education, free pedagogical content and curriculum from Oracle Academy, guest expert lectures, and guidance on effective implementation of the new Common Core State Standards.

Despite its efforts, the SMCOE STEM Center has struggled to get instructors to attend its trainings. Additionally, though the Center's employees seem to have personal interest in increasing girls' engagement in STEM, the program's design lacks an explicit focus on girls. The program needs to include greater consideration to gender equity.

National Girls Collaborative Project

The National Girls Collaborative Project (NGCP) is designed to bring together girl-serving STEM organizations to maximize resources by sharing evidence-based practices and program models. NGCP encourages its Collaborative members to implement a series of activities that are well-backed by existing research as being effective for increasing girls' success in STEM. A regional NGCP Collaborative called California Girls in STEM (CalGirlS) has recently developed in the Bay Area, with the Lawrence Hall of Science as the convening organization. The City of San Francisco, SFUSD or SF nonprofits could easily get involved.

NGCP's primary drawback is that it focuses on out-of-school-time, informal education programs rather than formal educational institutions, which restricts the extent of its impact.

KC STEM Alliance

The KC STEM Alliance is a collaborative network of educators, STEM organizations, and businesses that seek to support STEM education in the Kansas City area. The organization's primary activity is grant-making to support Project Lead the Way (PLTW) and For Inspiration and Recognition of Science and Technology (FIRST) programs in local school districts.

Neither of the two programs that the KC STEM Alliance primarily supports, Project Lead the Way and FIRST, have a prominent focus on gender equity. Further, the KC STEM Alliance does not offer any start up funding; instead, it only offers grants to existing PLTW and FIRST programs. This limitation will likely hinder program effectiveness and reach. Additionally, both PLTW and FIRST target middle and high school students. Because children form opinions about STEM at a very young age, the KC STEM Alliance's interventions may be occurring too late.

Conclusion and Recommendations

San Francisco Unified School District (SFUSD) should be commended for its decision to prioritize science and math education with its new SFSTEM Initiative. As this work moves forward, Ms. Sowers recommends that SFUSD, the City and County of San Francisco, and the Golden Gate STEM Alliance collaborate to implement the following series of actions:

Recommendation 1: Professional Development for Girl-Friendly Pedagogy

San Francisco should offer teachers a greater number of professional development opportunities. The San Mateo STEM Center's use of Oracle Academy trainings is a low-cost practice that could be replicated in San Francisco to strengthen computer science education.

Professional development should not stop with STEM knowledge and skills training for teachers. Instructors must be made familiar with pedagogical strategies specifically designed to engage girls. This is an area well-suited for collaboration with girl-serving organizations. Branches of the National Girls Collaborative Project (NGCP) have offered these types of trainings, and the new California Girls in STEM (CalGirlS) network of NGCP may have an interest in offering some of their own.

Recommendation 2: Female Role Models in the Classroom

Bringing female STEM professionals into the classroom is an activity perfectly suited for partnership with industry. For high school science, SFSTEM is considering collaborating with Technology Education and Literacy in Schools (TEALS), a nonprofit that partners high school

teachers with technology professionals to co-teach introductory or AP computer science courses. SFUSD should strive for a diverse representation of professionals in the classroom and request female professionals as a co-teachers whenever possible. SFSTEM should also consider inviting young women in STEM majors to speak in the classroom, tutor, or mentor students.

Recommendation 3: Participate in Local STEM Collaboratives

For their goal of increasing girls' success in STEM, San Francisco nonprofits and SFUSD have a promising potential collaborator in the new CalGirlS Collaborative. CalGirlS' events and activities could prove to be an excellent resources to aid San Francisco in deploying effective strategies to engage girls in STEM.

The San Francisco County Office of Education, San Francisco State University, and UCSF have already participated in the early development of the Golden Gate STEM Alliance. In order to achieve better alignment and coordination of Bay Area STEM efforts, representatives from the City of San Francisco and SFUSD should also consider participating in this initiative. Gender equity has not so far been a core priority for the Golden Gate STEM Alliance, so the San Francisco Department on the Status of Women and other actors should step in to advocate for the needs of girls and women as this fledgling initiative takes shape.

Recommendation 4: Increase Course Availability in High School

Many STEM subjects are only available at a handful of campuses at SFUSD. When possible, STEM course availability should be increased to expand student access. Targeted outreach must be conducted along with increased course availability in order to recruit girls and other underrepresented populations.

Recommendation 5: Increase STEM Content in Other Courses and K-8 Education

Due to its interdisciplinary nature, STEM can be incorporated across many content areas. Curriculum should incorporate relevant technology and students' attention should be drawn to the myriad applications of STEM content in order to enhance their understanding and better prepare them for the 21st century workforce.

In the lower grades, more class time must be spent on STEM. Because computer science, math and engineering jobs comprise the vast majority of STEM jobs, it is imperative that schools, teachers, and nonprofits find a way to better expose students to these topics. SFUSD could potentially collaborate with the Golden Gate STEM Alliance in this area, for one of CSLNet's current priorities is strengthening engineering education.