How to Attract WOMEN to STEM Careers

A Review to Help Educators Attract and Retain Female STEM Students

The information that follows is based on a thorough literature review of factors that influence women's pursuit of STEM fields, with particular attention to psychological influences.

It discusses the importance of confidence and interest; self-efficacy; role models and stereotype threat; attracting and retaining faculty; classroom content; and building community.

There are many factors that influence women's pursuit of STEM fields

It is not females' cognitive abilities that are falling short in science, technology, engineering, and mathematics (STEM). At the elementary, middle, and high school levels, girls today are equally or more likely than boys to take science and math classes, and they earn slightly better grades in those classes. However, in early-adolescence girls begin to lose confidence in math and science despite their performance, representing a shift in attitudes as opposed to ability. At the community college level, women complete just two in every five science and engineering associate's degrees; as freshman at four-year colleges, about twice as many men as women plan to study STEM; and disparities are even more dramatic in the labor market.

Females' low representation in STEM fields is troubling given national calls for more STEM education in order to maintain a competitive edge in the global economy. Increasing women's representation in STEM fields would also support women's economic stability and parity: although women typically earn less than men regardless of field, occupational segregation accounts for the majority of America's gender wage gap. The California Community Colleges play a key role in providing well-trained workers for STEM-businesses, especially in fast-growing emerging markets.

There is also a movement to add "arts" to the equation (turning "STEM" to "STEAM"). Adding the art component responds to industry's need for creativity and innovation in STEM fields. A significant body of research also documents the relationship between involvement in the arts and superb science: great scientists are far more likely than the general public to practice or appreciate art, and research increasingly demonstrates how art education may benefit students more broadly.

Generate Interest and Confidence

Students' interest and sense of confidence in a field tend to feed one another. While females and males exhibit similar STEM performance into high school, females' interest and confidence in STEM begins to dwindle. Research suggests ways in which schools can counteract this trend:

- Among undergraduate engineering majors at a four-year university, **perceived respect from professors was the strongest predictor of females' confidence.**
- In the first year of college, women attributed their pursuit of STEM fields to enjoyment of science and math classes, helpful faculty, **awareness of science and engineering career opportunities**, and their ability to work independently.
- In the second year, persistence was associated with possessing good **advisor relationships**, feeling accepted within the department, and continuing to enjoy math classes.
- By the third year, community influences such as **positive experiences in student societies** and at conferences, mentor relationships, and continuing interest in classes were the primary determinants of retention.
- In the fourth year, **intention to work in engineering after graduation** also mattered.

Recruit and Retain Students

Many studies address the importance of female role models in supporting women's performance and persistence in STEM fields. However, research has not generally found female role models to be as important for recruiting women into STEM. For example, increases in female STEM faculty at a diverse set of four-year colleges were not followed by increases in female majors in those fields. In fact, men are often among the most influential role models reported by women in STEM.

Why might female role models support women's *retention* in STEM fields, but bear less effect on *recruitment*? Part of the answer may be the extent to which women have identified with a STEM field, activating the detrimental effects of "stereotype threat." Stereotype threat is a fear of confirming a negative stereotype, such as women's lesser abilities in STEM fields, which results in underperformance.

For women who have not yet identified with a STEM field, gendered stereotypes may not be as salient as stereotypes about the culture or personality traits typical to STEM fields. Valuable role models for recruiting women into STEM may need to counter many negative stereotypes about STEM fields, including but not exclusive to stereotypes about women. For example, studies show:

- Women expressed less interest and lower anticipated success in computer science when exposed to virtual classrooms containing stereotypical items (e.g., Star Trek posters and video games) as compared to neutral items (e.g., nature posters and water bottles).
- Female computer science students exposed to role models with clothing, hobbies, and preferences that matched stereotypes about computer scientists believed they would be less successful in computer science than those exposed to role models more typical to the student body.

But women already invested in a STEM field are more threatened by negative stereotypes about women in STEM, such that even subtle cues could trigger stereotype threat. Encountering a competent female role model could buffer against the detrimental effects of negative stereotypes.

- Simply indicating one's gender at the beginning of a standardized test can diminish test scores of strong female math students.
- Women's performance on a math test improved when the test was administered by a competent female researcher (as opposed to a male). In fact, just learning about a competent female experimenter promoted women's performance.
- Women also performed better when they read about women who had succeeded in architecture, law, medicine, and invention (than when not presented with such examples).

Attract and Retain Female Faculty

For female students to interact with more gender-matched role models, more women must be drawn into and retained in faculty positions. What attracts women into these positions, what factors matter most for their satisfaction, and why do they tend to stay or leave?

- **Dissatisfaction with research support, career opportunities, and feeling a lack of freedom to express ideas** are associated with female faculty's turnover intentions.
- One study found satisfaction with **compensation** (including both salary and benefits) to be the strongest predictor of STEM female faculty's intention to continue their role, alongside satisfaction with job autonomy and security.
- Particular assets for female faculty may include flexible **family leave policies** (including elder care), medical leave policies, faculty development efforts, phased retirement options, travel support, sabbatical leaves, and shared academic positions.
- Research also underscores the **important role of *male* faculty** in supporting their female counterparts by building a strong faculty community and promoting positive and equitable behavior.

Enhance Classroom Content

Teachers' typical interactions with female versus male students and sensitivity to their preferred classroom styles can also influence women in STEM:

- Teachers tend to initiate more interactions with male than female students, particularly more negative interactions, which may indicate that teachers less often challenge or correct girls' thinking, perhaps in a sort of "benevolent sexism." **Teachers may make such an effort not to discourage female students that they fail to provide productive feedback**.
- **Educating student-teachers about gender equity** issues and gender-sensitive education has been shown to promote more equitable classroom interactions between teachers and students of both genders.
- Students should **understand that ability is flexible and can be learned (a "growth mindset").** Students randomly assigned to participate in workshops teaching strong study skills, ways to avoid stereotypical thinking, and how the brain can develop with practice have been shown to perform better.
- From a young age boys tend to engage more in classrooms with an emphasis on goals and hierarchy, whereas girls tend to engage in more cooperative classrooms. **STEM classrooms tend to be more goal-based, hierarchical, and independent than non-STEM classrooms, perhaps appealing more to boys'** preferences than girls'.
- Women's and men's career goals have also been shown to vary in some consistent ways (though it is important not to overemphasize these differences): typically, men more heavily emphasize "agentic goals" such as making money, while **women emphasize "communal goals"** like helping others. Among both women and men, careers in STEM fields are believed particularly poorly matched to communal goals, and interventions aimed at recruiting women into STEM fields often emphasize agentic goals like the increased earning potential afforded by STEM careers.
- **Educating students about projected earnings** in STEM fields has been shown to shape choice of major, but women's belief that careers in science can fulfill communal goals, as well as their attitudes towards science careers, also **improved when women were given descriptions of a scientist's day that included collaborative work.**
- Having a **diverse, energetic, and enthusiastic staff**; a curriculum centered on **hands-on, small-group, and project-based learning;** an emphasis on the **social relevance of science** and real-life issues; and exposing students to the nature of STEM occupations have all been found effective for drawing girls into STEM fields.

Inspire Self-Efficacy

There appears to be a chain of influence wherein factors including **expectations, interest, ability, and stress may shape women's sense of "self-efficacy" (or belief in their abilities)**, which in turn may more directly affect women's studying in STEM. Research shows that self-efficacy can be developed:

- Engineering students' self-efficacy was significantly improved with participation in pre-collegiate engineering classes involving **hands-on experiences, real-life applications, and problem-based projects.**
- However, brief extracurricular activities such as field trips and one-day workshops did not significantly influence students' self-efficacy.

Build Community

Experiencing a sense of community is another key support for many students:

- A **feeling of belonging** predicts college students' intentions to persist in STEM fields.
- A large study of STEM majors found that having **same-major friends** can support STEM students' outcomes, particularly for females. Friends' support of STEM interests and motivation also predicted students' interest in STEM careers.
- Women who experience highly competitive or isolating STEM environments may be especially likely to leave STEM fields. In fact, female doctoral students in STEM fields may utilize remote communication (e.g., email) and self-isolation as a means to appear competent (i.e., "I don't need help"), but this can prevent students from **comparing their experiences and developing competencies through interaction.**
- A program that increased female college student retention in STEM majors included living together during the first year and opportunities to participate in **lectures, panel discussions, mentoring, advising assistance, research internships, tutoring, and field trips.**
- A college summer science enrichment program provided students with a forum to **build friendships among similarly STEM-interested peers;** new and existing relationships with those in STEM majors were associated with more positive expectations for becoming a scientist.

Make Use of Resources

- American Association of University Women - **www.aauw.org**
- Engage: Engaging Students in Engineering - **www.engageengineering.org**
- Fight the (Stereo)Type: Nontraditional Careers and Occupations - **www.fightthetype.org**
- National Institute for Women in Trades, Technology and Science - **www.iwitts.org**
- National Alliance for Partnerships in Equity - **www.napequity.org**
- National Women's Law Center - **www.nwlc.org**
- The STEM Equity Pipeline - **www.stemequitypipeline.org**
- Understanding Stereotype Threat – **www.reducingstereotypethreat.org**
- United States Department of Labor Women's Bureau - **www.dol.gov/wb**
- White House Council on Women and Girls - **www.whitehouse.gov/administration/eop/cwg**
- Wider Opportunities for Women - **www.wowonline.org**
- Women In Non Traditional Employment Roles (WINTER) - **www.winterwomen.org**
- Women in STEM Knowledge Center - **www.wskc.org**

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