ENGAGING WOMEN IN STEM:
A Literature Review of Dominant Causes of Female STEM Attrition and Promising Mitigating Practices

By Laura Paxton Hassner
November 1, 2018
© 2018 Kevin Kubasik Charitable Trust. All rights reserved
STEM careers are high paying, in-demand, and provide avenues for innovation and creativity. They improve our lives, our environment, and personal experiences. However, the STEM workforce has yet to reach its full potential because of female STEM attrition, which begins in early adolescence and continues through adulthood.

Female STEM attrition starts in early adolescence and continues throughout careers. STEM-talented women are not pursuing STEM careers, are leaving the STEM workforce, and are failing to progress in STEM-related fields. Highly-qualified and motivated women are discouraged from entering STEM fields, which costs firms, industries, and the national economy billions of dollars. Implementing promising practices that cultivate motivation, skill acquisition, and facilitate career advancement may dramatically reduce attrition at the key junctures of education, hiring, and retention in the workplace.

Despite efforts to narrow the gender gap, neither employer initiatives nor education programs are successful enough -- and can even unintentionally discourage women from pursuing STEM careers. Millions of dollars are spent on diversity and inclusion efforts, yet turnover rates remain high.

In order to enact change, we must understand the underlying causes of female STEM attrition in early adolescence, college, and in the workplace. Stereotypes, gender bias, and sexual harassment experienced in academic and professional settings cause women to leave STEM fields. Too often, these barriers create a toxic culture that drives women from STEM education and related careers. In addition, women often join the field because they want to make a difference in people’s lives, but then fail to see the social impact of their work.

Individuals, STEM-talented women, and employers can all cultivate and develop a STEM workforce where women thrive. Several promising practices to help reduce female STEM attrition include:

- Leverage the societal value of STEM careers to encourage girls and young women to persist in STEM coursework and pursue STEM careers;
- Eliminate bias in recruitment, assignment, and promotional practices;
- Track, analyze, and share diversity metrics to identify both social responsibility and business outcomes;
- Foster a culture that actively supports women and institutes zero-tolerance for harassment;
- Encourage cross-gender mentorship and networking programs that help women navigate obstacles and develop leadership skills; and
- Educate students, teachers, and employees/employers about the consequences and impact of negative stereotypes on both social responsibility and business outcomes.
ENGAGING WOMEN IN STEM:
A Literature Review of Dominant Causes of Female STEM Attrition and Promising Mitigating Practices

THE IMPACT OF FEMALE STEM ATTRITION

Significant numbers of STEM-skilled and talented women either do not enter STEM careers, leave, or fail to advance. Female STEM attrition occurs at all levels, from middle school through upper management. Over half of highly-qualified women leave STEM careers, compared to 20% of non-STEM female professionals. 53% of men but only 41% of women with a STEM degree work in a STEM field within two years after graduation. A quick back-of-the-envelope calculation suggests that more than one-fifth of women with STEM degrees do not participate in the STEM workforce. An estimated 40% of qualified female engineers either quit or never even enter the profession. Promising practices at key intervention points of adolescence, during workforce entry and transitions, and within the workplace suggest opportunities to improve the hiring, retention, development and advancement of female STEM professionals.

The persistence and advancement of STEM-talented women varies across STEM fields and over time. In some STEM fields, particularly medicine, biology, and most social sciences, the numbers of women and men reach the same parity seen in the non-STEM workforce. While engineering firms meet their initial hiring goals for women, most women leave within 5-8 years. At 11% female, engineering is one of the most sex-segregated professional occupations. With an average female workforce of 26% percent, the technology industry is not far behind.

"Annually, STEM-talented female attrition costs the technology industry over $16 billion."

STEM-talented female attrition results in substantial costs to individual firms, entire industries, and the national economy. Annually, STEM-talented female attrition costs the technology industry over $16 billion. Women who leave are less likely to refer talented friends to their former employers and recommend products or

1 STEM-skilled and talented women are those with pronounced quantitative reasoning skills and scientific and mathematical interests.
services from those companies. These opportunity costs both preclude talent from being interested in working for that firm and cause revenue loss. Female tech attrition deprives the industry of an estimated $470-570 billion in new value that would have added over 1.5% to the national GDP.

**Gender diversity yields extraordinary results.** Gender diverse companies yield more valuable patents, experience increased sales revenue, and are 15% more likely to outperform their industry medians. The effect is pronounced at the senior executive team level: a 10% increase in gender representation correlates to a 3.5% increase in operating income. Companies with comparatively higher numbers of women in management and on their boards, and with clear policies on diversity and inclusion have lower price and earnings per share volatility and higher subsequent returns on equity.

**Female attrition significantly impacts technology firms, and it is getting worse.** Tech women leave at a 45% higher rate than tech men do. The 41% of women who leave tech careers within their first ten years do not exit the workforce altogether, they simply leave the tech industry. Tech women hold only 17% of industry C-suite positions. Although only 7% of information technology firms have at least one-third female representation on their boards (a metric widely adopted in Europe), those who do are rewarded with higher spreads in forward return on equity.

**MOST POPULAR INTERVENTIONS ARE NOT WORKING**

Despite focused interventions, the percentage of female STEM workers stagnated over the last decade. Emphasizing the lack of women in STEM can backfire by signaling an inherent lack of fit that discourages female adolescents from considering STEM. Poorly designed internships and summer jobs often echo the gender stereotyping that young women experience in school: men are often assigned to skill-building, challenging problems, while women receive secretarial tasks. Assuming that women will help or mentor other women is a mistake: women who have faced gender discrimination are likely to refuse to help and even actively distance themselves from other women. Relying on education alone is insufficient to help women persist in STEM: piquing interest helps to initially attract women to STEM, but satisfaction is what keeps them coming back. Tech firms have spent hundreds of millions of dollars on diversity and inclusion initiatives, but are no more diverse than they were before that spend, with persistently high rates of turnover in underrepresented groups. Failed initiatives tend to be viewed as Human Resources and Corporate Social Responsibility cost centers rather than as core growth opportunities. They also often focus on helping diverse individuals to integrate into the existing culture rather than successfully activating and leveraging the potential of their diverse workforce to create a new culture that creates the conditions ripe for innovation to occur.
DOMINANT CAUSES OF FEMALE STEM ATTRITION

Attrition begins in early adolescence, continues through college and into the workplace. A study of European girls found that their interest in STEM begins at age 11 and wanes around age 15. In college, although women represent more than half of all degree recipients, only 30% of STEM degrees are awarded to women. Many STEM women report that they do not ask or answer questions in class. Research suggests that their academic performance suffers due to a fear that they may confirm negative stereotypes.

Gender dynamics in college may prevent women from pursuing a STEM career after graduation. This may help to explain why college-educated women hold less than a quarter of all STEM jobs. Despite tech leaders saying they seek to increase gender diversity in their industry, only around 5% of technology firms' philanthropic giving focuses on promoting women and girls in STEM, suggesting an opportunity exists to further support STEM women and girls.

Women who leave STEM cite their frustration with persistent stereotypes and biases. Stereotypes hurt. Over 70% of adults across 35 countries hold implicit stereotypes associating men and masculinity with STEM. This impacts women’s interests, perceptions of self-efficacy, and aspirations as they consider or pursue STEM careers. Women may experience exacerbated performance anxiety as highly visible “STEM women.” Tech women report a "prove it again" bias, with two-thirds frustrated that they feel they must either provide more evidence of competence than men simply to be seen as equally competent or find their technical expertise called into question the moment they transfer from technical positions. Tech women face a maternal bias: mothers or elder caregivers are 79% less likely to be hired, half as likely to be promoted, paid significantly less, seen as less competent, and/or are held to higher performance and punctuality standards. Three-quarters of women describe the difficulty balancing being “too feminine to be effective and too masculine to be likable.”

Women leave STEM because of sexism and harassment. Between 20% and 50% of STEM women report being harassed. This compares to 22% of non-STEM women workers. 80% of STEM women witness sexism. In the "Brotopia" tech culture, over half of tech women (and 16% of men) report being sexually harassed, including being propositioned in exchange for a promotion. A staggering 74% of women in computing report some form of workplace gender discrimination, compared to 50% of all STEM women, 19% of STEM men, and 41% of women in non-STEM jobs.
Women who leave blame toxic cultures that leave them feeling marginalized and invisible. One-third of engineering women cite “workplace climate” as a primary reason for leaving. STEM women say that their ideas are routinely ignored in the workplace. 27% of women who leave tech report that others took credit for their work, while 25% report having been passed over for a promotion. Despite the fact that much teaming occurs in STEM, women report being marginalized on STEM assignments during college and given routine tasks, while men tackle the challenging problems and build key skills. Tech women face a further conundrum: risking being seen as “not a team player” by turning away work that men are rarely asked to do. Women are also less likely to land high-visibility assignments and so are less able to demonstrate their valuable skill sets which, in turn, drives selection for those same highly visible assignments. 35% of women who leave tech report leaving to seek a better opportunity.

Women also leave STEM because they are dissatisfied and feel it is a mismatch for their personal values. While 74% of tech women report “loving their work,” 56% of women leave mid-career (twice the exit rate of men), precisely when the loss of their talent is most costly to companies. Female engineers leave because of frustration with a workplace environment that they believe prevents them from reaching their professional and corporate goals. Others, who joined the field to make “a difference in people’s lives,” fail to see the social impact of their work. Notably, many women who leave engineering do not explicitly name gender or diversity as a factor for their departure, which can obfuscate the efforts of companies trying to track metrics on the reasons why women leave their firm.

PROMISING PRACTICES

Motivating women to persist in STEM coursework and to pursue STEM careers begins in adolescence. Self-efficacy, the perception that one “can do the work,” and motivation, the desire to “want to do the work,” precedes discretionary efforts to engage in, master, and persist in difficult coursework. Those who persevere in STEM cite their having developed a strong STEM identity in adolescence that motivates them to later pursue a STEM career. Female adolescents with high self-efficacy who perform better in math (a precursor for future success) have less mathematics test anxiety and are more likely to persist in STEM careers. The most critical early intervention is ensuring that girls succeed in math classes. By doing so, they build a strong foundation for future coursework, overcome test anxiety, and cultivate the
self-efficacy and empowerment that develops resilience. Praise in adolescence also matters: it impacts young women’s enjoyment of STEM subjects and predicts future course enrollment. It also correlates with early academic publications that drive lifetime productivity and promotions for women who choose to pursue graduate STEM degrees. In college, women benefit from the support of high-quality, structured mentorships (which may be online) that support them as they navigate challenges.

**Solving increasingly complex real-world problems sparks and sustains STEM interest.** STEM women cite altruism and real-world problem solving as motivating factors that piqued their initial interest in STEM. This later gives meaning and purpose to their STEM careers. Roughly twice as many STEM women as men value having a job that helps others. Experiential and purpose-driven learning help build relevance and a sense of the societal value and real-world applicability of STEM fields. This motivates female adolescents to pursue STEM. Yet, four in ten girls say they lack opportunities to gain practical experience.

**Small tweaks to hiring practices make a sizeable impact in hiring and retaining STEM-talented women.** Linguistic analyses demonstrate that using “gendered” language predicts the gender of the new hire, so taking care to use gender-neutral or even “feminine” language in job postings dramatically increases an organization’s chances of hiring a woman. A modified “Rooney Rule” that mandates the inclusion of at least two underrepresented candidates in the interviewing pool increases the likelihood of diversity in hiring. Mandating having diverse employees participate on hiring panels may increase the number of women and people of color hired, with one major tech company seeing an increase from 32% to 45%. Changing job postings to eliminate the two words “salary negotiable” helps close the pay gap by 45% because women tend to not negotiate salaries or are judged more harshly than men when they do. Banning salary negotiations entirely by offering the highest possible salary up front helps to both avoid bias in the negotiation process and prevent ill will from developing. Highly-educated women often start at lower levels than men and receive less pay, so practices like this help avoid long-term pay inconsistencies between men and women.
Developing a culture that supports STEM women and provides zero-tolerance for harassment helps ensure women advance in the STEM workplace. Nearly two-thirds of tech leavers indicate that they would have stayed if their employer fixed its culture. STEM firms who want to retain talented women need to be transparent with key diversity and inclusion metrics, intolerant of harassment cultures, and consider restructuring basic hiring and review processes to be more inclusive. Since women make up only roughly a quarter of the STEM workforce, human resources departments are less focused on supporting them. Reconsidering performance pay incentives also helps to eliminate long-term gender pay discrepancies.

Women thrive with support from sponsors to navigate workplace barriers, to develop leadership skills on high-visibility assignments, and to act as role models.

"67% of STEM women (and 65% of men) say a workplace mentor is critical for career advancement."

Yet, 86% of women lack a sponsor. 67% of STEM women (and 65% of men) say a workplace mentor is critical for career advancement. Networking helps too, especially when networks put women in direct connect with senior leadership or offer social support, both of which contribute to differential salary growth and long-term career success. Research on external networking is promising: in one study, participants at a women’s conference were twice as likely to receive a promotion and three times as likely to receive a minimum 10% pay increase than those in a control group. In-company networks help women build the skills and knowledge they need to be successful within the company’s culture and promote career satisfaction in those who participate. However, in-company networks can also backfire, reinforcing the “patriarchy” that negatively impacts issues affecting women. More research should be undertaken to understand what makes these programs successful as well as to identify more tangible, long-term metrics that track exactly how the cause and effect relationship works. Little convergence on common measurement tools or systems that quantify progress or easily enable a collective approach leaves individual organizations without a clear roadmap to success.

Using metrics to drive comprehensive diversity and inclusion priorities reduces employee turnover. Successful initiatives reduce incidences of unfairness, sexual harassment, and bullying behaviors, all closely linked to turnover. Preliminary research suggests that successful initiatives adopt a five-pronged approach: they establish clear diversity goals, offer employee bonuses for diversity referrals, appoint a Director of Diversity and Inclusion, conduct unconscious bias training, and establish Employee Resource Groups. 85% of tech companies track gender representation by level, but only 8% share these statistics widely within their organization. Publishing annual reports are critical to provide transparency but short pulse surveys should be done regularly. Companies who invest in career development and advancement opportunities decrease the likelihood that employees will leave.
KEY TAKEAWAYS

There is reason to be hopeful. A recent LinkedIn study revealed that more women are entering STEM fields today than ever before. Implementing promising practices that cultivate motivation, skill acquisition, and facilitate career advancement may dramatically reduce attrition at the key junctures of education, hiring, and retention in the workplace.

For STEM-talented women, consider advocating for:

- Pre-work experiences that cultivate women’s interest and skills in STEM coursework and careers;
- Effective and sustained cross-gender mentoring, sponsorship, and networking opportunities that begin in the first year of college;
- Transparent reporting and progress in women’s recruitment, retention, promotion, and pay;
- Education programs that address unconscious bias and sexism in the workplace; and
- Enforcement of stated policies on sexism and harassment.

For STEM employers and supporting organizations, consider action to:

- Align corporate social responsibility, philanthropic, and human resource talent strategies and develop a continuum of aligned success metrics;
- Provide increasingly complex pre-work experiences that begin in early adolescence;
- Provide consistent, cross-gender, formal mentoring, sponsorship, and networking opportunities with participation incorporated into performance and pay reviews;
- Reduce gender bias during interviews, salary negotiation, and the promotion process by diversifying interview teams and publicizing clear job performance and salary expectations;
- Place diverse candidates in challenging assignments that build both their skills and visibility;
- Educate managers that daily decisions about resource and talent allocation impacts the ability of women to gain the experience needed to aspire to higher managerial positions; and
- Share baseline and progress data that informs continuous improvement in business results and in women’s education and career experiences.
The Kevin Kubasik Charitable Trust is driven by the power of research, data, and practical insights to cultivate positive change. The trust was established in 2016 to honor the short life of an incredibly curious, tech-talented, and caring young man who sought evidenced-based solutions to some of the world’s vexing social challenges.
SOURCES


² Please note that all electronic sources were accessed between May and September 2018.


Equality Challenge Unit, “Athena SWAN Charter”, Available at: https://www.ecu.ac.uk/equality-charters/athena-swan/.


Funk, Cary and Kim Parker, “Most Americans believe STEM jobs pay better, but few see them as offering more flexibility for family time”, Pew Research Center, 9 January 2018, Available at: http://www.pewsocialtrends.org/2018/01/09/most-americans-believe-stem-jobs-pay-better-but-few-see-them-as-offering-more-flexibility-for-family-time/.


Harrisburg University, “STEM-UP Network seeks to recruit, retain, and advance women in STEM”, Available at: http://harrisburgu.edu/stem-up-network-seeks-to-recruit-retain-and-advance-women-in-stem/.


Include, “Compensating Fairly”, Available at: http://projectinclude.org/compensating_fairly#.


Include, “Invest in sponsors to invest in your employees’ careers”, Available at: http://projectinclude.org/investing_in_sponsorships.


Surur, "Only 6.7% of women graduate with STEM degrees – Microsoft aims to change that with #MakeWhatsNext", MS PowerUser, 7 March 2017, Available at: https://mspoweruser.com/only-6-7-of-women-graduate-with-stem-degrees-microsoft-aims-to-change-that-with-makewhatsnext/.


