A WORD FROM...

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Photo is courtesy of Jim Gipe.

There are many good things to notice about the status of women in mathematics these days. In 2014, Maryam Mirzakhani won a Fields medal; Karen Uhlenbeck was awarded the Abel prize in 2019; earlier this year Melanie Matchett Wood received the National Science Foundation's Alan T. Waterman Award; Joan Birman and Gigliola Staffilani were elected to the National Academy of Sciences this past April; and the profession has elected two women, Jill Pipher and Ruth Charney, back to back to be the presidents of its most prestigious society, the American Mathematical Society. And yet overall the number of women in our field has stagnated.

According to the most recent NSF National Center for Sciences and Engineering Statistics report "Women, Minorities, and Persons with Disabilities in Science and Engineering" (2021),[1] "Over the past 2 decades, the share of women receiving bachelor's degrees in mathematics and statistics declined and the share of women receiving master's degrees was stagnant. At the doctoral level, women's share increased between 1998 and 2008, from 25.7% to 31.1%. The share then declined to 28.0% in 2018, even though there was an increase in the number of women receiving doctoral degrees." A closer look at the data shows that there is much higher representation of women in statistics (39% in 2019), and while we applaud the gains made there, without statistics in the rest of mathematics only 26.8% of 2019 PhD recipients were female. On the scale of elite academic activity, the trend remains that women drop down or drop out of mathematics at a much higher rate than men. Women earn about 42% of undergraduate degrees, only 27% of PhDs (Figure 12 of report). Female PhD mathematicians make up 33% of Assistant Professors and only 18% of Full Professors. More telling is that 41% of non-tenure track (or equivalent) PhD mathematics faculty are women (Table 9-28 of report).

There have been many great programs to help women get into and through graduate school in mathematics: EDGE, the Summer Math Program at Carleton College, the George Washington University Summer program for women, The Nebraska undergraduate conference, the Postbac Program for women at Smith College, the IAS Program for Women in Mathematics. Many women have thrived in mathematics because of these programs. Most of these are no longer funded. NSF tells us that though we've made strides, these programs have not "moved the needle" in solving the women in math "problem." Most of these programs set out to prepare women for the rigors of graduate school. A support system is established among the women in the program and women are warned and readied for the challenges that lay ahead. We prepare them to go off to battle! Each of these programs, and others, works to "change the woman" which is an expensive proposition. Indeed, what we need to do is *change the culture*.

Fifteen years ago my colleague Jim Henle and I wrote an opinion piece for the *Notices* called "What does a mathematician look like." The point was not only that the majority of mathematicians look like (white) men. The point was also that the paths they took, the decisions they made early on were similar. It is normal to think that the way we do or did something is the best way to do it; or that traits that showed we were good at math are key indicators of research potential. But these things are not true. Moreover, it is not just the entry ticket that keeps many women away. It is the system we have in place at every stage. Graduate school in math is often a competitive culture with high stakes exams. A review process that is pervasive in mathematics pretends to be objective, but unconscious bias comes creeping in when we see a female name. Women still face unwelcome interaction and disproportionate

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[1] https://ncses.nsf.gov/pubs/nsf21321

service expectations which make academia a less satisfying place for them. On top of this, the social and economic costs of a top-track academic career are high. Before landing the R1 tenure track job, most newly minted mathematicians must now take multiple short-term positions. The best of these will be a reasonably paid, low teaching-load postdoc. But almost all of these will be very limited term, requiring a new mathematician to move multiple times before settling into a permanent position. This requires the financial and family support to put career above all else. The job must be fulfilling enough to make the sacrifices worthwhile.

A couple of years ago the *Washington Post* ran an article entitled "Women who are elite mathematicians are less likely than men to believe they are elite mathematicians."[2] The article discusses how the underrepresentation of women in STEM may in part be due to women underestimating their abilities. Similarly, most of us have heard that men apply for a job/promotion when they meet just 60% of the qualifications, but women apply only if they meet fully 100% of them.[3] There are many studies that show that competition does not motivate women as much as it motivates men.[4] Men are often more eager to compete, and their performance improves with competition. But this is not necessarily so for women. In mathematics, this means women often do not do the self-promotion needed to really get ahead. They are less likely to apply for promotions, or to submit their papers to the highest level journals. And, they may simply tire of an environment where competition is the norm.

Any statement about what's good or bad for women (or for any group) is necessarily too simplistic. Some women do thrive in our current culture. Generalizations about women are often based on cisgender individuals only. And women hold identities beyond their gender. Intersectionality theory teaches us that the problems are not just additive, they may be subtly or wholly different. We must work to include everyone in mathematics. I think most mathematicians believe that the potential to do great mathematics is not limited to people who look a certain way or fit a narrow profile. The next step is to recognize that it is the current culture of our discipline that is discouraging so many from realizing their potential.

The call for transformational change has grown louder and I am hopeful about some current initiatives. The SEA change (Stem Equity Achievement) program of the American Association for the Advancement of Science (AAAS)[5] endeavors to advance institutional transformation in support of diversity, equity, and inclusion in STEM disciplines. TPSE Math[6] is leading the SEA change effort in the mathematical sciences and I am happy to be a part of the initial group that will produce a set of guidelines to help mathematics departments understand how their policies and practices relate to equity and inclusion and develop plans for change. The Association for Women in Mathematics was recently awarded an NSF grant which features several initiatives to improve the mathematics culture. These include the expansion of the successful "women in" research networks which have enabled women to create great mathematics together; workshops that bring an intersectional view of unconscious bias and unwelcome interaction to help mathematicians understand and drive change at their institutions; and professional development opportunities to help women move into leadership roles in our profession.

As we emerge from the crisis of a global pandemic there is an urgency for change. Women have experienced a disproportionate number of job losses since the start of the pandemic. The Bureau of Labor Statistics figures for September 2020 showed four times the number of women dropping out of the labor market as men. While that was perhaps the worst month, women have been harder hit overall. This is different than most previous economic downturns, where men lost more jobs than women. According to Econofact,[7] "The fact that this recession is impacting men and women differently from past recessions could also have broader consequences for families and the trajectory of the economic recovery." A report by the American Progress Institute entitled "How COVID-19 Sent Women's Workforce Progress Backward," states "The collapse of the child care sector and drastic reductions in school supervision hours as a result of COVID-19 could

[2]https://www.washingtonpost.com/news/wonk/wp/2017/08/08/women-who-are-elite-mathematicians-are-less-likely-than-men-to-believe-theyre-elite-mathematicians/?noredirect=on&utm_term=.1c68c53bbfe9

[3]https://www.forbes.com/sites/womensmedia/2014/04/28/act-now-to-shrink-the-confidence-gap/#6558af915c41

[4]*See for example "Gender and competition,"* Niederle and Verterlund in Annu. Rev. Econ. *3 (2011), 601–630 (DOI 10.1146/annurev-economics-111809-125122).*

[5]https://seachange.aaas.org

[6]https://www.tpsemath.org/projects

[7]https://econofact.org/impact-of-the-covid-19-crisis-on-womens-employment

drive millions of mothers out of the paid workforce. Inaction could cost billions, undermine family economic security, and set gender equity back a generation."[8] Women in math and science have also been disproportionately affected. An article in *Nature* reports[9] "female researchers, particularly those at early-career stages, are the hardest hit. Submissions to preprint servers, such as arXiv, rose more quickly for male authors than for female authors…." The *Nature* article continues with some initial suggestions for how to support and encourage women in research including alter evaluation criteria, set quotas, and destigmatize caregiving. The National Academies of Sciences, Engineering, and Medicine is undertaking a fast-track study focused on early indicators of the potential impact of the COVID-19 pandemic on the careers of women in academic science, engineering, and medicine. Some of their findings are already available on their website.[10]

The pandemic intensified challenges for all underrepresented groups in STEM. The title of another article in *Nature* sums it up: "It's like we're going back 30 years': how the coronavirus is gutting diversity in science." An article in the *Chronicle of Higher Education*[11] predicts that "whatever form the university takes post-pandemic, it will be more white, more male, more straight, more monied, and less accessible to people with disabilities than it was before the pandemic." Let mathematics defy this prophesy. Let us become a profession that is not just welcoming, but is supportive and truly values diversity. As we emerge from the pandemic it is a great time to examine our existing culture and practices. It is a time to embrace difference and embrace change.

[8] https://www.americanprogress.org/issues/women/reports/2020/10/30/492582/covid-19-sent-womens-workforce-progress-backward/

[9] *"The career cost of COVID-19 to female researchers, and how science should respond,"* https://www.nature.com/articles/d41586-020-02183-x

[10] https://www.nationalacademies.org/our-work/investigating-the-potential-impact-of-covid-19-on-the-careers-of-women-in-academic-science-engineering-and-medicine

[11] https://www.chronicle.com/article/the-university-were-losing