

The Impact of COVID-19 on Collaboration, Mentorship and Sponsorship, and Role of Networks and Professional Organizations

AUTHORS

Misty Heggeness, Ph.D. (1)

Rochelle Williams, Ph.D. (2)

Affiliations: (1) U.S. Census Bureau; (2) Programs for the National Society of Black Engineers (NSBE)

Communicating Authors:

Misty Heggeness

U.S. Census Bureau

4600 Silver Hill Road

Washington, DC 20233

misty.l.heggeness@census.gov

Rochelle Williams

National Society of Black Engineers (NSBE)

205 Daingerfield Road

Alexandria, VA 22314

rwilliams@nsbe.org

INTRODUCTION

COVID-19 has had an overwhelming reach into many aspects of science, technology, engineering, mathematics, and medicine (STEMM) academic life; research collaborations, mentor/sponsor relationships, networks, and professional organizations have not been spared (Al-Omoush et al., 2020; Kramer, 2020b). Academic institutions have been disrupted. From the way communities experience in-person campus life to balancing increasing personal and family needs with increased workloads as campuses transitioned to online and hybrid teaching, advising, and mentoring, it all required adjustments to normal routines (Alexander, 2020). In addition, the onset of the pandemic disproportionately impacted women nationwide, decreasing labor force participation and hours worked, especially for mothers and women with caregiving responsibilities who struggle with childcare, dependent care, and school closures (Alon et al., 2020; Heggeness, 2020; Kalenkowski and Pabilonia, 2020; Tedeschi, 2020). The academic scientific workforce has not been immune to this gendered difference as published studies and STEMM experts alike continue to highlight the differentially gendered impact of the pandemic on science and scientific collaborations (Buckee et al., 2020; Gruber et al., 2020; Kramer, 2020b; Minello, 2020; Myers et al., 2020).

Women have traditionally faced unique barriers to advancement within the academy in terms of achieving tenure and receiving equal credit for publications (Huang et al., 2020; McDermott et al., 2018; Sarsons et al., 2020), but the additional challenges due to COVID-19 have been acutely overwhelming for academic research women partly due to the fact that they disproportionately carry a heavier burden of informal labor both within their households (Jolly et al., 2014; Myers et al., 2020) and in service activities (like mentoring and advising) at work (Kramer, 2020b). Evidence suggests that shifting priorities both within the household and at work for academic women during this pandemic has restricted their ability to engage in collaborative

work and networking at the same level they might have been engaged prepandemic (The University of Wisconsin System Women's and Gender Studies Consortium, 2020; Zimmer, 2020). In light of this challenge, institutions are being encouraged to understand the explicit and implicit mechanisms of the pandemic on shifting norms in collaboration and networking for women STEM academics. If no action is taken, the differential impact that the pandemic has had specifically on academic women's ability to collaborate, mentor, and network will continue as we move forward (Kramer, 2020b), potentially worsening already existing inequalities.

This chapter focuses on how the pandemic has impacted collaboration, mentorship, and sponsorship, as well as the role networks and professional organizations have served, for academic women during 2020 when upwards of 47 million cases of coronavirus were reported to the World Health Organization (World Health Organization, 2020). It is important to take into account the false assumption that ensuring equity for one group (e.g., women) creates equity for all minoritized identities (e.g., women of color, women with disabilities) within said groups (Centers for Disease Control and Prevention, 2020b; Malisch et al., 2020). As such, an intentional, intersectional, and inclusive lens is used to explore how collaboration, mentorship, and sponsorship have changed as a result of the pandemic and provide a comprehensive overview of the ways in which systems, institutions, and professional organizations can support and mitigate the negative effects of COVID-19 on academic women and other groups that have been disproportionately impacted by the pandemic (Crenshaw, 2016; Harris and Patton, 2019).

Material Selection Process

We conducted an extensive review of recent articles on the academy, women, STEM, COVID-19, collaborations, and networks both in scientific journals as well as in the broader public domain of media, newspapers, and blogs. Additionally, we conducted a literature review for

rigorous evaluations on the impact of mentoring, professional organizations, and institutions in enhancing professional development and advancement. We reviewed the websites of professional scientific, engineering, and medical organizations and networks such as the American Geophysical Union, Society of Women Engineers, and the ASPIRE Alliance to determine how they are responding to membership needs. We also viewed webinars (live and recorded) by various societies and networks, for example, ADVANCE Resource and Coordination (ARC) Network, American Economics Association (AEA) Committee on the Status of Women in the Economics Profession (CSWEP), and others to cull resources.

DEFINITIONS

When considering the difference between collaboration and networking, or between mentorship and sponsorship, *networking* refers to the act of growing one's connections and visibility within a field through formal and informal exposure to and exchanges with new colleagues who share similar research interests. Networking includes but is not limited to the act of engaging in professional organization conferences, academic seminars, and other related activities (Mickey, 2019). *Collaboration* involves an act of extended engagement with individuals from one's network towards the pursuit of a shared or common research agenda. Newman (2000) describes collaborative networks as a group of at least two scientists who have authored academic papers together. Collaborators are a subset of one's professional network and, most often, are those with the closest shared interest to the individual researcher. Among one's network, it is important to have individuals who are mentors and sponsors.

While there is no standardized definition of mentorship or sponsorship, there are descriptors used to differentiate the two terms from one another. Mentors are generally recognized

as those who possess wisdom and knowledge, provide resources, and are willing to assist mentees in navigating career choices. On the other hand, sponsors are recognized as individuals in leadership positions who can use their power, influence, or stature to advocate for the advancement or visibility of an individual (Catalyst, 2020b; Rockquemore, 2015). Sylvia Hewlett's (*Forget a Mentor*) *Find a Sponsor: The New Way to Fast-Track Your Career* defines a **mentor** as someone who "...give[s] valuable advice, build[s] self-esteem, and provide[s] an indispensable sounding board when you're unsure about next steps. But they are not your ticket to the top..." (Hewlett, 2013, 11) and a **sponsor** as "...someone with power who believe[s] in [you] and [is] prepared to propel and protect [you] as [you] set about climbing the ladder" (7). Both mentors and sponsors are important elements to any successful career in academia.

Professional societies and organizations exist as skeletal organizations that facilitate networking and collaboration by providing a shared or common space for like-minded researchers to interact, share information, and learn about each other's research through conferences and other society-sponsored activities. As such, these bodies play a pivotal role in facilitating mentorship and sponsorship programs for individuals within the same professional fields throughout the country and serve as the primary source of postcollegiate education and skills training for America's workforce (American Society of Association Executives, 2020; Cree-Green et al., 2020). Fifty-seven million adults in America take formal work-related courses or training each year, and more than 69 percent of those individuals receive those training courses from either a private business or a professional association (American Society of American Executives, 2020). STEM-based societies and organizations are critical to maintaining strong networks and systems of collaboration as they provide an opportunity for academics and scientists with shared interests

to interact, learn about each other's research, spark ideas for future collaborations, and lend assistance in moments of great need, such as after natural disasters (Cree-Green et al., 2020).

HISTORICAL EVENTS AND THE IMPACTS ON COLLABORATIONS AND NETWORKING

The COVID-19 pandemic is not the first time a major global crisis has shifted norms at universities associated with academic collaboration and networking. After World War II, international collaborations on university campuses and interactions among academic colleagues globally were stunted, resulting in reduced productivity (such as with paper publications and patent awards) and a slowing down of new and novel advancements along the scientific research frontier (Iaria, Schwarz, and Waldinger, 2018). Prior to the development of the internet, collaborative interactions entailed physically traveling to a collaborator's location or correspondence through letters and phone conversations. In recent decades, the internet and email have facilitated a faster and easier method for collaborative interactions. These advanced technological connections did not depend on multiple collaborators physically being in the same location (e.g., lab work) (Ding et al., 2010).

On September 11, 2001, the United States was forever changed as threats to the security of the country drove changes to how colleges and universities accept students, postdoctoral students, and faculty from abroad. International student migration dropped post-9/11 and shifted worldwide student mobility trends (Johnson, 2018). Barriers to visa and work permits were reported to stifle international collaboration and engagement advancements in innovation and productivity (Chellaraj, Maskus, and Mattoo, 2005).

Four years later, in August of 2005, Hurricane Katrina ravaged the southern states. When reviewing the impact of Katrina on colleges and universities in New Orleans, a special committee convened by the American Association of University Professors found that administrators abandoned their existing regulations and policies and implemented alternative measures for decision-making that moved away from inclusive methods for checks and balances. During this time, students and faculty also relocated to other campuses, where these changes influenced both the workflow and psyche of faculty and students—and those who collaborated and worked with them (American Association of University Professors, 2007).

Professional societies and networks can serve as conduits to standing up programs and policies that help mitigate the loss of collaborative networking among women scientists, as they have historically responded to national crises by equipping their members to meet societal needs (Morris and Washington, 2018). For example, the Association of American Medical Colleges (AAMC) organized an emergency conference call with all medical school deans in the United States to coordinate the response from the National Institutes of Health and academic medicine to ascertain the health-care needs of patients affected by Hurricane Katrina. Additionally, AAMC created a website to coordinate offers of housing and lab space for researchers and students displaced by the storm (Cohen, 2005). Professional organizations have also advocated for the needs of the scientific workforce and continue to engage in advocacy and outreach efforts on behalf of the scientific community and related groups (Segarra et al., 2020).

What can be learned from these historic experiences? Methods of collaboration among scientists are hindered and stunted by crisis events either through man- and nature-made restrictions or policies restricting communication and engagement standards with potential collaborators. These barriers to collaborative networks have long-term effects that bleed into future

success, including achieving tenure and reducing potential future collaborations and research output of academics and STEMM researchers (Chai and Freeman, 2019; Chellaraj, Maskus, and Mattoo, 2005; Iaria, Schwarz, and Waldinger, 2018). Restricting or cancelling participation in professional organization conferences, which occurred regularly in the early spring of 2020, has also been shown to alter future collaborations negatively (Chai and Freeman, 2019). Yet, professional organizations can play a vital role in the interinstitutional efforts required to meet the needs of its membership and the society-at-large.

THE IMPACTS OF COVID-19 ON COLLABORATIONS AND NETWORKING

With advanced technology and cloud computing, collaborations can easily flow across state and country lines and, at first glance, it may appear that these technologies have mitigated or reduced the damage to collaborative work during the pandemic (Apuzzo and Kirkpatrick, 2020). However, collaborative researchers have still had to adjust to the sharp elimination of in-person engagement due to public health policies related to COVID-19 (Centers for Disease Control and Prevention, 2020a), and for women in STEMM with children or other dependent care responsibilities, many had significantly less time in the day to engage in collaborative efforts and networking because of increased domestic tasks within their homes due to COVID-19 that could no longer be outsourced (Heggeness, 2020; Myers et al., 2020). So, even with advanced technologies, sociopolitical cross-national events and global crises can stifle collaborative innovation, and more pressing events like the lack of childcare or eldercare for working female scientists can restrict the ability to fully participate.

Preliminary evidence is emerging suggesting that women are struggling to keep up with collaborations. Studies have suggested that team size has decreased since the pandemic and that

women's shares of first authorships, last authorships, and general representation per author group have decreased during COVID-19 (Andersen et al., 2020; Fry et al., 2020). Additionally, researchers investigating the gender disparities in published research during COVID-19 found that the proportion of women authors publishing on all topics as the first author has decreased by 4.9 percent and that the percentage drop becomes much more prominent when they analyze the papers about COVID-19. The proportion of women that write on COVID-19-related topics as the first authors has decreased by 44.5 percent, and when observing the authors regardless of the order, the proportion of women writing about COVID-19 decreased by 15.4 percent (Muric et al., 2020). These early studies suggest that if attention is not paid to women academics in STEM and solutions are not proposed to buffer the negative impact, progress in gender equality in the STEM fields will reverse.

The Impact of COVID-19 on International and Distanced Collaborations

International and distanced collaborations involve additional hurdles for keeping teams on track and STEM fields advancing in normal times. With the arrival of COVID-19, many collaborative endeavors were unprepared for a disruption such as the pandemic and “the pandemic...robbed many laboratories of international researchers and the diverse skills and viewpoints they bring” (Woolston, 2020). Field experiments, which by nature are conducted on site within local communities, have been lost to the extent travel of principal investigators and other staff conducting the experiments was essential to its advancement (Devi, 2020). Science magazine reported, “The coronavirus pandemic had already canceled one summer field research season. Now it [had] come for another: the Antarctic summer...the United States and United Kingdom would put most of their planned Antarctic research into deep freeze, including their

ambitious joint campaign to study Thwaites Glacier, the Antarctic ice sheet most at risk of near-term melting” (Voosen, 2020).

THE RESPONSE TO COVID-19 FROM PROFESSIONAL ORGANIZATIONS AND NETWORKS

In the wake of a global pandemic, in-person seminars transitioned to virtual seminars and in-person coffee breaks and happy hours converted into virtual meetups on video conferencing platforms allowing for a broader participation from international colleagues. Those in privileged situations (e.g., those without care responsibilities) navigated new paths forward despite the need for social distance and the inability to meet physically in one central location—and universities and professional organizations adjusted budgets to accommodate the financial requirements needed for this virtual transition and lower enrollments (Hemelt and Stange, 2020). In many ways, the move to virtual platforms provided new opportunities for those with limited travel funds to participate in conferences and seminars in which they otherwise would not have been able to take part. Additionally, virtual seminars gave institutions the ability to invite speakers to present their research they would not have otherwise been able to invite due to travel budgets, and individuals across the country gained opportunities to participate in some institution-specific seminars that they would otherwise have not attended (Kalia, Vivek et al., 2020; Segarra et al., 2020). However, while these expansions opened access, they did not eliminate the challenges of attending these events while engaged in childcare activities within their households—as experienced by many women in academic STEM.

On March 27, the Coronavirus Aid, Relief and Economic Security (CARES) Act was signed into law, providing over \$2 trillion for individuals, small businesses, corporations,

hospitals, state and local governments, and 501(c)(3) nonprofit groups. Unfortunately, the CARES Act did little to assist the majority of trade and professional associations experiencing severe revenue losses because of COVID-19. Despite the critical international importance of professional organizations to the careers and industries that drive economic growth and societal advancement, the governments failed to account for the systemic challenges nonprofit associations and women and BIPOC-owned businesses would encounter in pursuing Payroll Protection Program (PPP) funds and the like. These organizations and women STEM business owners remain vulnerable and at high risk as the pandemic continues to limit member participation and open doors for independent businesses.

Despite financial constraints, professional organizations and networks in STEM are being called to remain resolute in their tenets to promote professional excellence and ignite change at the intersection of a global health crisis and a fight for racial justice within the United States (Community Brands, 2020; SWE, 2020). In the midst of social distancing guidelines and stay-at-home orders, professional organizations catered to an emerging set of member needs around collaboration, mentorship, and sponsorship, while navigating constraints due to the cancellation of in-person events, decreased philanthropic support, and less income typically supplied by membership fees. These groups, particularly STEM-based professional organizations, have long supported the advancement of professional standards through a variety of mechanisms (e.g., publishing journals, making awards, providing opportunities for the exchange of knowledge and continuing education, and advocacy). During the COVID-19 pandemic, as they responded quickly to member and societal needs, they also strived not to undo years of effort in creating diverse and equitable opportunities for persons with traditionally excluded identities. These realities need to

be at the forefront of the minds of academic leadership and the professional organizations and networks that support women in STEMM.

With the onset of COVID-19, came distance communication, learning, and engagement platforms that quickly became the main mechanism for learning and research exchange. Zoom was used by school-aged children and college and university professors and students alike to hold virtual classes, seminars, and office hours, as well as by organizers at professional societies to host webinars and conferences. For example, the American Economics Association (AEA) Committee on the Status of Women in the Economics Profession (CSWEP) held two webinars¹ highlighting how universities should respond to the disparate impact of COVID-19 on women faculty and how women government economists were managing work, productivity, and agency production tasks during the pandemic.

Through the discussions during the AEA CSWEP webinars, they shared that many universities were extending the tenure clock and allowing more flexibility into tenure schedules. They discussed how leaders in natural sciences were giving faculty an extra year without teaching (especially junior faculty) with a plan for having someone else to do the teaching (sometimes established tenured faculty). They recommended that faculty keep a log of their COVID-19–related work experiences and document additional burdens and challenges in keeping their research going during the pandemic. They also suggested conducting pulse surveys of faculty regularly to have a set of snapshots regarding how faculty across departments are coping. They encouraged taking advantage of the increase in webinar meetings and potentially cold-calling other scientists to set up virtual meetings to discuss research interests, as well as taking an opportunity to invite people from far away to present in departmental seminars. Senior colleagues should

¹ More information available at <https://www.aeaweb.org/about-aea/committees/cswep/videos/2020/zoom/>.

volunteer to connect junior colleagues with people within their own networks, and they generally agreed that during this crisis senior faculty need to actively step up and provide help and additional support to junior colleagues—especially those with small children in the home.

THE IMPACTS OF COVID-19 ON COLLABORATIONS AND NETWORKING FOR WOMEN FACULTY

Women are much more likely to be on faculty today than almost a century ago, but they are more likely to reside in lower-ranking positions in STEMM and less likely to advance to full professorship (Nonnemaker, 2000; McDermott et al., 2018). Since they are more likely to be in lower-ranking positions, they are also younger and are more likely to have small children at home (McChesney and Bichsel, 2020). In the midst of a major pandemic, care needs to be taken by institutions and structured organizations to anticipate areas where women's professional productivity and advancement could be negatively impacted with respect to collaborative research (Muric et al., 2020; Andersen et al., 2020).

There are general paths that collaborative research, in particular, has taken in response to this change in the ability to physically meet in person. A first is to heavily interact using online platforms such as Zoom, WebEx, or Microsoft Team meetings, emails, cloud-computing shared spaces, and other digital formats (Clark, 2020). In this path, one can expect a relatively small decline in collaborative research due to technology. However, other family obligations may deter or hinder the ability to collaborate even if remote options are open and accessible (Myers et al., 2020).

A second path proves to be a much more vulnerable space for women in STEMM. The second path includes individuals and projects that require face-to-face interaction to thrive and

survive. These could include projects like fieldwork abroad or bench/wet lab research—collaborations that require expensive and exclusive lab equipment to advance cannot easily be replicated in a home office. In these situations, collaborations have been put on hold or slowed down (Radecki and Schonfeld, 2020). These delays in timing have the potential to sour time-sensitive lab projects and put a strain on demonstrating outcomes of grants and other types of research funding, and as labs adapt to COVID-19 safety measures they have to adjust to doing more with less because of social distancing and other measures (Brockmeier, 2020; Radecki and Schonfeld, 2020; Schiffer and Walsh, 2020; Schmidt, 2020).

Even though federal funding agencies have been generously providing support to scientists during the pandemic,² the effect of COVID-19 on collaborative networks does have the potential to negatively impact future grants that may have been funded based on current collaborative research that was slowed down or terminated as COVID-19 introduced severe challenges to scientific data collection as well as advancements in clinical trials (Heidt, 2020; Whitlock, 2020; Yeager, 2020). “By one count...more than 70 companies...reported an interruption to at least one clinical trial because of the pandemic” (Whitlock). Even the U.S. Census Bureau had to delay its door-to-door data collection program for the 2020 Census by several months because the pandemic made it risky for enumerators to collect responses in person (Census Bureau, 2020). These challenges to data collection and essential travel have put research at risk, and reduced or slowed down the speed of research and publication of results. This, in turn, has the potential to negatively affect tenure and promotion. Compounded on this are the additional barriers of engagement for women in STEMM, in particular the additional workload within their households spurred by the pandemic.

² For more information, see: <https://grants.nih.gov/policy/natural-disasters/corona-virus.htm>.

Additional Impact on Women Faculty of Color

In addition to the “long-standing systemic health and social inequities” that have “put many people from racial and ethnic minority groups at increased risk of getting sick and dying from COVID-19” (Centers for Disease Control and Prevention, 2020b), faculty women of color are also having to contend with social justice issues both internal and external to their institutions. The killing of Breonna Taylor, George Floyd, and the continued racial unrest in the United States during the pandemic disproportionately negatively impacts faculty of color (McKinsey and Company, 2020). The intersection of COVID-19 and racial unrest severely impacts the productivity and advancement of women of color, especially if these events are tied to experiences of exclusion or non-awareness on the part of the institution (Isselbacher, 2020). Additional challenges abound in getting noticed and being visible in one’s field. Buckee et al. (2020) describe the complex situation of women scientists, especially women scientists of color, studying COVID-19 who are not noticed by the media and yet are resoundingly responsible for getting the work done and advancing breakthrough science.

To address these issues, Black engineering faculty from multiple institutions formed the grassroots organization Black In Engineering to draft and disseminate the call to action *On Becoming an Anti-Racist University* (Black in Engineering, 2020). While profoundly necessary, drafting this call to action took considerable time away from teaching preparation, mentoring, and research that these scholars would have otherwise been engaged in. Moreover, as institutions of higher education continue to offer junior faculty extensions on their tenure clocks, faculty question if, given the prevalent and systemic issues of equity and inclusion in the academy, it is enough (Weissman, 2020; Khamis-Dakwar and Hiller, 2020; Mickey, Clark, and Misra, 2020). STEM

institutions must prioritize active engagement with women faculty of color and take action steps to mitigate the additional barriers and roadblocks they experience.

Additional Impact on Women Faculty with Children and Caregiving Responsibilities

Children and caregiver responsibilities are another layer of challenges that STEM women academics have been dealing with during the pandemic (Five Hundred Women Scientists, 2020). The COVID-19 pandemic produced disproportionately additional informal domestic work on women with children. Many parents or caregivers are unable to participate in international or distanced collaborations, even virtually, because of the time commitment required that competes with the need to serve as a homeschool teacher to school-age children in their care.

This is not a new issue. In March of 2018, the Working Group of Mothers in Science (WGMS) published an opinion piece in the *Proceedings of the National Academy of Sciences (PNAS)* entitled, “How to Tackle the Childcare–Conference Conundrum.” WGMS compiled four recommendations directed toward research societies and conference organizers titled CARE, for Childcare, Accommodate families, Resources, Establish social networks. These recommendations were made to provide guidance on how to address the “childcare-conference conundrum.” This was a direct response to what they expressed as the parent-researcher struggling to attend key conferences and further their careers while securing care for children. Along the same lines, conference organizers were facing their own conundrum—how to better accommodate mothers and families at meetings and events. As such, “the CARE recommendations were established to intentionally address women in academia having equitable opportunities to make contact with representatives from funding agencies, communicate new research and discoveries, form collaborations, and attract new members to research teams” (Calisi and WGMS, 2018). These

considerations are even more relevant during the pandemic when mother's workload within their households has increased substantially (Del Boca et al., 2020; Sevilla and Smith, 2020).

THE IMPACTS OF COVID-19 ON CONFERENCING

Even prior to COVID-19, researchers had been calling for a paradigm shift in how scientific conferences are conducted due to climate change and the need to reduce fuel emissions (Levine et al., 2019). While professional conferences were forced to cancel in the first half of March 2020 (Benchekroun and Kuepper, 2020), they quickly started converting to virtual programs starting in the last 2 weeks of March (American Society of Association Executives, 2020), and virtual conferencing became the new normal in 2020. Professional organizations made decisions about whether to hold in-person or virtual meetings on a rolling basis, cancelling or rescheduling in-person events anywhere from 3, 6, or 12 months ahead of time. Given the fact that many professional organizations contract large conferences years in advance, it is highly likely groups will return to in-person conferencing postpandemic.

Researchers have found both positive and negative aspects of virtual meetings for graduate students, postdocs, and new faculty. Benefits of virtual engagement include conferences that are more accessible to early-career individuals by eliminating the barriers associated with travel and funding (Adams, 2020; Segarra et al., 2020). While virtual conferences may provide broader access to early-career scientists, the experience is different because networking is limited to one's ability to engage with other scientists via a virtual screen. The experience of attending a major society conference often occurs early in an academic's career, either while still in graduate school or as a postdoc. Engaging in sessions and seeing established academics presenting their latest research in person encourages new ideas, networking, and opportunities to share one's own

research with other researchers. The social hours, dinners with colleagues, randomly running into other researchers in the halls are good examples of the value of in-person meetings. What starts as general banter of similar interests bubbles into a handful of email or phone exchanges as data is procured and ideas expand—eventually leading to a full-fledged collaboration on an exciting new line of research. Even if these initial conversations do not develop into collaborations, at least the face-to-face introductions are developed and that person remembers you a year later at the next conference or pays attention to your new research because they share a similar interest.

The cancellation of conferences may lead to an entire cohort of early-career scientists and academics who have lost out on these opportunities if not for the development of new technologies taking the conferencing circuit virtual (Benchekroun and Kuepper, 2020). How the cancellation of conferences in 2020 and the move to virtual conferences will impact the careers of early-career scientists going forward is yet to be seen. Institutions should work through how this may be affecting their own early-career academics and plan alternative options to help mitigate the negative effects—whether this includes a more robust mentoring program of early-career and late-career faculty or something else is yet to be determined.

Collaboration and Networking: The Role of Networks/Professional Organizations when Considering Membership, Conferences, and Events

Professional organizations can play a pivotal role in the resource sharing and networking components that are pivotal to one's career advancement and ongoing education. Even with the aforementioned technological advances that allow remote communication, physical attendance at various venues (e.g., conferences, lectures, and networking events) are primary means by which scholars build their research programs (Segarra et al., 2020). As women continue to face inequitable obstacles to fully attending and participating in networking and development

experiences because of responsibilities related to children and other family obligations (e.g., eldercare), professional organizations now have an opportunity to reimagine the structure of membership, conferences, and events. Fortunately, technology now gives alternate ways to continue the work, and by using an inclusive lens, organizations can broaden access by reimagining conferences and meetings.

Shifting From a Members-Only to Open-Access Model

Online communities serve as one mechanism in which professional organizations can promote inclusive online environments that drive conversation around gender equity. Within the first month of the pandemic, Higher Logic, an engagement platform that delivers online communities and communications software to over 3,000 customers, primarily associations, reported that online community engagement increased between February and April of 2020 (Bell, 2020). Given that professional organizations serve as the “brain trust” for STEMM communities, this indicates that members are relying on their association communities as vital sources of connection and information. Thus, given the financial strains on everyday American citizens due to COVID-19, providing broader access to membership benefits such as online discussions and resource libraries can prove to be beneficial to the community at large.

For example, the National Society of Professional Engineers (NSPE) and American Society for Microbiology (ASM) opened their online discussion forums to the public to facilitate communication and engagement with leading NSPE and ASM members, respectively (National Society of Professional Engineers, 2020; American Society for Microbiology, 2020). While not explicitly tied to gender equity efforts, members at the American Occupational Therapy Association (AOTA) are using their online community as a source of connection and education. In all, overall logins at AOTA were up 109 percent between mid-March 2020 and mid-April 2020.

They also found that new member logins, those utilizing the community for the very first time, increased by 149 percent. While in the online community, online discussion posts increased 48 percent, views of library content saw a 100 percent increase, and library downloads increased 122 percent between February 2020 and April 2020 (Bell, 2020).

BIAS IN VIRTUAL ENVIRONMENTS

In July 2020, the Society of Women Engineers (SWE) published a survey report titled, *Impact of COVID-19 on Women in Engineering and Technology*. The survey of its members, open between June 3, 2020 and June 15, 2020, was conducted to examine how the pandemic affected their personal and professional lives. Analysis focused on responses received from women and queer/non-binary people who made up 98 percent of the total respondents: 1,360 (36 percent) respondents identified as working professionals and 25 percent of respondents were people of color. Of the SWE professionals who responded, 31 percent reported experiencing bias during virtual meetings. Specifically, reporting “getting talked over, interrupted, or ignored more frequently during virtual meetings than those held in person” (SWE, 2020). When disaggregating the data by age group, a higher proportion of younger SWE professionals (ages 18–24 and 25–34 years old) than SWE professionals aged 55–64 years old reported getting ignored (35 percent), interrupted (38 percent), and talked over (22 percent) more frequently during online meetings than those held in person.

SWE professionals of color were as likely to report similar frequencies of getting interrupted, talked over, and ignored in virtual meetings as their white peers, however, women of color and genderqueer/non-binary SWE professionals of color disproportionately reported other concerns about losing their job due to the economic impact of COVID-19. Additionally, in a report

published by Catalyst in June 2020, 45 percent of women business leaders reported that it was difficult for women to speak up in virtual meetings, where 42 percent of men business leaders agreed with this observation, and one in five women had recently felt ignored and overlooked by coworkers during video calls (Catalyst, 2020a).

A review of the public-facing web pages of 246 STEMM professional organizations conducted for this report did not immediately show evidence of what steps organizations are taking to combat the bias women experience in virtual meetings and events, nor how they are intentional about highlighting presentations, keynotes, and resources written by women during COVID-19. In a study conducted to review the features of scientific conferences, researchers found that 97 percent of 270 scientific conferences examined lacked a statement of gender balance or diversity (Sarabipour et al., 2020). Additionally, they found that out of the meetings reporting names of chairs, organizers and invited speakers online, only 43 percent and 34 percent of conferences achieved gender parity for conference chairs and session chairs respectively; 41 percent achieved gender parity for conference organizers or steering committees; 32 percent and 34 percent achieved gender parity for keynote and plenary speakers, respectively; and only 17 percent had equal numbers of male and female invited or featured speakers (Sarabipour et al., 2020).

Researchers reviewing medical conferences also reported women are underrepresented among conference and symposium session chairs, plenary or keynote speakers, invited lecturers, or as panelists in a broad range of academic meetings (Larson et al., 2019; Gerull et al., 2019; Ruzycski et al., 2019). What is important to note is the role of professional societies in the sponsorship of women during this time, where for academic promotion, these organizations can provide the opportunity for development of national recognition and academic relationships beyond the home institution (Cree-Green et al., 2020). Similarly, the American Geophysical

Society investigated the chances of scientists from minority racial and ethnic groups that are underrepresented in Earth and space sciences being given speaking opportunities, compared with other applicants at their annual fall meeting from 2014 to 2017. The results indicated that first authors from underrepresented minority (URM) groups contributed 7.7 percent of all the abstracts in the sample ($n = 2,981$) and that URM applicants were disproportionately students or early-career scientists (79 percent compared with 59 percent of non-URM authors) and were less likely to be invited to give presentations (Ford et al., 2019).

Reducing or Alleviating Financial Pressures

As travel and face-to-face restrictions remain in place for many institutions and companies alike because of social-distancing guidelines (Centers for Disease Control and Prevention, 2020a), there are increasingly popular methods for convening that organizations have embraced to ensure access and inclusion. The American Society for Engineering Education (ASEE) reduced their annual conference registration rate and provided full registration scholarships available for up to 200 members with financial need, specifically those who were winners of best-paper awards, first-time authors, and professional track [non-tenure-track] or untenured faculty members. In addition to the financial support from Engineering Unleashed to support these registration scholarships, the ASEE Board reallocated funds from their reserves to provide an additional \$200 need-based registration scholarships for up to 500 members (Adams, 2020).

Building Virtual Environments Conducive to Collaboration and Networking

Prior to COVID-19, researchers investigating the shortcomings of scientific conferences found it imperative that organizers of virtual meetings and events improve strategies for facilitating digital connections (Sarabipour et al., 2020; Avery-Gomm, Hammer, and Humphries, 2016).

Specifically, they found that scientific organizations were utilizing features such as Slack to facilitate both group and one-on-one discussions during and after meetings, along with incorporating Twitter to deliver poster sessions (Avery-Gomm, Hammer, and Humphries, 2016; Royal Society of Chemistry, 2019; Sarabipour et al., 2020). However, as professional organizations shift to virtual events due to COVID-19, they are being cautioned to keep membership engagement in one central location to ensure members can readily find information and directly network with the organization and other members (Community Brands, 2020). As such, efforts to transition conferences and events to inclusive virtual spaces hinge on investing in immersive and interactive experiences that promote collaboration and networking (Sarabipour et al., 2020). The question still remains as to how virtual meeting components (e.g., ability for participants to engage one-on-one or in a group using video instead of chat, informal meet-ups, and social interaction) directly impact women's participation, advancement, safety, and ability to collaborate and network with their peers in this new setting.

THE IMPACT OF COVID-19 ON MENTORSHIPS AND SPONSORSHIPS

When women have sponsors, it can narrow the advancement gap between women and men in academic STEM (Patton et al., 2017). Research has shown mentors can positively impact the career outcomes and advancement of academic women (Ginther et al., 2020), but also suggests that mentor/sponsor relationships serve as a source of men's invisible advantage in STEM given women's lack of access to senior academics (O'Connor et al., 2020). In order to succeed within institutions that have explicit and implicit norms defining success, women academics need seasoned advocates that will be there to support, provide guidance, answer questions, quell doubts, and suggest viable pathways to achieving their professional goals (National Academies of

Sciences, Engineering, and Medicine, 2020). Studies have shown that women benefit from multiple mentors—both men and women—and that mentees receive a different experience from mentors who identify as men versus those who identify as women (O’Brien et al., 2010). The importance of mentors, and lots of them, for women STEMM academics is essential during difficult times, which is why it is of top priority for institutions to proactively support, encourage, and develop mentorship and sponsorship programs for their female faculty and staff (Mickey, Kanelee, and Misra, 2020).

Teaching and Mentoring

During this pandemic, women faculty have reported having less time for advising, mentoring, and research due to caregiving responsibilities (Anwer, 2020; Malisch et al., 2020). Specifically, they have had the same amount of course workload with the additional burden of transitioning their courses into a remote setting, while simultaneously experiencing the increased burden of dependent care. This leaves little time for two other major aspects of their professional lives—mentoring and research (Kramer, 2020a; Minello, 2020; Zimmer, 2020).

According to the interim report on COVID-19 and Engineering Education presented by ASEE, only 53 percent of faculty that completed a survey agreed they were given adequate resources from their institution to transition to online teaching. Most institutions did not reduce teaching load or advising/mentoring loads in response (Gruber et al., 2020). However, learning to teach remotely required a lot more time, unanticipated time, from faculty (American Society for Engineering Education, 2020). It remains to be seen whether university professors have, on average, transitioned successfully to teaching entirely remote classes, and how this success has been disaggregated using an intersectionality framework. What is clear is that other areas of faculty’s professional, and personal, life will suffer due to the expansion of time required to

transition to online courses that will reduce time for other activities, since there are, in fact, only 24 hours in a day (Alexander, 2020).

This pandemic has only exacerbated this issue of inequity for women faculty, who through societal norms carry a heavier burden of caregiving responsibilities in their private lives—both in terms of caring for children as well as for elderly parents (Schiebinger, Henderson, and Gilmartin, 2008). In June 2020, over 600 faculty, staff, students, and administrators registered for the ARC Network’s town hall, “Ensuring Equity in COVID-19 Institutional Responses.” This virtual event sought to learn from the higher education community the equity issues they are experiencing during the pandemic in order to identify critical issues and challenges facing the drive for systemic, sustained equity as the academy moves through the pandemic. Transcripts revealed challenges raised by attendees include, but are not limited to:

- Effective communication from administration across faculty, staff, and administrators.
- Ensuring inclusivity without overburdening marginalized faculty.
- Advocating through budgetary restrictions.

Further review of the transcripts revealed that members of the NSF ADVANCE community were asked whether or not they were included in decision-making processes with upper-level administration. One co-principal investigator of an NSF ADVANCE grant reported they had not been asked to participate in any high-level discussions, whereas two principal investigators with institutionalized ADVANCE offices reported they were asked to assist on equity issues and strategies to shape their institution’s response to COVID-19. Given the current efforts taking place at institutions with NSF ADVANCE programs, institutionalized ADVANCE offices,

as well as current ADVANCE programs, could be leveraged early in designing their approach to supporting women faculty, and faculty more generally, by temporarily reducing teaching load, and reducing intermediate research goals related to tenure and other promotions.

The Impact of Gendered Faculty Networks on Women

Networks represent a resource for individuals to locate opportunities, gain information and skills, and contribute to the formation of social capital (Williams and Durance, 2008). A 2019 meta-analysis, conducted by an ARC Network Virtual Visiting Scholar, explored the implications of STEM faculty networks for career success through an intersectional gender lens (Mickey, 2019). This research suggests there are three primary ways in which faculty networks are gendered to hamper women in STEM. First, women have smaller networks than their male counterparts. Second, women STEM faculty also tend to be more disconnected from the most prominent or central figures in research networks as compared to men. Finally, both men and women scientists tend to have connections with people who are similar to themselves in socially significant ways. However, for women, gender-based networks are negatively associated with organizational status, providing them with lesser quality information and resources (Mickey, 2019). Research also suggests that Black women rely on gender and racial/ethnic-based affinity networks for career support (Rothstein and Davey, 1995), and they also maintain stronger relationships with advisors and mentors from their former campuses. Black women faculty also tend to network with other Black women faculty through professional associations for both personal and research support (Mickey, 2019).

The advancement gap between men and women in academic STEM is not because women need to be “fixed,” but because they need guidance in navigating systems that inherently have performance support and reward bias built into them (Castillo and Benard, 2010; Roper,

2019). During this pandemic, while it is important for women faculty to continue to have access to mentors and sponsors, It is equally important to interrogate the systems that cause women to be “over mentored and under sponsored” (Ibarra, Carter, and Silva, 2010). Thus, when considering how gendered faculty networks have impacted the retention of women faculty in STEM, it is evident that the role of mentorship and sponsorship during COVID-19 is two-fold: (1) to support women faculty in navigating the systemic, professional, and personal challenges the evidence supports they will encounter as a result of the pandemic, and (2) to provide guidance and advocacy as they expand their networks.

Leveraging Affinity Groups/Working Groups and STEMM Networks to Promote Gender Equity During COVID-19

COVID-19 has highlighted the need for systemic overhaul in both institutions and professional organizations due to the continued barriers to access, inclusion, and advancement for minoritized communities. As such, there needs to be improved articulation of the work professional organizations are doing to promote gender equity during catastrophe, and how this will be accounted for in their long-term return to operations.

One way in which professional organizations can better highlight their efforts towards supporting women in academic STEMM during COVID-19 is via working groups. Working groups (also called affinity groups or divisions) are organization-recognized micro-communities that can serve to promote diversity and inclusion efforts and allow for networking, mentoring relationships, and other opportunities for professional and personal development (Taylor, 2019). Historically, affinity groups were centered on race or gender, but these groups are increasingly being created for those sharing other characteristics, such as age, sexual orientation, and disability status. Groups for women in professional organizations typically address gender equity,

recruitment and retention, awards and recognition, and career advancement (Taylor, 2019; Association of American Medical Colleges, 2020).

When considering the role of gender-centered affinity groups/working groups housed at professional organizations, evidence on the overarching roles of these groups suggests that during the COVID-19 pandemic these groups have been deployed to (1) advocate for the women members within the organization, (2) support the inclusion and raise the visibility of women in virtual meetings spaces, and (3) ensure organizations take intersectionality into account as they develop interventions to support women's advancement in the field.

To further improve efforts to support academic women in STEMM during and after COVID-19, evidence suggests that creating partnerships with networks who specialize in addressing gender equity issues in STEMM could further amplify gender equity work at professional organizations (ASPIRE Alliance, 2020; ARC Network, 2020; National Institutes of Health Equity Committee, 2020). STEMM networks have been leading discussions on ensuring equity for women in academia during COVID-19; however, their reach is often limited to those who are already knowledgeable of the network. By crafting intentional partnerships between STEMM networks and professional organizations, efforts can simultaneously heighten the visibility of women-centered working groups within the society and broaden the reach of STEMM networks. Given that one high-impact function of many professional organizations is sponsorship (e.g., nomination for awards, leadership opportunities, scientific plenaries, reviews, visiting professorships) (Cree-Green et al., 2020), coupled with the fact technical and scientific work rely on research teams, groups, and the cooperation of people (Fox, 2001), these bodies have an opportunity to shift how mentoring and sponsorship is viewed both within and outside academic institutions for women in STEMM.

To develop larger-scale interinstitutional change, there are opportunities for institutions and professional organizations to engage a number of equity-centered networks in STEMM. For example, for the past 20 years, the NSF ADVANCE program has provided funding to support the implementation of evidence-based systemic change strategies that promote equity for women STEM faculty in academic workplaces and the academic profession. In 2010, the ADVANCE Implementation Mentors (AIM) Network was formed to establish a common mentoring network for ADVANCE program coordinators/project directors (at all developmental stages of ADVANCE grants) with the purpose of answering questions and providing support; sharing promising practices; and establishing a common resource base. With membership of more than 80 program directors and managers, AIM is a community of practice that accelerates and disseminates the work of NSF ADVANCE. More recently, the ARC Network was established in 2017 to facilitate authentic, intentional dialogue between researchers and practitioners, connect inclusiveness to organizational principles and practices, and account for and incorporate intersectional perspectives throughout their work. Both networks have been instrumental in convening national audiences to discuss the issues women faculty in STEMM are facing and the resources they need to survive the current crisis.

CONCLUSION

At the intersection of a global health crisis and a fight for racial justice within the United States, professional organizations and networks must investigate how bias and marginalization materialize in rapid response to membership and societal needs. To meet the needs of academic women navigating the early stages of COVID-19, it will be incumbent upon professional organizations and networks to use an intentional, intersectional, and inclusive lens to ascertain the

myriad of opportunities for growth if they truly endeavor to build STEMM capacity and diversify these fields with qualified persons from traditionally excluded identities.

Federally funded endeavors such as the NSF's ADVANCE program and grassroots initiatives like the STEM Family Travel Network have called on professional organizations to magnify policies and practices that not only support equity and inclusion but also mitigate the systemic factors that create inequities in the academic profession for women (National Science Foundation ADVANCE Program, 2020; STEM Family Travel Network, 2020). To meet the needs of members navigating COVID-19, many professional societies and STEMM networks have transitioned their in-person events to virtual experiences, adjusted various submission deadlines to accommodate for continued uncertainty, and advocated both locally and nationally on behalf of their constituents (American Society of Association Executives, 2020; Community Brands, 2020).

The preeminent challenge, if an equitable and inclusive academic workforce is truly the goal, is to rise up and actively engage in solutions that work for women STEMM academics. Further consideration is needed to address the gendered implications of quarantine, particularly, whether the different needs of women are recognized in the decision-making process of their workplaces and the professional communities in which they are affiliated. As such, our review of the literature has failed to account for any systematic studies of how STEMM networks and professional organizations function during COVID-19 in aggregate. Specifically, who they serve, what they do, and with whom they collaborate.

Across the STEMM community for academic women, these five broad questions remain:

- (1) what are the characteristics of networks and professional organizations that provided services;
- (2) what services were provided, and to whom;
- (3) what resources were used to provide services;
- (4) what networks facilitated the ability of professional organizations to deliver services; and
- (5)

what lessons can be learned from these efforts? Additionally, as calls for research related to the impact of COVID-19 on networks and mentoring emerge,³ it begs to question what concerted effort between institutions, networks, and professional organizations is taking place to examine the unexpected successes and the systemic barriers women faculty of color in STEMM experience as a result of COVID-19.

³ For examples, see: <https://www.emeraldgrouppublishing.com/journal/ijmce/mentoring-times-crises-pandemics-and-social-distancing>, <https://www.academicpeds.org/announcements/special-call-for-papers-novel-educational-approaches-in-response-to-covid-19/>, and <https://www.elon.edu/u/academics/undergraduate-research/purm/call-for-papers/>.

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APPENDIX

LIST OF ASSOCIATIONS PROVIDED BY HEGGENESS AND WILLIAMS

Association

AACE International
ABET, Inc.
ABSA International
Academies Collaborative
Acoustical Society of America
AIChE
AIP Publishing
Alliance of Crops, Soils & Environ. Scientific Societies
American Anthropological Association
American Association for Anatomy
American Association for Cancer Research, Inc.
American Association for Clinical Chemistry: AACC
American Association for the Advancement of Science (AAAS)
American Association of Bioanalysts
American Association of Engineering Societies
American Association of Petroleum Geologists
American Association of Pharmaceutical Scientists
American Association of Physicists in Medicine
American Association of Physics Teachers
American Association of Textile Chemists and Colorists
American Astronomical Society
American Ceramic Society
American Chemical Society
American College of Veterinary Internal Medicine
American Concrete Institute
American Council of Engineering Companies
American Crystallographic Association
American Dairy Science Association
American Ecological Engineering Society
American Epilepsy Society
American Geophysical Union
American Indian Science and Engineering Society
American Industrial Hygiene Association
American Institute for Medical & Biological Engineering

American Institute of Aeronautics & Astronautics
American Institute of Architects
American Institute of Chemists
American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.
American Institute of Physics
American Institute of Professional Geologists
American Mathematical Association of Two-Year Colleges
American Mathematical Society
American Medical Colleges
American Meteorological Society
American National Standards Institute
American Nuclear Society
American Oil Chemists' Society
American Ornithological Society
American Pediatric Society
American Physical Society
American Physiological Society
American Phytopathological Society
American Psychological Association
American Public Works Association
American Society for Biochemistry and Molecular Biology
American Society for Cell Biology
American Society for Clinical Pharmacology & Therapeutics
American Society for Engineering Education
American Society for Engineering Management
American Society for Healthcare Engineering
American Society for Microbiology
American Society for Nondestructive Testing, Inc.
American Society for Parenteral and Enteral Nutrition
American Society for Pharmacology and Experimental Therapeutics
American Society for Quality
American Society of Agricultural and Biological Engineers
American Society of Certified Engineering Technicians
American Society of Civil Engineers
American Society of Gas Engineers
American Society of Heating, Refrigerating and Air Conditioning Engineers
American Society of Human Genetics
American Society of Landscape Architects
American Society of Materials, International
American Society of Mechanical Engineers
American Society of Naval Engineers

American Society of Parasitologists
American Society of Plant Biologists
American Society of Safety Engineers
American Society of Test Engineers
American Society of Tropical Medicine and Hygiene
American Sociological Association
American Speech-Language-Hearing Association
American Statistical Association
American Vacuum Society
American Water Resources Association
American Water Works Association
American Welding Society
AOAC International
ASHRAE
ASM International
ASQExcellence
Association for Behavioral Analysis International
Association for Computing Machinery
Association for Facilities Engineering
Association for Hospital Medical Education
Association for Information Science and Technology
Association for Iron and Steel Technology
Association for Molecular Pathology
Association for Psychological Science
Association for Public Policy Analysis and Management (APPAM)
Association for Research in Vision and Ophthalmology
Association for the Advancement of Artificial Intelligence
Association for the Advancement of Cost Engineering
Association for the Advancement of Medical Instrumentation
Association for Women in Computing
Association for Women in Mathematics
Association for Women in Science
Association of American Medical Colleges
Association of American Veterinary Medicine Colleges (AAVMC)
Association of Biomolecular Resource Facilities
Association of Clinical Research Professionals
Association of Conservation Engineers
Association of Energy Engineers
Association of Environmental & Engineering Geologists
ASTM International
Audio Engineering Society

BICSI
Biomedical Engineering Society
Biophysical Society
Board of Certified Safety Professionals
Botanical Society of America
Casualty Actuarial Society
Clinical Laboratory Management Association
Coalition for Academic Scientific Computation
Coastal and Estuarine Research Federation
Computing Research Association
Computing Science Accreditation Board (CSAB)
Construction Management Association of America
Construction Specifications Institute (CSI)
Council for Agricultural Science and Technology
Council of Engineering and Scientific Specialty Boards
Council of Landscape Architectural Registration Boards (CLARB)
Council of Scientific Society Presidents
Council on Undergraduate Research
Directed Energy Professional Society
Ecological Society of America
Electrochemical Society
Entomological Society of America
Environmental Engineering Geophysical Society
Fabricators and Manufacturers Association, International
Federation of American Societies for Experimental Biology
Federation of Associations in Behavioral & Brain Sciences
Federation of Materials Societies
Fluid Power Society
Geochemical Society
Geological Society of America, Inc.
GeoScienceWorld
Human Factors and Ergonomics Society
IFSCC (International Federation of Societies of Cosmetic Chemists)
Illuminating Engineering Society of North America
IMAPS-International Microelectronics Assembly and Packaging Society
Industrial Research Institute
Infectious Diseases Society of America
INFORMS (Institute for Operations Research and the Management Sciences)
Institute of Biological Engineering
Institute of Electrical and Electronics Engineers, Inc.
Institute of Environmental Sciences and Technology

Institute of Food Technologists
Institute of Industrial and Systems Engineers
Institute of Mathematical Statistics
Institute of Transportation Engineers
International Association of Medical Science Educators – IAMSE
International Federation for Medical and Biological Engineering
International Society for Computational Biology
International Society for Magnetic Resonance in Medicine
International Society for Pharmaceutical Engineering, Inc.
International Society for Stem Cell Research
International Society of Automation
International Society of Explosives Engineers
International Solar Energy Society
International Urogynecological Association
Laser Institute of America
Linguistic Society of America
Materials Research Society
Mathematical Association of America
Metal Powder Industries Federation
NACE International
National Academy of Engineering
National Association of Corrosion Engineers
National Association of Multicultural Engineering Program Advocates, Inc.
National Council of Examiners for Engineering and Surveying
National Council of Structural Engineers Associations
National Council of Teachers of Mathematics
National Environmental Health Association
National Foundation for Infectious Diseases
National Institute of Building Sciences
National Society of Black Engineers
National Society of Professional Engineers
North American Association for Environmental Education
Oceanic Engineering Society
OSA - The Optical Society
oSTEM Inc
Population Association of America
Psychonomic Society
SACNAS
SAE International
SAMPE (Society for the Advancement of Material and Process Engineering)
Seismological Society of America

Sexual Medicine Society of North America
SHPE - Society of Hispanic Professional Engineers
Society for Biological Engineers
Society for Conservation Biology
Society for Imaging Science & Technology
Society for Industrial & Applied Mathematics
Society for Industrial and Organizational Psychology
Society for Industrial Microbiology and Biotechnology
Society for Investigative Dermatology
Society for Mining, Metallurgy, & Exploration, Inc
Society for Neuroscience
Society for Pediatric Research
Society for Sedimentary Geology
Society for the Study of Reproduction
Society of Actuaries
Society of Allied Weight Engineers
Society of American Military Engineers
Society of Asian Scientists and Engineers
Society of Cable Telecommunication Engineers
Society of Economic Geologists
Society of Environmental Toxicology & Chemistry
Society of Exploration Geophysicists
Society of Fire Protection Engineers
Society of Flight Test Engineers
Society of Manufacturing Engineers
Society of Mexican-American Engineers and Scientists
Society of Motion Picture and Television Engineers
Society of Naval Architects and Marine Engineers
Society of Petroleum Engineers, Inc.
Society of Plastics Engineers
Society of Reliability Engineers
Society of Toxicology
Society of Wetland Scientists
Society of Women Engineers
Soil and Water Conservation Society
Southeastern Consortium for Minorities in Engineering
SPE - Inspiring Plastics Professionals
SPIE (The International Society for Optical Engineering)
Standards Engineering Society
TAPPI
The American Ceramic Society, Inc.

The American Medical Women's Association
The Ecological Society of America
The Electrochemical Society
The Endocrine Society
The Histochemical Society
The Minerals, Metals & Materials Society
Women in Engineering Programs and Advocates Network

Process: To collate a list of professional STEM organizations, we first selected organizations represented by membership in the Council of Engineering and Scientific Society Executives. We also utilized the comprehensive list of professional organizations and associations compiled on <https://jobstars.com/science-professional-associations-organizations/>. We also did special searches for computing, mathematical, and medical professional organizations to ensure adequate representation.