STEM Inclusion Study

ORGANIZATION REPORT:
AMERICAN ASSOCIATION OF PHYSICS TEACHERS (AAPT)

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EXECUTIVE SUMMARY

The STEM Inclusion Study, led by Dr. Erin Cech (University of Michigan) and Dr. Tom Waidzunas (Temple University), is the first large-scale, national-level study to simultaneously examine the experiences of women, racial and ethnic minorities (REM), persons with disabilities, and lesbian, gay, bisexual, transgender, and queer (LGBTQ) individuals working in the science, technology, engineering and math (STEM) workforce.[1] The study advances knowledge of the structures and cultures of STEM fields that may undermine equality of opportunities and outcomes on the basis of gender, racial/ethnic category, disability, and LGBTQ status. Overall, the goal of the study is to better understand processes of disadvantage experienced by members of STEM-related professional organizations in order to inform diversity and inclusion efforts in these organizations, as well as other STEM-related entities and institutions.

This organization participated in the survey phase of the STEM Inclusion Study, alongside a number of other STEM-related professional organizations. [2] With permission from the organization, the research team surveyed members of this organization on a variety of topics related to members' day-to-day experiences in their workplaces and their encounters with other STEM professionals. Using data from this survey, this report examines trends regarding (a) *experiences of inclusion and marginalization*, analyzing employees' perceptions of their workplace climate, feelings of personal fit, and harassment on the job; (b) *professional valuation*, the extent to which respondents believe they are respected and taken seriously as STEM professionals, and (c) *reports of workplace fairness,* the frequency with which respondents report instances of hostility and unfair treatment in their workplaces toward members of disadvantaged groups. We compare reports of fairness across employment sector (college or university, K-12, for profit sector and other employment sector).

Regarding *experiences of inclusion and marginalization*, persistent patterns emerged by gender, disability status, and race/ethnicity in this organization. Specifically, controlling for employment sector, education level, and age, women, persons with disabilities, and some racial/ethnic minority group members are significantly more likely to report experiences of marginalization in their workplace than their colleagues. A similar pattern emerged regarding *professional valuation*: women, persons with disabilities, and certain racial/ethnic minority group members are significantly more likely to report having their professional expertise devalued, receiving less respect from their supervisors and co-workers, and feeling as though they have to work harder than their colleagues to be seen as competent STEM professionals.

Regarding patterns in *workplace fairness,* organization members across different employment sectors reported witnessing or experiencing instances of negative treatment and harassment with some frequency: for instance, 29% of respondents reported witnessing negative treatment by gender in their workplaces in the last three years, and 18% reported witnessing negative treatment along the lines of race/ethnicity. These instances of negative treatment were reported more frequently among organization members working in higher education, compared to those employed in K-12 and for-profit sectors.

This report begins with a brief introduction to inequality issues within the STEM workforce, then summarizes the survey results of this organization and offers suggestions for addressing these issues. In particular, we highlight the finding that women report significantly less positive experiences than men on *every measure* of marginalization and professional devaluation that we examine here, and we find racial/ethnic differences, and differences by disability status and LGBTQ status on several measures.

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[2] In total, the STEM Inclusion Study aims to include 15-20 professional organizations, seeking to maximize representation from the array of STEM disciplines, sectors, and industries. The names of the professional organizations are kept confidential to protect the confidentiality of individual survey participants.

BACKGROUND

In both public and scholarly discourse, there is growing interest surrounding the retention and representation of certain socio-demographic groups in the STEM workforce. Investigating the processes of disadvantage that underrepresented groups in STEM face helps illuminate the factors that prevent talented and motivated individuals from advancing in STEM. Yet, scholars are only beginning to understand the particular mechanisms that reproduce these disadvantages within STEM workplace interactions, within STEM organizations, and within the contexts of science and engineering professional cultures. There is a pressing need for more research on these issues.

Investigations such as those undertaken by the STEM Inclusion Study are especially timely, as research over the last three decades has documented processes reproducing the underrepresentation of women, racial/ethnic minorities, LGBTQ persons, and persons with disabilities in science and engineering. Historically, women have been underrepresented in STEM in the United States (Iskander et al. 2013), and similar patterns are recorded in countries such as Korea, Switzerland, and Australia (Buccheria, Abt Gurber and Bruhwiler 2011). Women are less likely than men to enter STEM fields and more likely than men to leave them (Frehill 2012). In attempts to explain these gaps, research has not found any evidence of a performance gap between men and women (Koul, Lerdpromkulrat and Chantara 2011). Rather, stereotypes regarding who "fits" STEM are strongly connected to women's under-representation in STEM, perpetuate "chilly" climates for women, and undermine the perception of women's competence as STEM professionals (Archer et al. 2013, Cech 2013, Cech et al. 2011, Cheryan et al. 2011). For instance, in a blinded study of science faculty hiring a student lab manager, men applicants were rated as more competent and likable than women applicants and offered higher salaries than women, even though the applicants had otherwise identical applications (Moss-Racusin et al. 2012). Among faculty populations, women tend to receive fewer resources, less mentoring, face greater criticism and isolation from peers, and are shouldered with more administrative and service work than men (McIlwee & Robinson 1991, NSF 2007).

Existing research has also detailed the experiences and challenges of racial/ethnic minorities in STEM fields. Racial/ethnic minorities (particularly African Americans and Hispanics) are highly underrepresented in STEM majors, in STEM faculty positions, and in STEM positions in industry, compared to their representation in US population more broadly (Babco 2003, Huradto et al. 2010). This underrepresentation is attributed to a range of issues, including unequal educational opportunities and mentoring (Moreno et al. 2006), implicit bias (Turner 2002, Moody 2004), and feelings of isolation within academic departments and communities (Zambrana et al. 2015). This underrepresentation of racial/ethnic minority faculty in STEM departments, furthermore, gives minority students the impression that they do not have a place in STEM or academic fields (Nelson and Brammer 2012). Thus, the under-representation of minority faculty and students in STEM are closely tied with one another—without mentors with whom minority students can relate, they are less likely to believe that they can be successful in STEM fields (Nelson and Brammer 2012). Less research has examined the experiences of racial/ethnic minority persons employed in STEM outside of academia, although there is reason to believe that experiences of marginalization and exclusion extend to non-academic sectors as well.

Scholars are only beginning to understand the experiences of LGBTQ individuals in STEM, but limited previous research indicates that LGBTQ persons frequently face marginalization and unfair treatment compared to their non-LGBTQ peers. Cumulatively, prior studies indicate the existence of negative climates for LGBTQ faculty and students in higher education and suggest a link between this climate and academic/career consequences. A recent campus climate study of students, faculty, and administrators revealed negative experiences for LGBTQ college students and faculty (Rankin et. al 2010). For example, 31 percent of LGBTQ students and faculty reported that they were not comfortable with the climate on their campus climate and 20 percent feared for their physical safety. Faculty and students in

STEM departments specifically report similar, if not more extreme, experiences of marginalization in science and engineering departments (Cech 2013; Cech and Waidzunas 2011; Bilimoria and Stewart 2009; Gunckel 2009). Further, recent research on employees of STEM-related federal agencies found strong and persistent workplace experience inequalities for LGBTQ-identifying persons compared to their non-LGBTQ colleagues (Cech & Pham 2017).

Little is understood about the experiences of persons with disabilities in STEM education and employment as well. Early research suggests that STEM fields may be particularly difficult and marginalizing environments for those with disabilities. Disability is often associated with negative stereotypes about intellectual ability; those with disabilities are often perceived as less intellectually competent than their peers (Slaton 2013). In STEM, this association is further compounded by the fact that STEM culture often silences discussions of bodily ability when evaluating performance (Knorr-Certina 1995, Siebers 2010, Slaton 2013).

Methodological Summary: In the spring of 2017, the STEM Inclusion Study fielded a confidential survey to this organization's membership list.[3] Members were sent a pre-notification email in April 2017, followed a week later by an email with a unique URL survey link. Participation in the survey was voluntary and individual responses are kept strictly confidential.[4] All survey results below are presented in a way that ensures that any given individual's responses are not individually identifiable. A small group of students (N=130) also participated in the survey. For the purposes of this report, we focus only on the workplace experiences of organization members who were employed at the time of the survey.

Table 1 below presents the proportion of employed respondents by gender,[5] race/ethnicity (respondents could identify with more than one racial/ethnic minority category), LGBTQ status, disability status,[6] and employment sector (university/college, K-12, for-profit, or other).

Table 1: Descriptive Statistics of Sample by Demographic Characteristics (N=1,160)

Demographic Characteristics	Percent of the Sample
Women	31.38%
Men	67.90%
Hispanic	4.39%
Asian	5.10%
Black	2.20%
White	86.61%
Other race/ethnicity	1.70%
LGBTQ	5.46%
Disability (physical, mental or emotional)	20.99%
Employed at University or College	45.47%
Employed in K-12 school	25.58%
Employed in for-profit sector	2.12%
Employed in other sector	5.70%

[3] The membership list was provided to the research team via a secure online file sharing application. The membership list was used only for the purposes of this research. This organization's participation the study was approved by the University of Michigan Institutional Review Board.

[4] Respondents participated in an online survey that took approximately 15-minutes to complete. The survey consisted of active members with a paid membership to this organization. The survey was distributed via a private email link, to 4922 individuals. Survey sample size: 1828, response rate: 37%. We include in this analysis only those respondents who were employed (N=1,160) at the time of the survey. Survey data was analyzed using Stata statistical programming package. The survey results above report univariate statistics (means).

[5] The category "women" includes both cis-gender and transgender women and the category "men" includes both cis-gender and transgender men.

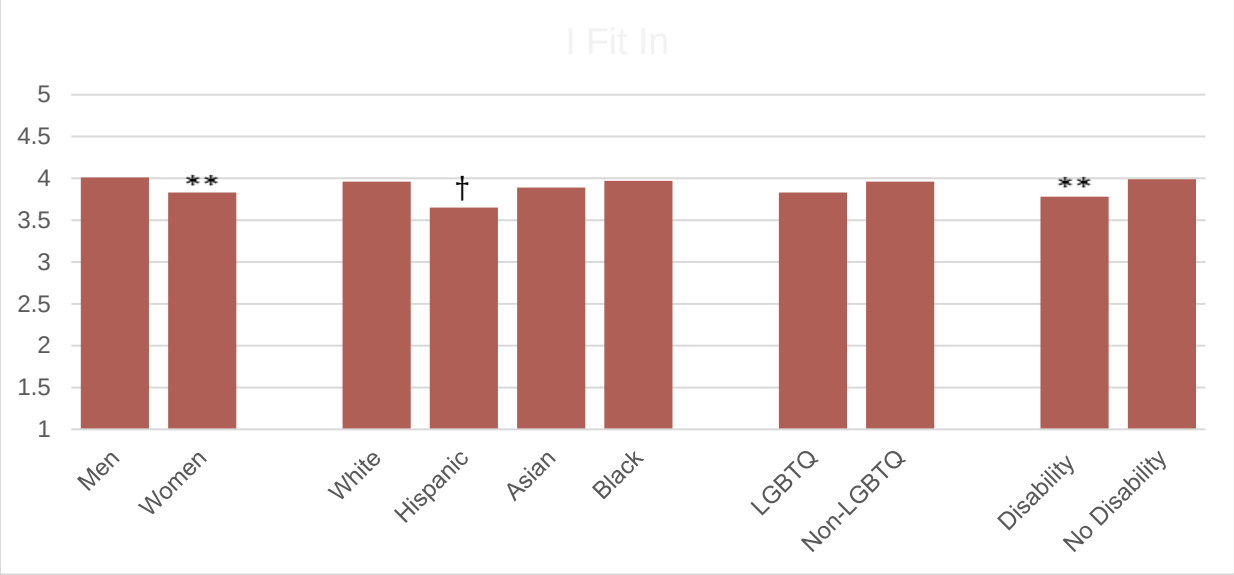
[6] Note: 18.05% of the sample identified as having a physical disability, and 6.47% of the sample identified as having a mental or emotional disability.

1. Inclusion and Marginalization

As noted above, previous research has found that women, racial/ethnic minorities, LGBTQ persons, and persons with disabilities in various arenas in STEM education and employment report more frequent experiences of marginalization and isolation than their colleagues (Frehill 2012, Cech 2013; Cech and Waidzunas 2011; Bilimoria and Stewart 2009; Gunckel 2009). This marginalization has consequences for long-term satisfaction and retention of these groups in STEM education and employment (Eglash 2002, Chang et. al 2008, Zambrana et. al 2015, Laschinger et. al 2004).

We explore patterns of inclusion and marginalization across demographic categories in this organization on four key indicators: (1) whether they feel like they fit in with other people in their workplace, (2) whether they have read or heard insensitive comments in their organization in the last year, (3) whether they worry that their mistakes garner more visibility than those of their colleagues, and (4) whether they have been harassed verbally or in writing in their workplace. In this work, we consider each axis of marginalization independently. However, we recognize that within a theory of intersectionality (Crenshaw 1991), forms of marginalization across these dimensions are interlocking and interwoven. In our research aggregating data across professional societies in the STEM Inclusion Study, we will have a sample size large enough to explore intersectional effects in our analysis of survey results.

Fig 1: "I feel like I fit in with other people in my workplace."



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

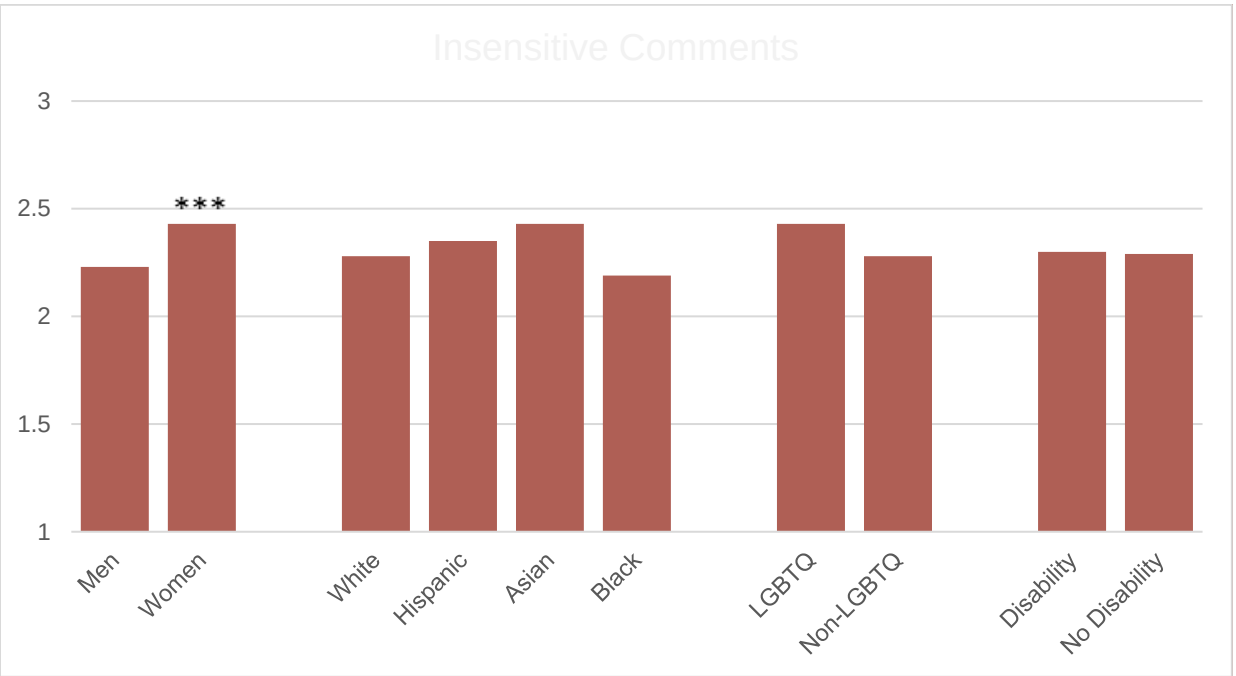
Figure 1 represents respondents' feelings of "fit" in their current workplace among other employees (values range from 1-5, 1=Strongly Disagree through 5=Strongly Agree). The values are predicted probabilities, or the means for each group holding variation by age, sector, and education level constant.

There are several significant differences on this measure of marginalization, as indicated by the asterisks above the bar (***p<.001, **p<.01, *p<.05, †p<.10, two-tailed test).[7] First, compared to men, women are significantly less likely to report that they feel like they fit in their workplace.

Further, Hispanic respondents are marginally significantly less likely than their white counterparts to report that they fit in, and respondents with a disability were less likely than their peers to report that they fit in. Although the mean for LGBTQ persons is lower than for non-LGBTQ persons, this difference is not statistically significant.

Overall, the averages among all demographic groups were relatively high, with respondents feeling on average between "Neither Disagree nor Agree" and "Agree" in regards to fitting in with others at their work.

Fig 2: "I have read or heard insensitive comments in my workplace that I found offensive."



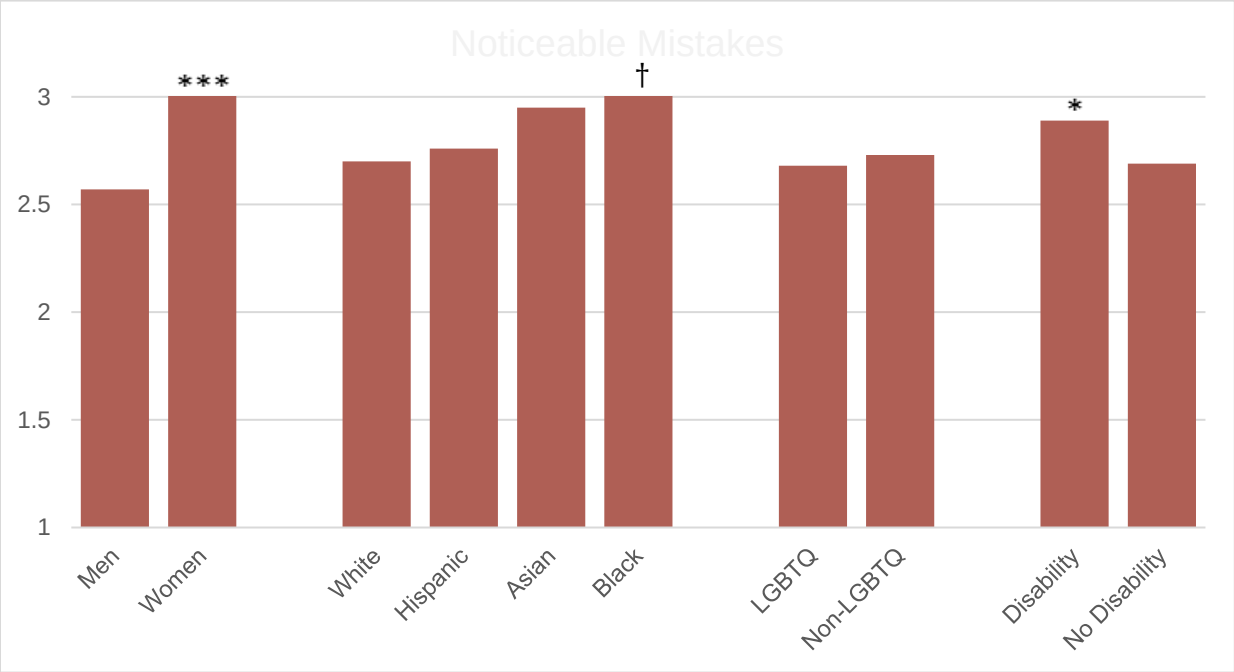
Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=Never, 2=At least once in the past year, 3=At least once a month or more)*

This second measure indicates whether some groups are significantly more likely than others to have encountered insensitive or offensive comments in their workplaces. Such comments are an important mechanism of marginalization in workplaces. Overall, across all demographic groups, respondents reported encountering an offensive comment at least once in the past year.

[7] Significance levels were determined by logistic, OLS, or ordered logistic regressions (depending on the dependent variable in question) that included measures for gender, racial/ethnic category, LGBTQ status, age, disability status, education level and employment status. These models were multiply imputed (20 imputations using the chained command in Stata) so that all figures have an N=1,160

Women reported that these insensitive comments happened significantly more frequently than men reported them happening. There were no other significant group differences on this measure. Although there are some differences in the means across other demographic categories, these differences are not statistically significant.

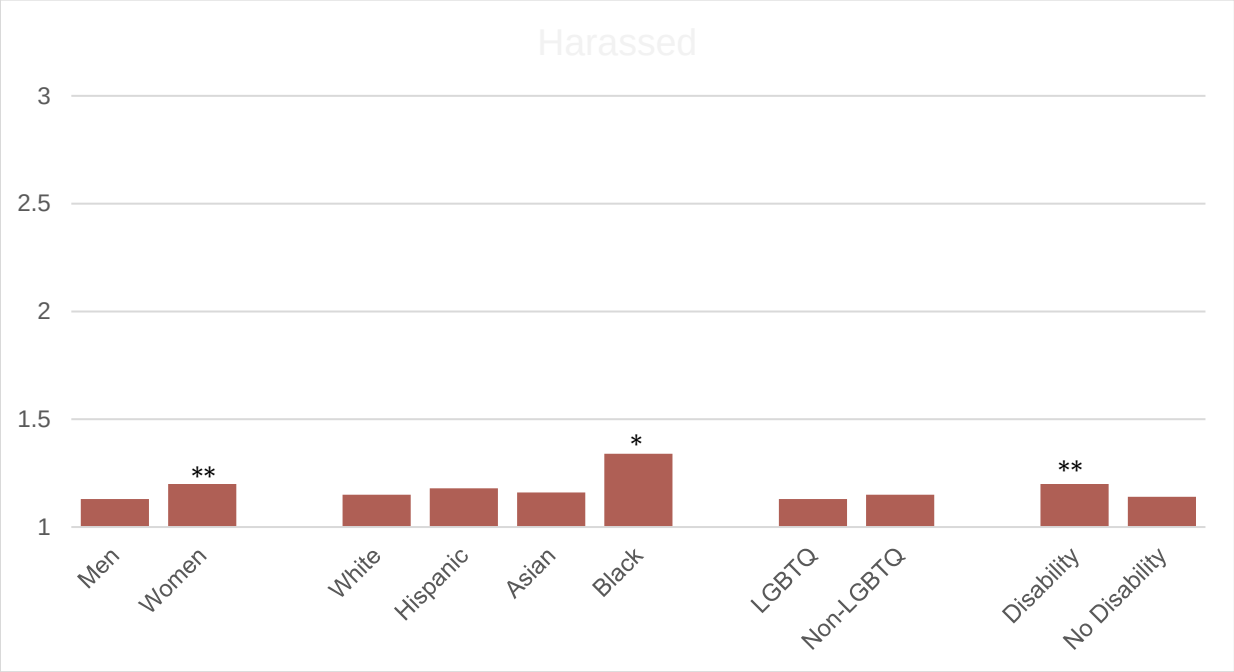
Fig 3: "I worry that my mistakes are more noticeable than the mistakes of others."



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

Another important indicator of marginalization is the extent to which disadvantaged groups fear that their mistakes will be more visible than those of their colleagues. In the figure above, there are several significant group differences: net of variation by sector, education level, and age, women are more likely than men, black respondents marginally more likely than whites, and persons with disabilities more likely that those without disabilities to worry that their mistakes garner more negative attention than their colleagues.

Fig 4: "I was harassed verbally or in writing on the job in the last year."



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=Never, 2=At least once in the past year, 3=At least once a month or more)*

Overall, as indicated in Fig 4, experiences of direct harassment are relatively rare. However, women were significantly more likely than men to report experiencing harassment at work in the last year.

Black respondents were also significantly more likely than white respondents to report harassment, and persons with disabilities were significantly more likely than others to report harassment. These differences are significant net of variation by age, sector, and education level.

Summary of Patterns of Marginalization

Several strong demographic patterns emerged on the marginalization measures above. The most persistent pattern was along the lines of gender: women respondents consistently reported more frequent experiences of marginalization in their workplaces than men, net of other demographic and work characteristics. These gender differences emerged on each one of the marginalization measures we include in our analysis. For example, women were more likely than men to report witnessing offensive comments in their workplace, more likely than men to report being harassed at work, and more likely to state that they worried their mistakes were more noticeable than others. These results point to a concerning pattern of institutional marginalization of women employees in workplaces.

Another consistent pattern that emerged is the marginalization experienced by persons with physical disabilities or mental illness. Respondents with one or more disabilities were significantly less likely than their otherwise similar peers to feel that they fit in at their workplaces and more likely to report that their mistakes were more visible than the mistakes of their colleagues. These patterns point to an important point of consideration for this organization as it advocates for the interests of its members.

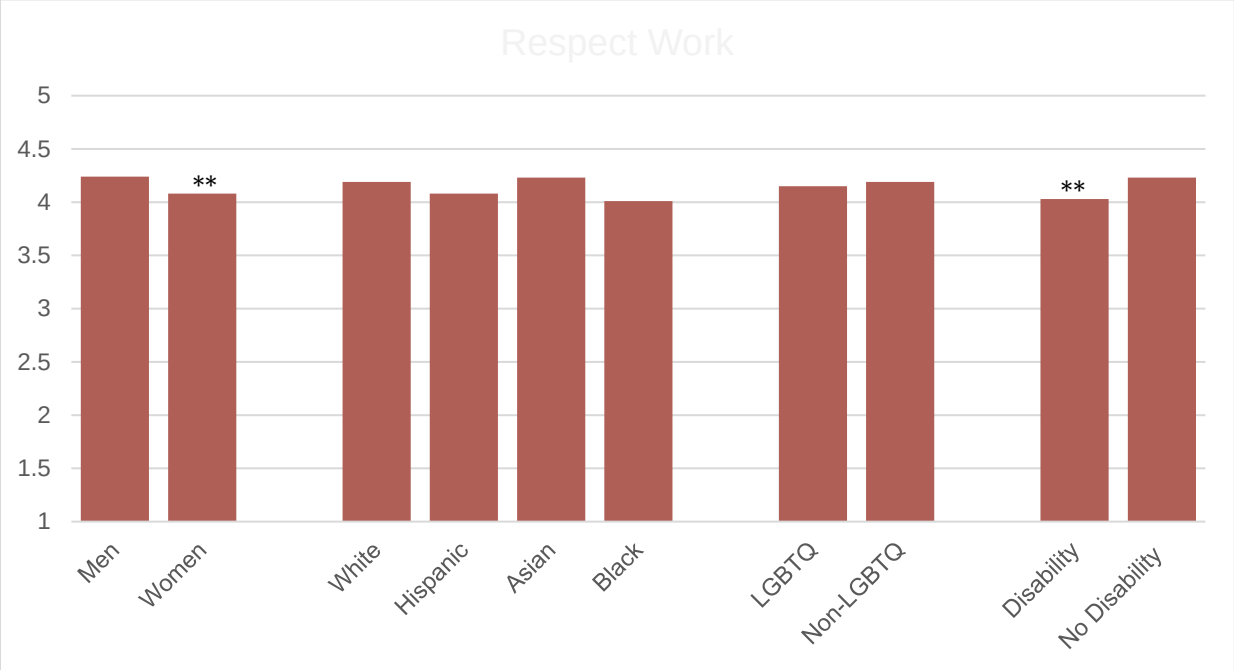
Several other patterns of marginalization emerged. First, black respondents were significantly more likely than white respondents to report being harassed at work, and had the highest rates of harassment overall. Black respondents were also marginally significantly more likely than white respondents to report that their mistakes were more noticeable than their colleagues. Hispanic respondents were less likely than white respondents to agree that they fit in with others (although this was marginally significant), and their averages for this measure were the lowest among demographic groups. Finally, LGBTQ individuals were marginally more likely than their non-LGBTQ peers to report encountering offensive comments in their workplaces. In short, LGBTQ persons, persons with disabilities, and women were significantly more likely than their non-LGBTQ, non-disabled, and male counterparts to report a chilly climate at their workplace.

2. Professional (De)valuation

Prior research has found that disadvantaged groups within STEM often experience their colleagues questioning their scientific and engineering competence and performance (Moss-Racusin et. al 2012, Steele 2003, Chang et al. 2008, Williams 2014). Disparities in the recognition of the professional excellence of women, people of color, and LGBTQ individuals in STEM exacerbate the disciplinary issues of underrepresentation and attrition in STEM education and careers (Shapin 1995, Collins and Evans 2007, Williams 2014, Steele 2003, Chang et al. 2008, Nelson and Brammer 2012).

In this section, we examine five important indicators of professional devaluation: (1) whether they believe their work is respected in their workplace, (2) whether they believe their supervisor respects them, (3) whether they believe they are held to the same standard as their colleagues, (4) whether their boss gives them less credit than they deserve, and (5) whether they believe they have to work harder than their colleagues to be perceived as legitimate professionals.

Fig 5: "In my workplace, my work is respected."



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

As above, the bar charts in this section present the predicted means for each demographic category, net of variation by age, education level, and sector. The asterisks represent significant differences across those categories, as determined by OLS or ologit regression models (***p<.001, **p<.01, *p<.05, †p<.10, two-tailed test).

Figure 5 captures the extent to which respondents feel as though their work is respected within their workplaces (1-5; 1=Strongly Disagree, 5=Strongly Agree). Respondents typically feel that their professional work is respected—answers lie on average between somewhat and strongly agree. However, women are significantly less likely than men to report that their work is respected and persons with disabilities are significantly less likely than those without disabilities to report that their work is respected by their colleagues.

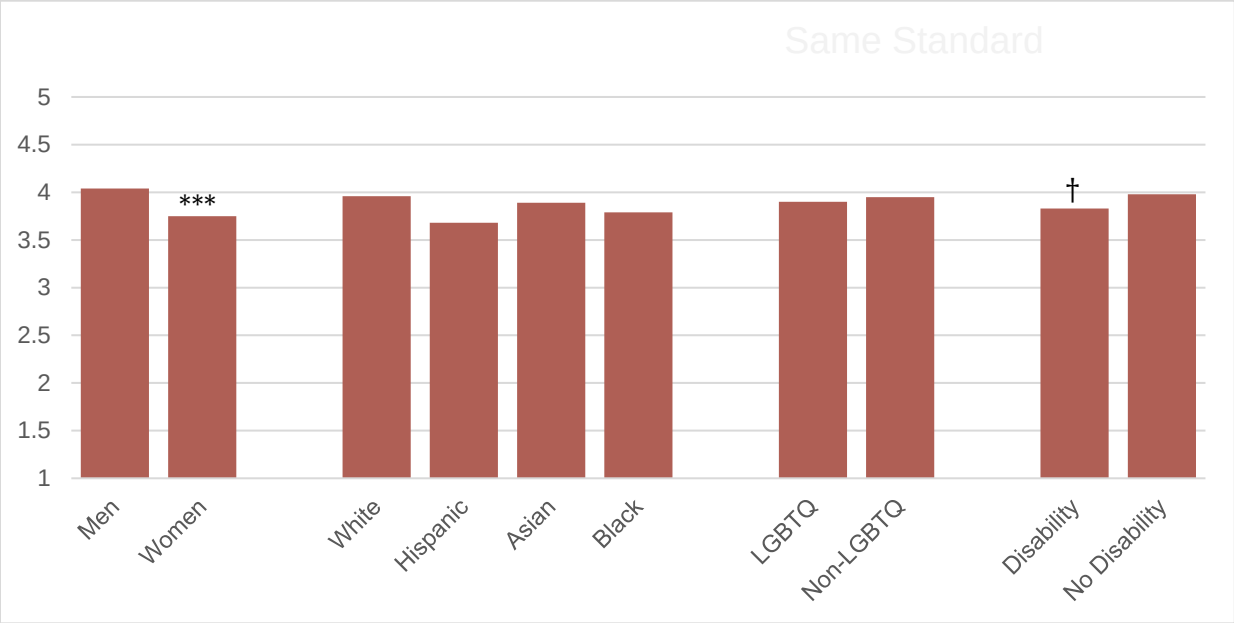
Fig 6: "My supervisor treats me with respect."

Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

The second measure captures whether respondents feel respected by their supervisors (Fig 6). In general, respondents typically report that they experience at least a certain degree of respect from their supervisors. However, there are important demographic differences.

Specifically, women are significantly less likely than men with the same education level, the same age, and in the same sector to report that their supervisors respect their work. Similarly, Hispanic and black respondents are marginally less likely than their white counterparts to report that their supervisors respect them.

Fig 7: "I am held to the same standard as others for promotion and advancement."

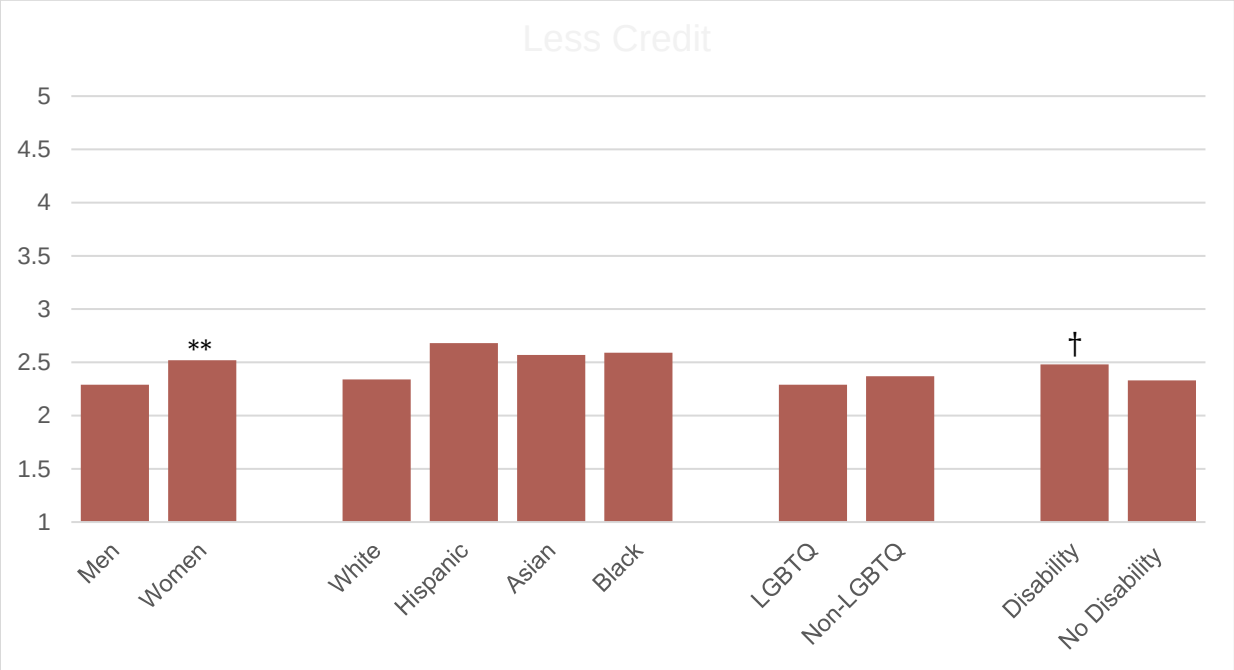


Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

Another important indicator of professional respect is the extent to which respondents believe that they are held to the same standard for advancement and promotion as their colleagues (Fig 7). Those who feel that they are held to a higher standard may not advance as quickly, and are not given the same level of respect for the same quality of work.

Consistent with the results above, women are significantly less likely than men to report that they are held to the same standard as their colleagues in their workplaces. Additionally, persons with disabilities are marginally less likely to report that they are held to the same standard as those without disabilities.

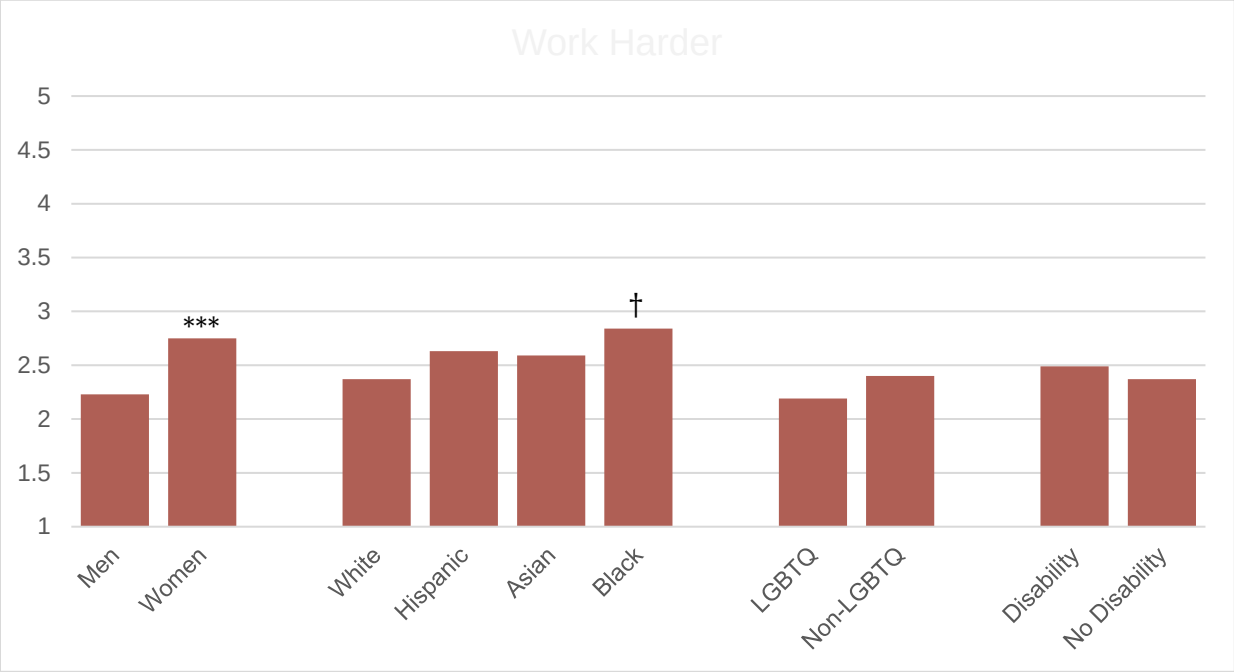
Fig 8: "My boss gives me less credit than I deserve."



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

Similar to the measures above, Figure 8 reports the extent to which respondents agree that their boss gives them less credit than they deserve. In general, respondents typically disagree with this statement: the average sits between "somewhat disagree" and "neutral." Yet, as before, there are important demographic differences: women are significantly more likely than men to report that their boss gives them less credit than they deserve, and those with disabilities are also marginally more likely to agree with this statement than people without disabilities.

Fig 9: I have to work harder than my colleagues to be perceived as a legitimate professional.



Predicted Probabilities by gender, race/ethnicity, LGBTQ and disability status, net of differences by sector, age, and education level. *(1=strongly disagree to 5=strongly agree)*

As a final measure of professional valuation, Figure 9 above reports the predicted means on a measure that asks respondents the extent to which they agree that they have to work harder than their colleagues to be perceived as a legitimate professional. As a whole, responses average between "disagree" and "neutral."

But, as before, there is important demographic variation. Specifically, women are more likely than men, and black respondents are marginally more likely than white respondents, to agree that they have to work harder to be perceived as a legitimate professional.

Summary of Patterns of Professional Devaluation

Among the measures in this professional devaluation category, we see similar trends as those reported in the measures relating to marginalization. Gender was once again the basis of the strongest pattern observed—women have significantly more negative values on all measures in this category: women are less likely than men to report that their work is respected, less likely to report that their supervisor treated them with respect, less likely to report that they are held to the same standard for promotion as others, more likely than men to report that their boss gives them less credit than they deserve, and more likely than men to report that they had to work harder than others to be viewed as a professional.

Individuals with disabilities also frequently reported instances of professional devaluation. Respondents with disabilities were significantly less likely than counterparts without disabilities to report that their work is respected and more likely to report that they are held to a different standard than their colleagues and get less credit than they deserve for their work. Again, these differences are net of variation in the sample by education level, age, and employment sector.

Lastly, a few differentials emerged by race/ethnicity. Black and Hispanic respondents, compared to white respondents, reported levels of agreement that their supervisor treated them with respect. Furthermore, black respondents were

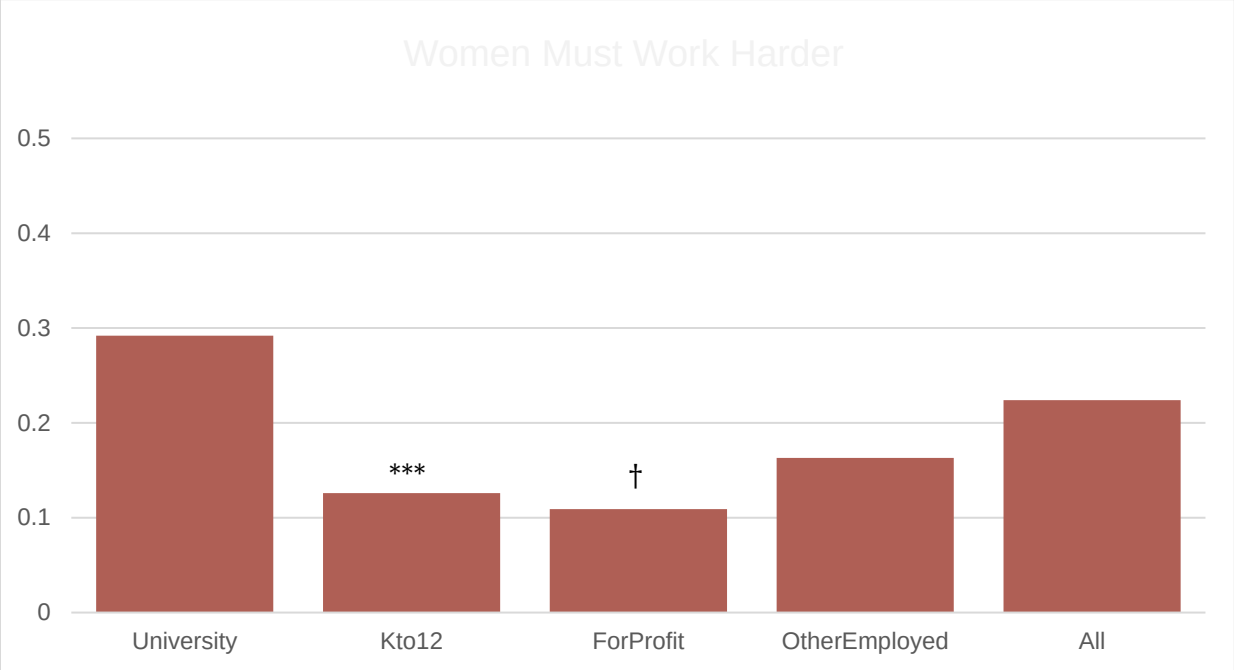
more likely than white respondents to report that they have to work harder than their colleagues to be viewed as a legitimate professional.

3. Patterns of workplace fairness across sectors

In the sections above, we compared experiences of marginalization and professional devaluation across demographic categories, controlling for variation for several work factors, including employment sector. However, members of this organization work across a variety of employment sectors (e.g., universities, K-12 classrooms, for-profit companies); the climate for disadvantaged groups may vary considerably across these sectors. As such, this section compares indicators of chilly climates (by gender, race/ethnicity, LGBTQ status and disability status) across different employment sectors. It allows us to ask, are certain sectors more positive for under-represented members of this organization than others?

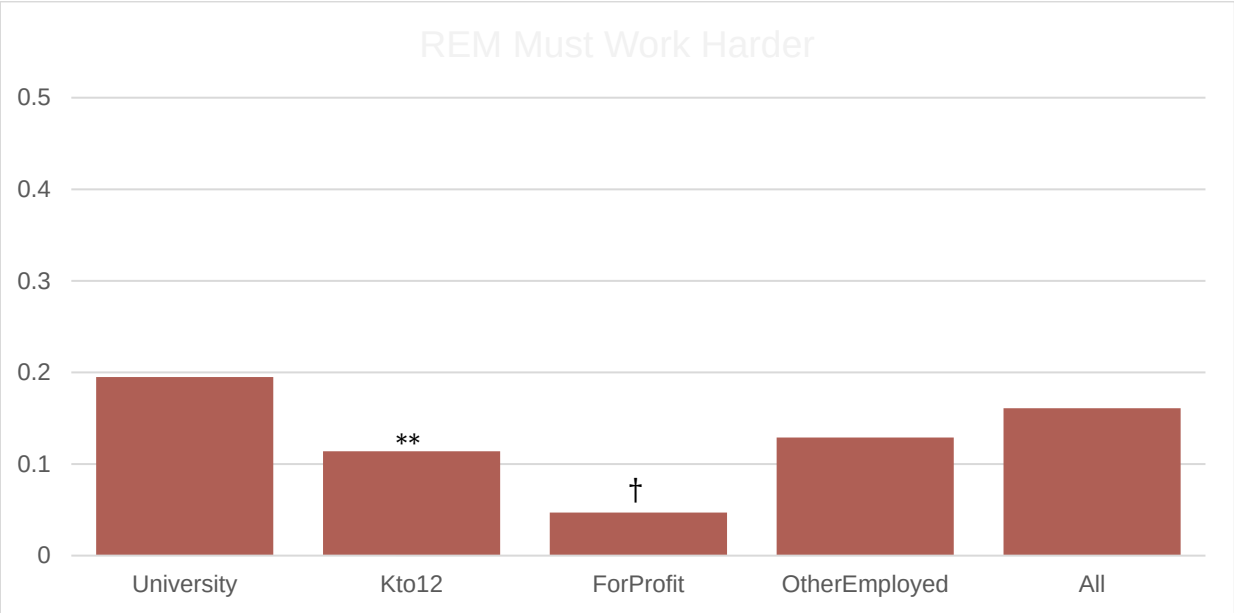
The three figures below present the proportion of respondents in each sector who agree that women, racial/ethnic minorities, and LGBTQ persons must work harder than others to convince their colleagues of their competence.

Fig 10: Proportion of respondents by sector agreeing that "Women in my workplace must work harder than men to convince colleagues of their competence."



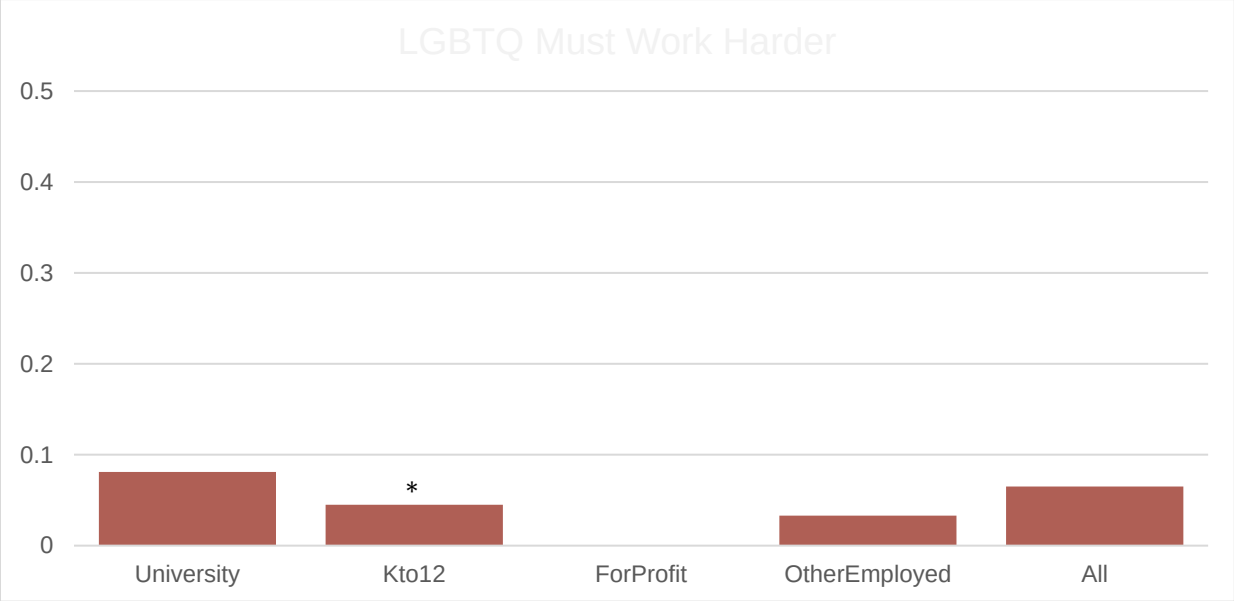
Predicted Probabilities by employment sector. *(proportion who agree between 0 and 1)*

Fig 11: Proportion of respondents by sector agreeing that "Racial/ethnic minorities in my workplace must work harder than whites to convince colleagues of their competence."



Predicted Probabilities by employment sector. *(proportion who agree between 0 and 1)*

Fig 12: Proportion of respondents by sector agreeing that "LGBTQ individuals in my workplace must work harder than non-LGBTQ persons to convince colleagues of their competence."



Predicted Probabilities by employment sector. *(proportion who agree between 0 and 1). NOTE: No respondents in the For Profit sector reported that LGBTQ persons in their workplace have to work harder than their non-LGBTQ colleagues, so the value is zero.*

The figures above represent the predicted probability of the proportion of respondents in each sector who agree with each statement, holding constant variation by demographics (gender, race/ethnicity, age, disability status, LGBTQ status, and education level). The asterisks indicate significant differences between the university sector (which includes all 4-year and 2-year institutions) and the other sectors: K-12 education, for-profit private sector, and other sectors (a small category that includes non-profit and governmental sectors). Significance levels determined by logistic regression models; see footnote 5 for more details (***p<.001, **p<.01, *p<.05, †p<.10, two-tailed test).

Starting with the first figure in this section, Figure 9, the rightmost column in the graph displays the proportion of respondents overall (22%) who report that women have to work harder than men to convince colleagues of their competence. There is also significant variation in this outcome across sectors: over a quarter of respondents in the university sector report a chilly climate for women. In contrast, respondents employed in K-12 education (13%) and those employed in the for-profit sector (11%) are significantly less likely those employed in the university sector to say that women in their workplace tend to have to work harder than men to convince their colleagues of their competence.

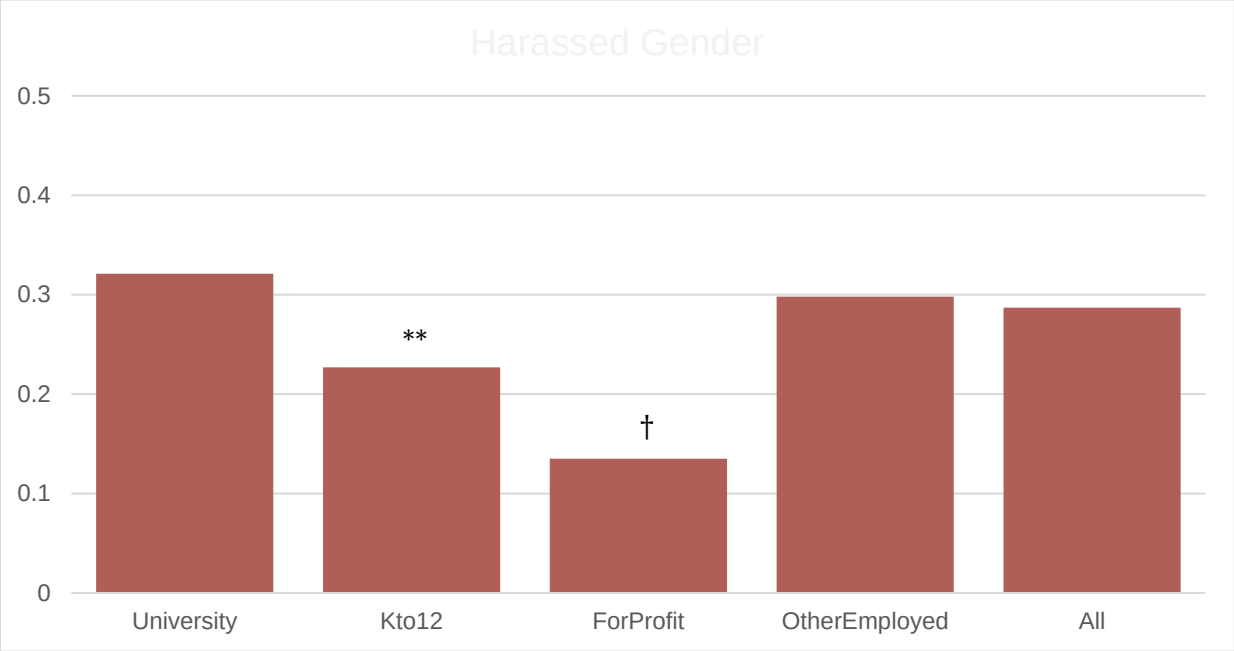
Figure 10 presents results on a question that asks about a chilly climate for people of color in respondents' organizations. Across all employment sectors, 16% of respondents say that racial/ethnic minorities have to work harder than whites in their organization to be seen as competent professionals. As before, the proportion of respondents reporting this chilly climate is highest in the university sector (20%) and marginally significantly lower (5%) in the for profit sector.

Although LGBTQ status is not always able to be read off the body, as gender and race/ethnicity often are, workers still may witness differential treatment of out LGBTQ colleagues in their workplaces (Cech & Rothwell 2017). Figure 11 indicates that 7% of respondents report that LGBTQ persons in their work environment have to work harder than their non-LGBTQ colleagues to convince colleagues of their competence. Once again, university sector has the highest proportion of respondents (8.5%) who see this disadvantage in their workplace, net of demographic variation. In contrast to the university sector, only 5% of respondents in the K-12 sector report this type of chilly climate for LGBTQ workers. None of the respondents in the for-profit sector reported a chilly climate for LGBTQ persons.

Note that these figures represent respondents (women and men, whites and people of color, LGBTQ and non-LGBTQ respondents) reporting on the climate of their employing organizations. To see how men and women report on their *own* experiences, see results part 1 and 2 above. Also note that these results are best understood *relationally:* to see which sectors sector seems to have the strongest or weakest patterns of chilly climates. Estimates of bias in workplaces tend to underestimate the level of bias in the organization overall.

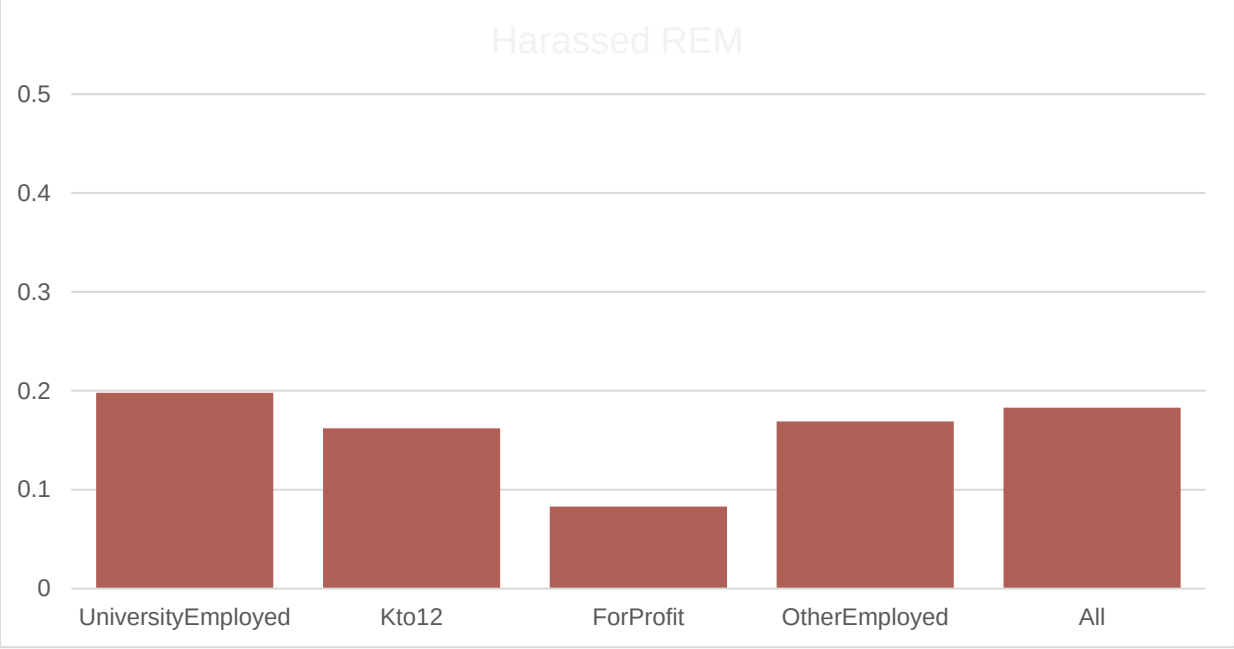
Figures 13-16 below present the proportion of respondents in each employment sector who report having witnessed persons in their workplace being treated differently based on their demographic category.

Fig 13: Proportion of respondents by sector who reported witnessing person(s) being treated differently due to gender in last three years.



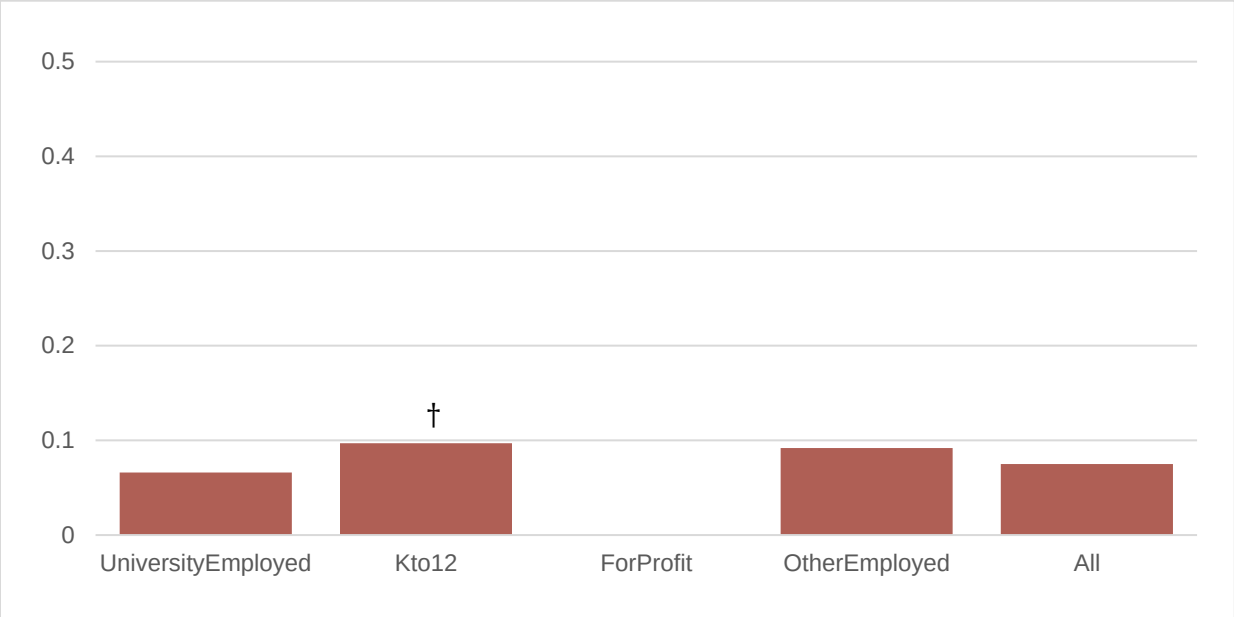
Predicted Probabilities by employment sector. *(proportion who agree, between 0 and 1)*

Fig 14: Proportion of respondents by sector who reported witnessing person(s) being treated differently due to race/ethnicity in last three years.



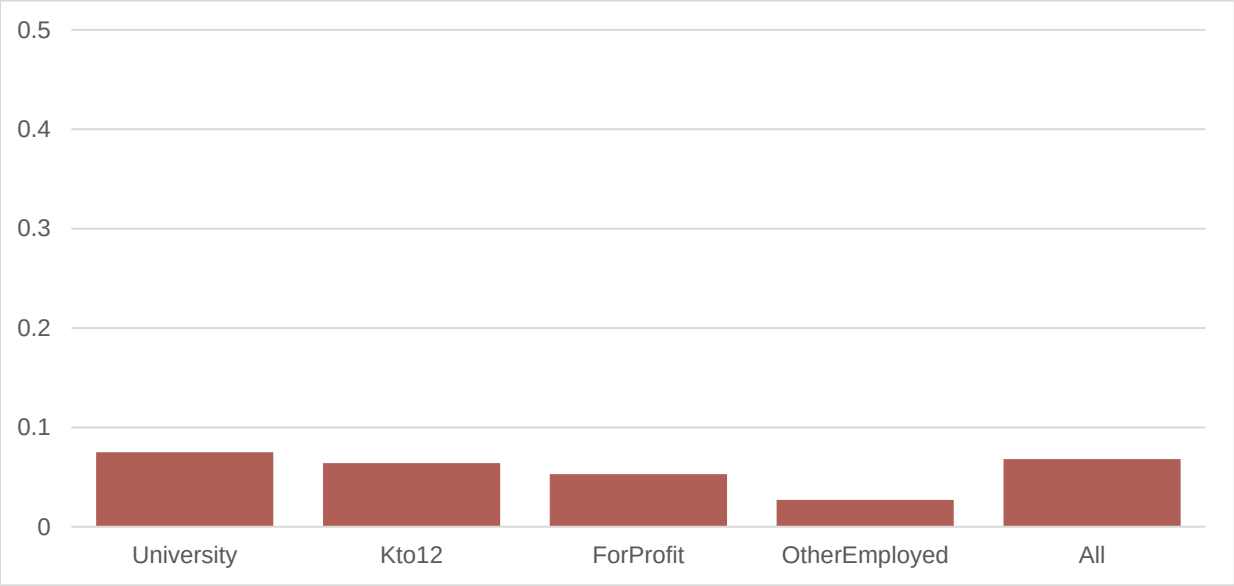
Predicted Probabilities by employment sector. *(proportion who agree, between 0 and 1)*

Fig 15: Proportion of respondents by sector who reported witnessing person(s) being treated differently due to LGBTQ status in last three years.



Predicted Probabilities by employment sector. *(proportion who agree, between 0 and 1). Note: No respondents in the For Profit sector reported witnessing LGBTQ persons being treated differently in the last three years.*

Fig 16: Proportion of respondents by sector who reported witnessing person(s) being treated differently due to disability status in last three years.



Predicted Probabilities by employment sector. *(proportion who agree, between 0 and 1)*

As in the previous section, Figures 13-16 present the proportion of respondents in each employment sector who report that they have observed women (Fig. 13), racial/ethnic minorities (Fig. 14), LGBTQ persons (Fig. 15) and persons with disabilities (Fig. 16) being treated differently in their workplace on the basis of these statuses. Significance levels indicate statistically significant differences between respondents in the university sector versus other employment sectors, as determined by logistic regression models; see footnote 5 for more details (***p<.001, **p<.01, *p<.05, †p<.10, two-tailed test).

Figure 13 depicts the frequency with which respondents reported that they observed a person or persons being treated differently in their workplace due to their gender in the last three years. Among all employment sectors, 29% of all respondents report witnessing instances where someone was treated differently on the basis of gender in their organization in the last three years. The statistic among those employed in higher education is particularly striking. Nearly a third (32%) of respondents working in institutions of higher education reported witnessing differential treatment on the basis of gender in the last three years. The climate in other sectors appears to be comparatively better: only 23% of K-12 workers, and only 14% of workers in the for-profit sector report gender-based differential treatment. Note that these employment sector differences are net of variation by demographic categories (gender, race/ethnicity, etc.).

The next figure (Fig. 14) presents the frequency with which respondents have observed differential treatment on the basis of race/ethnicity in their workplaces. Among respondents in all workplace sectors, 18% reported observing at least one instance of race-based differential treatment in the last three years. There are no significant differences by sector.

Figure 15 depicts the proportion of respondents who reported observing differential treatment in their workplace on the basis of LGBTQ status. As before (possibly due to the frequent invisibility of LGBTQ status), a comparatively low proportion of respondents reported observing LGBTQ-based differential treatment. However, 8% overall reported observing an instance this form of bias in the last three years.

Finally, Figure 16 presents the proportion of respondents who reported that they observed differential treatment on the basis of disability status. Among respondents across all employment sectors, 7% reported viewing an instance of disability-based differential treatment in the last 3 years. Rates across sectors were fairly consistent, with no significant differences across sector.

As before, these results are best understood relationally—to see patterns of chilly climates by employment sector and identify which sector(s) have the most frequent incidences of bias. People typically under-report harassment and differential treatment in their organizations, so these should be taken as conservative estimates of the actual bias occurring in these sectors. To see how different demographic groups report on their *own* experience of bias, see Parts 1 and 2 above.

Summary of patterns

Part 3 of this report described patterns of workplace chilly climate by employment sector (University, K-12, for-profit, and other sectors). Among these sectors, employees in the university sector reported consistently more negative climates for women and racial/ethnic minorities than reported by those in other sectors. With the exclusion of one factor (Fig. 16, different treatment by disability status), University employees reported unfair workplace practices at a significantly higher rate than employees in other sectors. For example, 29% of University employees agree that women must work harder than men to convince colleagues of their competence, and 20% feel that racial/ethnic minorities should do the same. 32% of University employees saw different treatment due to gender, and 20% of University employees saw different treatment due to race. Such findings indicate that patterns of disadvantage are particularly strong among this organization's respondents in higher education.

Overall, the lowest rates of unfair treatment were reported by workers in the for-profit sector. This reflects the experiences of members of this organization working in industry (a small proportion of the membership overall) and does not necessarily reflect the realities of the for-profit sector more generally. The research of the STEM Inclusion Study will be better able to compare the experiences across employment sectors of STEM more generally.

SUMMARY OF FINDINGS

The results from this survey point to both positive and negative aspects of diversity and inclusion as experienced by members of this professional organization. First, personal experiences of harassment in general are relatively low, and respondents across demographic groups generally felt their work is respected by their colleagues and that their supervisors treated them with respect. Respondents on average generally did not believe their boss gave them less credit than they deserve, nor that they have to work harder than others to be given the same professional recognition. Most respondents in this organization did not report high levels of LGBTQ bias in their organizations (although it is not clear whether this is due to the lack of visibility of LGBTQ status vis a vis other demographic characteristics like gender and race/ethnicity). Lastly, the majority of respondents did not observe instances of chilly climates toward persons with disabilities. While these general trends suggest that members of this organization tend to have positive experiences in their workplaces, these patterns differed substantially across demographic category.

The survey results pointed to several concerning trends regarding the marginalization and professional valuation of under-represented members of this organization. We find pervasive gender differences in workplace experiences: women had significantly more negative experiences on *every measure in our analysis*, net of variation by age, education level, employment sector, and other demographic factors. Similarly, persons with disabilities and racial/ethnic minority respondents reported significantly more negative experiences than their peers across a number of different marginalization and professional devaluation measures. LGBTQ status, to a lesser extent, also was a factor in marginalization.

Regarding experiences of marginalization, women, persons with disabilities, and black and Hispanic respondents had more experiences of marginalization than men, persons without disabilities, and white respondents, respectively. Most of these patterns were echoed in the professional devaluation measures, whereby women, persons with disabilities, and black and Hispanic respondents more frequently reported that their competency and value was questioned in their workplace.

Finally, our results show that the most consistently negative diversity and inclusion issues occurred in the university sector, especially compared to K-12 and for-profit sectors.

Broadly speaking, results from this study highlight both areas that are encouraging and areas that require further consideration. These results indicate crucial considerations regarding the satisfaction and retention of talented women, racial/ethnic minorities, persons with disabilities, and LGBTQ individuals in STEM, as both workplace climate and experiences of discrimination have an impact on organization members' satisfaction, and subsequent retention in STEM.

Suggestions for Moving Forward

The results reviewed above point to three key areas of intervention that the organization should consider:

1.
Women and racial/ethnic minorities report persistently more negative work experiences compared to white men. Feelings of marginalization and, experiences of exclusion are significantly more common among these respondents. The organization should consider ways it can help foster inclusion for women and people of color, as well as having open dialog

about the ways that the STEM expertise of women and people of color are undermined in members' workplaces.

2.
Disability status was a significant factor in a number of the marginalization and devaluation measures. Disability status is rarely considered and discussed within the context of inclusion and diversity in STEM related professional organizations. However, over 20% of members of this organization report some kind of disability, whether physical or mental. The organization should consider initiatives and programming and that might allow persons with disabilities to articulate the way that this organization could better support them and promote their interests.

3.
Respondents in university settings reported instances of differential treatment and bias toward disadvantaged groups significantly more frequently than respondents in K-12 or for-profit employment settings. This suggests the need to explore departmental and institution-level factors that promote these patterns of bias at the local institution level. This differential also provides the opportunity for organization members from different employment sectors to learn from one another. For example, what tactics do members employed in K-12 and for-profit sectors use to foster inclusiveness at the local level that may be able to be imported into the university setting?

Recommendations

Given the unique entity of the professional organization and its reach, our recommendations for STEM diversity and inclusion initiatives within AAPT may also be applicable for AAPT members to utilize within their own workplaces.

Our recommendations for the American Association of Physics Teachers include:

- Regular dialog with constituencies of disadvantaged groups (e.g., through focus groups and panels) to identify ongoing issues and ways the organization could provide support through programming, networking, and policy change.
- Regular 'climate surveys' measuring factors such as marginalization, inclusion and professional (de)valuation.
- Increase the number of AAPT employees and leaders who are women, persons with disabilities, LGBTQ, and people of color—in all categories, from administrative to professional.
- Recommend dual/multi membership and other partnerships with minority-centered STEM professional organizations.
- Partner with companies and organizations that offer employment opportunities for Physics teachers of minority status.
- Consider—or provide greater support for—minority-group-focused caucuses within the organization with can serve as information and networking hubs.
- Integrate diversity and inclusion programming into current conferences (e.g, the expansion of the current new faculty or employee training to involve a seminar on macroaggressions in workplaces; adding an implicit bias workshop into a leadership/management training; sponsoring workshops about supporting underrepresented students in STEM majors).
- Create and continue programming at AAPT conferences regarding disability etiquette, hidden illnesses, work habits, and accommodations testing.
- Ensure that the diversity represented in the organization is reflected in the choice of keynote and plenary speakers at regional and national conferences.
- Share the events and materials of minority and women centered STEM professional

organizations (e.g, advertising the Women in Physics conference in the organization newsletter).

- Create an AAPT scholarship fund specifically to help advance the education and careers of women, disabled individuals, LGBTQ individuals, and people of color.
- Spotlight individuals in physics (e.g., a website feature) who are addressing issues of marginalization and exclusion within the field.
- Ensure all organization websites and emails are fully ADA compliant and compatible with accessibility plug-ins.
- Video-record and close-caption significant keynote addresses at AAPT conferences and make them available online for those who are unable to attend.
- Expand the Diversity section of the AAPT website beyond Herstory.
    - Consider adding information, Q&As, and resources regarding disability etiquette, gender identity etiquette, and so forth, accessible to all who visit the AAPT website.
    - Consider featuring articles, stories, and interviews regarding the underrepresentation of women and people of color in Physics and STEM as a whole.
    - Consider adding a retention and recruitment section on the website listing advice and current research on supporting women and people of color in STEM education (geared toward those in academia teaching minority students).
- Share and publicize AAPT's diversity goals to increase accountability.
- Develop a diversity, equity, and inclusion (DEI) 'seed fund' for AAPT members to establish DEI initiatives in their workplace.
- Create a diversity & inclusion specialist role (different from a Human Resources Generalist role) in the organization to provide support and further recommendations for ongoing diversity and inclusion efforts.
- Collaborate with a diversity-centered consulting firm to receive further recommendations, learn hiring practices to combat inequity, and create other methods of increasing membership diversity.
- Note that the findings here are reported along a single axes of inequality, and cannot reveal all patterns of marginalization that may pertain to groups experiencing multiple forms of marginalization simultaneously. Further work in the STEM Inclusion Study that aggregates survey responses from multiple professional associations will provide further analysis on these intersections.

This organization's participation in the STEM Inclusion Study is an important signal of its willingness to consider and confront diversity and inclusion issues among its membership. Inequality in STEM is an intractable problem that has no silver bullet solution. It will take deliberate and sustained effort to help move the needle in this and other STEM-related professional organizations.

METHODOLOGICAL APPENDIX

Inclusion and Marginalization Questions	
(a) Insensitive Comments	I have read, heard and/or seen insensitive comments in my workplace that I found offensive. (mean = 2.3)
(b) I Fit In	Overall, I feel I 'fit in' with the other people in my workplace. (mean = 3.93)
(c) Noticeable Mistakes	I worry that my mistakes are more noticeable than the mistakes of others. (mean = 2.74)
(e) Harassed	In the last 12 months, I was harassed verbally or in writing on the job. (mean = 1.15)
Professional (De)valuation Questions	
(a) Same Standard	I am held to the same standard as others for promotion or advancement. (mean = 3.92)
(b) Less Credit	My boss gives me less credit than I deserve. (mean = 2.37)
(c) Work Harder	I have to work harder than my colleagues to be perceived as a legitimate professional. (mean = 2.44)
(d) Supervisor Respect	My supervisor treats me with respect. (mean = 4.29)
(e) Respect Work	In my workplace, my work is respected. (mean = 4.18)
Workplace Fairness Questions	
(a) Women Work Harder	Generally speaking, women in my workplace must work harder than men to convince colleagues of their competence. (mean = .183)
(b) LGBTQ Work Harder	Generally speaking, LGBTQ individuals in my workplace must work harder than non-LGBTQ individuals to convince colleagues of their competence. (mean = .058)
(c) REM Work Harder	Generally speaking, racial/ethnic minority individuals in my workplace must work harder than non-minority individuals to convince colleagues of their competence. (mean = .137)
(d) Harassed Race	Overall, in the last 3 years, have you ever observed a person or persons being treated differently in your workplace due to any of the following characteristics? Race or ethnicity. (mean = .192)
(e) Harassed Gender	Overall, in the last 3 years, have you ever observed a person or persons being treated differently in your workplace due to any of the following characteristics? Gender. (mean = .295)
(f) Harassed LGBTQ	Overall, in the last 3 years, have you ever observed a person or persons being treated differently in your workplace due to any of the following characteristics? Sexual Identity. (mean = .085)
(g) Harassed Disability	Overall, in the last 3 years, have you ever observed a person or persons being treated differently in your workplace due to any of the following characteristics? Disability. (mean = .081)

In the "Inclusion and Marginalization" questions, the variables *InsensitiveComments*, *Harassed*, and *ChillyClimate* were all coded on a 1-3 scale, with 1=Never, 2=At least once in the past year, and 3= At least once a month or more.

Works Cited

1. Archer, Louise, Jennifer DeWitt, Jonathan Osborne, Justin Dillon, Beatrice Willis and Billy Wong. 2013. "'Not girly, not sexy, not glamorous': primary school girls' and parents' constructions of science aspirations." Pedagogy, Culture & Society 21(1):171-194.

2. Bell, Amy E., Steven J. Spencer, Emma Iserman, and Christine ER Logel. 2003. "Stereotype threat and women's performance in engineering." Journal of Engineering Education 92(4): 307-312.

3. Bilimoria, Diana and A. J. Stewart, ""Don't Ask, Don't Tell": The academic climate for lesbian, gay, bisexual, and transgender faculty in science and engineering," NWSA Journal, vol. 21, pp. 85-103, 2009.

4. Buccheria, Grazia, Nadja Abt Gürber and Christian Brühwiler. 2011. "The Impact of Gender on Interest in Science Topics and the Choice of Scientific and Technical Vocations." International Journal of Science Education 33(1):159-178.

5. Cech, Erin. 2013. "The Veiling of Queerness: Depoliticization and the experiences of LGBT engineers: presented at the ASEE Annual Conference and Expositions, Atlanta.

6. Cech, Erin A. and Michelle V. Pham. 2017. "Queer in STEM Organizations: Workplace Disadvantages for LGBT Employees in STEM Related Federal Agencies." *Social Sciences.* 6(1):1-12.

7. Cech, Erin, Brian Rubineau, Susan Silbey, and Carroll Seron. 2011. "Professional Role Confidence and Gendered Persistence in Engineering." *American Sociological Review* 76(5): 641-66.

8. Cech, Erin and William R. Rothwell. Federally Unequal: Intersectional Contours and Organizational Contexts of LGBT Work Experience Inequalities among Federal Employees. *Work in Progress*. University of Michigan, Ann Arbor.

9. Chang, Mitchell J., Oscar Cerna, June Han, and Victor Saenz. 2008. "The contradictory roles of institutional status in retaining underrepresented minorities in biomedical and behavioral science majors." *The Review of Higher Education* 31(4): 433-464.

10. Cheryan, Sapna, John Oliver Siy, Marissa Vichayapai, Benjamin J. Drury and Saenam Kim. 2011. "Do Female and Male Role Models Who Embody STEM Stereotypes Hinder Women's Anticipated Success in STEM?" *Social Psychological and Personality Science* 2(6):656-664.

11. Crenshaw, Kimberle. 1991. "Mapping the Margins: Intersectionality, Identity Politics, and Violence against Women of Color." Stanford Law Review 43(6):1241-99.

12. Dryburgh, Heather. 1999. Work Hard, Play Hard: Women and Professionalization in Engineering-Adapting to the Culture. *Gender and Society* 13(5): 664-682.

13. Eglash, Ron. 2002. "Race, Sex, and Nerds: From Black Geeks to Asian American Hipsters." *Social Text* 20(2): 49-64.

14. Frehill, L.M. 2012. "Gender and Career Outcomes of U.S. Engineers*." International Journal of Gender, Science and Technology* 4(2). http://genderandset.open.ac.uk/index.php/genderandset/article/view/199.

15. Gunckel, K. L. 2009. “Queering Science for All: Probing Queer Theory in science education,” *JCT (Online*) 25: 62-75.

16. Herring, Cedric. 2009. “Does diversity pay? : Race, gender, and the business case for diversity,” *American Sociological Review* 74:208-224.

17. Hughes, Roxanne. 2012. “Gender Conception and the Chilly Road to Female Undergraduates’ Persistence in Science and Engineering Fields.” *Journal of Women and Minorities in Science and Engineering* 18(3): 215-234.

18. Iskander. E. Tiffany, Paul A. Gore Jr., Cynthia Furse and Amy Bergerson. 2013. "Gender Differences in Expressed Interests in Engineering-Related Fields ACT 30-Year Data Analysis Identified Trends and Suggested Avenues to Reverse Trends." *Journal of Career Assessment* 21(4):599-613.

19. Knorr-Cetina, K. (1995). Laboratory studies: The cultural approach to the study of science. In S. Jasanoff, G.E. Markle, J.C. Petersen and T. Pinch (Eds.), Handbook of science and technology studies (pp. 140-166). Thousand Oaks: Sage Publications.

20. Koul, Ravinder, Thanita Lerdpornkulrat and Soontornpathai Chantara. 2011. “Relationship Between Career Aspirations and Measures of Motivation Toward Biology and Physics, and the Influence of Gender.” *Journal of Science Education* 20(5): 761-770.

21. Laschinger, Heather K. Spence, Joan E. Finegan, Judith Shamian, and Piotr Wilk. 2004. "A longitudinal analysis of the impact of workplace empowerment on work satisfaction." *Journal of Organizational Behavior* 25(4): 527-545.

22. Moody, JoAnn. 2004. *Faculty diversity: Problems and solutions.* Routledge.

23. Moss-Racusin, Corinne A., John F. Dovidio, Victoria L. Brescoll, Mark J. Graham and Jo Handelsman. 2012. “Science faculty's subtle gender biases favor male students.” *Proceedings of the National Academy of Sciences of the United States of America* 109(41):16474-16479.

24. Nelson, Donna J., and Christopher N. Brammer. 2010. A national analysis of diversity in science and engineering faculties at research universities. *Diversity in Science Association*.

25. Patridge, E. V., R. n. S. Barthelemy, and S. R. Rankin, “Factors impacting the academic climate for LGBQ STEM faculty,” *Journal of Women and Minorities in Science and Engineering*, vol. 20, 2014.

26. Ponjuan, Luis, Valerie Martin Conley, and Cathy Trower. 2011. "Career stage differences in pre-tenure track faculty perceptions of professional and personal relationships with colleagues." *The Journal of Higher Education* 82(3): 319-346.

27. Rankin, S., G. Weber, W. Blumenfeld, and S. Frazer, “2010 State of higher education for lesbian, gay, bisexual and transgender people,” ed: *Campus pride*, 2010.

28. Robinson, G. J., and J. S. Mcllwee. 1991. Men, women, and the culture of engineering. *The Sociological Quarterly* 32(3): 403-21.

29. Sallee, Margaret W. 2011. “Performing Masculinity: Considering Gender in Doctoral Student Socialization.” *The Journal of Higher Education* 82(2):187-216.

30. Seron, Carroll, Susan Silbey, Cech, Erin, and Brian Rubineau, 2016. Persistence Is Cultural: Professional Socialization and the Reproduction of Sex Segregation. *Work and Occupations* 43(2):178

31. Severiens, Sabine and Geert ten Dam. 2012. "Leaving College: A Gender Comparison in Male and Female-Dominated Programs." *Research in Higher Education* 53(4):453-470.

32. Siebers, Tobin. 2008. "Disability theory."

33. Slaton, Amy E. 2013. "Body? What body? Considering ability and disability in STEM disciplines." *age* 23: 1.

34. Smeding, Annique. 2012. "Women in Science, Technology, Engineering, and Mathematics (STEM): An Investigation of Their Implicit Gender Stereotypes and Stereotypes' Connectedness to Math Performance." *Sex Roles* 67(11):617-629.

35. Trower, C. A. Oct.2008. "Competing on culture: Academia's new strategic imperative." Unpublished presentation, (http://www. advance. iastate. edu/conference/conferencepdf/2008_10-11trower_hoc. pdf).

36. Turner, Caroline Sotello Viernes. 2002. Diversifying the faculty: A guidebook for search committees. Association of American Colleges and Universities, 1818 R Street, NW, Washington, DC 20009.

37. Waldo, Craig R. 1999. "Working in a majority context: A structural model of heterosexism as minority stress in the workplace." *Journal of Counseling Psychology* 46(2): 218.

38. Zambrana, Ruth Enid, Rashawn Ray, Michelle M. Espino, Corinne Castro, Beth Douthirt Cohen, and Jennifer Eliason. 2015. ""Don't Leave Us Behind" The Importance of Mentoring for Underrepresented Minority Faculty." *American Educational Research Journal* 52(1): 40-72.