Making Women Feel Welcome: How Volunteering Impacts Undergraduates' Biases in STEM

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Introduction

- Despite continued efforts at nearly all levels of education, women remain underrepresented in college-level science classes and majors, and in the STEM workforce as a whole. As many basic science courses remain male-dominated spaces, an unwelcoming environment represents a key barrier to entry and success for women in these fields.
- The women that do find success in these areas typically do so through a well-established sense of belonging/identity in STEM — research indicates that cultivating a STEM identity for women is heavily dependent on the recognition they do or do not receive from their peers and mentors (Carlone & Johnson, 2007).
- When biased peer groups dismiss and/or fail to take women in science seriously, it becomes difficult for them to identify as valued members of the academic STEM community, contributing to the high proportion of women who leave these majors (Glass et al., 2013).
- Volunteering is one potentially promising route to making the STEM community more welcoming to women; it has been shown to cause introspection regarding one's self and beliefs (Tierney et al., 2022), and thus could be used to target biases against women in these fields.
- At many universities, programs exist where undergraduates work with younger, K-12 populations to encourage the pursuit of science for everyone — some programs also investigate how these children feel about who can be a scientist through questions and surveys that accompany the science content.
- Volunteering programs that probe for biases in populations like elementary and middle school-aged children serve as great settings to covertly challenge the biases of those who are volunteering. Through the repeated exposure to ideas about equity in science and the fact that anyone is capable of succeeding in these fields, volunteers may be led to consider their own feelings about who can be a scientist as well.

Research Questions

What are the relationships between beliefs about who is good at STEM and how that is related to societal ideas?

What are the experiences of undergraduate males and females in STEM students who work with elementary and middle school-aged children teaching that anyone can be a scientist?

Results

Table A: Neutrality Differences in Participant Gender Groups

Gender	Percentage of Neutral Respondents			
	Men STEM	Men NonSTEM	Women STEM*	Women NonSTEM
Male	57.1%	71.4%	71.4%	57.1%
Female	25.8%	77.4%	32.3%	25.8%

Note: * = marginal significance, $p = 0.055$

Table B: Linear Regression — Participant's Gender, "Men STEM" Proportion Score, and Own Rating of Gender-based Academic Aptitude predicting Rating of Societal Academic Aptitude Bias.

Predictor	*Estimate (unstandardized B)*	*SE*	*95% LL*	*95% UL*	*p*
Gender	0.110	0.239	-0.377	0.597	0.647
"Men STEM" Proportion Score	1.116*	0.292	0.532	1.711	< 0.001
Own Academic Aptitude Bias	-0.188	0.155	-0.505	0.129	0.235

Note: $R^2 = 0.426$, * = $p < 0.05$

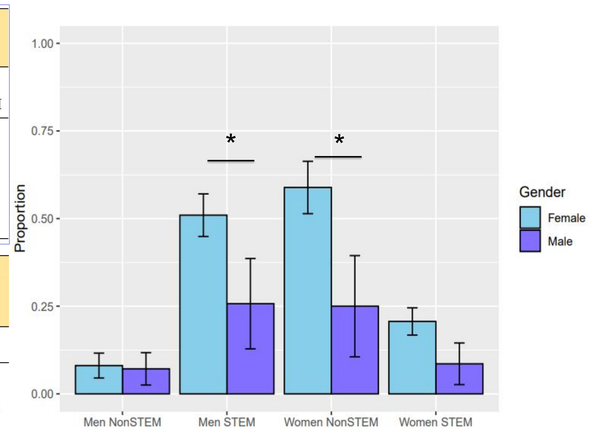

Figure 1: Difference in Average Societal Bias Proportion Scores between Male and Female Respondent Groups

Note: * = $p < 0.05$ (for the difference between Female and Male respondent groups). Error bars depict standard error of the mean values for each participant gender group's average proportion.

- **Undergraduate women in STEM remain far more aware of the role of gender bias in their environment than their male peers.**
  - Female speaker: *"There is still work to be done. And I wish people would be okay with being corrected about stuff like that. Just like, 'Oh, I'm not a, I'm not a sexist, I have daughters'-- like my own dad said that a few times. I'm like, you still say sexist things."*
  - Male: *"I feel like I'm not super observant of that all the time… I think sexism [goes] over my head because it doesn't really affect me"*
  - Female: *"Most people are being good about it; they're not treating me differently at all. I don't feel, like, othered by them, in a sense. But when it happens, I feel most of the time it is unintentional. So I don't want to be mad at them if they don't know they're doing it, or [they're] not, like conscious of it. But sometimes I'm just not satisfied -- like when one of my peers is explaining something like stereochemistry to me, and I understand the concept… And it's also incorrect what they're saying. I'm just like, I do understand this information. And I don't know, sometimes it does feel like I'm seen as less intelligent, and it sucks."*
- **While a big push has been made to make women in STEM feel accepted, there is a big difference between being accepted and welcomed/desired.**
  - Female: *"I think in STEM women can be successful, but I don't know. Welcome kind of implies that they're wanted. And I think in some fields, yes, women are wanted, they're appreciated, they're respected, and I hope that's the majority opinion -- I think it might be, but I don't know sometimes. I just have days where I feel like I meet certain people. And I feel like they don't want me to be here like that."*
  - Female: *"With 'hard' STEM being more male-dominated[…] Definitely, there is a difference between me and my peers[…] And having my friends telling me that, 'Oh, she's the only person in her O-Chem class', or 'she's the only girl in her O-Chem group', or like how sometimes [a girl] feels left out in discussions or even in lab decisions, like presentations or final decisions, her voice is not being heard."*

Methods

Quantitative pre-surveys were given during volunteer orientation. They were initially asked questions about their major, their career goals, and demographic information.

→ Participants were then asked about to judge societal gender bias in academic settings. They selected the academic subjects, if any, they thought society would typically say men were better at, then the subjects women were better at. If no subjects were selected, the participant was considered "neutral".

→ Then, participants were asked if they felt that society generally believes that there are some subjects men or women are better at than the other gender. After this, they were asked if they *personally* believed that there are some subjects men or women are better at than the other gender. The survey then ended.

→ The post-survey was given during the volunteer's final session, approximately 3 weeks later (the average volunteer visits classrooms twice per week for these 3 weeks). The same questions were asked to allow for longitudinal comparison.

→ Participants that completed both surveys were included in quantitative analysis ($N = 39$, with 7 males and 32 females, resulting from a gender-skewed volunteering population).

→ Volunteers were contacted by email after the surveys to participate in interviews, in which the impact of gender on their lived experiences was explored ($N = 13$, with 4 males and 9 females).

Discussion

Main Findings

- **Females on average felt that society believes that men are typically more suited to STEM subjects, and that women are more suited to NonSTEM subjects, to a greater degree than the males.**
- **Female and male respondents also differed in neutrality for the "Women STEM" category — male participants were more likely to believe society sees women as no better than men in STEM areas than females were.**
- The significant predictor of participants' assessment of societal academic aptitude bias (that is, if society thinks men or women are better at some subjects than others) was the proportion score for the "Men STEM" category.
- Importantly, the participant's own academic aptitude bias (that is, their own belief that men or women are better at some subjects than others) was not shown to be a significant predictor of societal academic aptitude bias. **This suggests that participants did not necessarily believe that their own biases aligned with what they see in society.**
- Interview themes supplemented these findings, indicating that males may be more conservative in their evaluations of societal gender bias because of its less noticeable impact on them overall.
- **Interview themes revealed that undergraduate women were far more aware of a possible gender bias in STEM, and reported a nuanced difference in feeling accepted but not welcomed or sought out to be in STEM.**

Limitations

- We had a small sample and gender ratio was representative of our volunteering program's demographics, but was still highly skewed towards women.
- Particularly for interviews, social desirability bias had the potential to play a major role in this study, which could have impacted our results and caused them to represent more progressive viewpoints than they have otherwise.

Future Directions

- Future research should investigate the role of multiple identities in creating these trends. Seeing how ethnicity, socioeconomic status, and other factors predict gender bias outcomes may prove important in furthering this study's results — using larger, more balanced sample sizes would also be a big step toward clarifying this study's conclusions.

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