

Article

Barriers and Assistance for Female Leaders in Academic STEM in the US

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Abstract: Women in science, technology, engineering, and mathematics (STEM) fields are underrepresented, and women are also less likely than men to be in leadership positions generally. Little is known about the intersection of these areas: women in leadership in STEM. To determine what sort of barriers and assistance female STEM leaders have encountered, a survey was developed asking women who are in academic leadership positions in STEM about their experiences. The main barriers were similar in the STEM area and in leadership: balancing work/home life, devaluing of achievements, and imposter syndrome. The main two types of assistance in both STEM and leadership were support from spouse/partner, and encouragement from peers. The main barriers women encounter are cultural and will take time to overcome. The main assistance women have had comes from people, not training or institutional structures.

Keywords: gender, academic, STEM, leadership, barriers, assistance

1. Introduction

In the United States, women make up 50.8% of the general population, 57% of college graduates, and 39% of science, technology, engineering, and mathematics (STEM) bachelor's degree recipients [1]. In certain fields, the percentage of women is particularly low: physics grants only 20% of bachelors degrees to women, engineering 21%, and computer science 19%.

While there are many issues involving women's participation in STEM, this study focuses on one piece: the presence and participation of women in leadership in STEM fields in academia in the US. [Author] reported recently on the proportions of women serving in academic leadership positions in the US [2]. The rate of participation in leadership tends to be lower than the proportion of women in the STEM fields. Why are women not rising to these positions at the same rate as they participate in STEM? What are the barriers women encounter on their path to a STEM leadership position?

1.1. Literature Review

There is very little research on women's leadership in STEM [3,4]. What little is known matches with the typical barriers encountered by women in leadership and in STEM. In a survey of its membership, the US-based Association for Women in Science found that cultural issues were the largest part of what female STEM leaders encountered: ideas or work being credited to men, imposter syndrome, being assumed to be less competent, and general gender bias [5]. Gender bias also was at the heart of problems for women in Singapore [6].

The literature on the barriers to women's leadership is extensive. A good overview is provided by the American Association of University Women [7], listing broad categories of barriers as pipeline problems, gender discrimination, caregiving, lack of mentors, stereotyping, and bias. At a more specific level, female leaders have faced harassment [8,9], implicit gender bias [10], imposter syndrome [11], and issues with caregiving [12] and other home/work problems [13,14]. The book

“Through the Labyrinth” by Eagly & Carli provides a useful overview of women’s leadership research [15].

In the STEM fields, research on barriers to women’s participation has been conducted for decades. There is no one easy answer to encouraging women and other under-represented groups to go into and stay in STEM. The latest research suggests that many of the problems women face are similar to what women in leadership positions face: implicit gender bias [16], harassment [17,18], dual-career couple issues [19], imposter syndrome [20,21], home/work balance [22], and lack of sense of belonging [23]. Many of these issues are discussed in references [24,25].

The factors that support women’s advancement in leadership are quite varied. Support comes in many forms: from one’s spouse [26,27] and family [28], from peers and superiors [29]. Advocacy from mentors and sponsors can help women progress [29,30], and formal leadership training programs can provide useful skills [29,31]. Many of these supports can be part of the networking [32,33] that is useful for women looking to lead.

For women in the STEM fields, similar drivers support career progression. Encouragement from teachers [34], family [35], and peers [36] can help set a young woman on the STEM path. Networking and mentorship help women stay the course [37]. Sponsorship and advocacy help progression in the field [38]. A useful meta-analysis of literature is provided by Blackburn [39].

Given that the most common problems women encounter in STEM and in leadership are similar, do these experiences interact with one another? Having dealt with a particular issue once, is dealing with it again easier? This study focused on determining what barriers women faced as leaders in STEM.

1.2. Research Questions

What barriers do women encounter as they move through STEM, and as they move into leadership? What forms of assistance do they encounter in these two areas?

Do female STEM leaders feel that having encountered bias in one area has helped them deal with bias in the other?

2. Materials and Methods

Based on the literature, a survey was developed to gather information about what has helped women attain leadership positions in STEM, and what has hindered their path. The survey was designed for women in active STEM leadership positions. The focus was on academic leadership, so the chosen position titles included department chair, dean, and program director.

The survey included both multiple-choice and short answer questions, and also gathered demographic and leadership position data from respondents. Questions were designed to separate out barriers and assistance in the STEM area from those experienced in the leadership arena.

The survey was pilot tested with 13 women, contacted through social media. After the pilot-testing, the survey was revised. Then the formal survey was activated, and survey participants were invited through word of mouth, social media, and via flyers at appropriate conferences.

A total of 134 responses were received at the time of analysis. To control variables, only US and Canadian participants were analyzed. Similarly, those whose leadership position did not match the criteria above were removed from analysis. This left 68 responses.

3. Results

3.1. Barriers to women's participation in leadership and in STEM

How do the barriers women encounter compare in their path through STEM and their path to leadership? Table 1 lists the number and percentage of women who had encountered certain barriers in their path to *leadership*. Respondents could choose more than one, so totals do not add up to 100%.

Table 1. Number and percentage of women encountering barriers to leadership.

| Barrier | % of respondents | Number of respondents |
|---|------------------|-----------------------|
| Balancing work and home life | 79 | 54 |
| Devaluing of your achievements | 66 | 45 |
| Feeling of inadequacy/impostor phenomenon | 66 | 45 |
| Microaggressions | 63 | 43 |
| Discouragement from peers or supervisors | 57 | 39 |
| Blatant gender bias | 56 | 38 |
| Disparaging comments about your gender | 49 | 33 |
| Dual-career couple issues | 41 | 28 |
| Blatant sexual harassment | 16 | 11 |

The data for barriers in STEM are similar. Table 2 lists the barriers encountered in *STEM*, separate from leadership.

Table 2. Number and percentage of women encountering barriers to STEM.

| Barrier | % of respondents | Number of respondents |
|---|------------------|-----------------------|
| Balancing work and home life | 81 | 55 |
| Feeling of inadequacy/impostor phenomenon | 71 | 48 |
| Devaluing of your achievements | 65 | 44 |
| Blatant gender bias | 54 | 37 |
| Dual-career couple issues | 54 | 37 |
| Microaggressions | 53 | 36 |
| Discouragement from peers or supervisors | 50 | 34 |
| Disparaging comments about your gender | 50 | 34 |
| Blatant sexual harassment | 7 | 5 |

Respondents could also list other problems they dealt with in either STEM or leadership. For leadership, 16 respondents listed additional barriers, paraphrased here:

- Goalpost moving/lack of clarity in metrics for promotion
- Targeted negative pushback to leadership
- Told I'm "too young" or "not ready"
- Salary discrimination
- Discouragement from superiors
- Age
- Academic sabotage, toxic work culture
- Ideas ignored then offered by male peer

Perhaps the most disheartening response was the woman who said she had encountered "normal gender and minority challenges, nothing unexpected".

Only four women wrote of other barriers in STEM: not being considered when openings arise, a “sink or swim environment on campus”, the same barriers as leadership, and being a first generation academic.

When asked what the biggest challenge was for women in the leadership track, 20 of 67 said gender bias: examples include “Men dominating conversations, meetings, arguments” and “Male colleagues pushing back against my authority and decisions”. Recognition or being taken seriously was cited by 17 women: “Being taken seriously by senior men who dismiss most things said or done by women as ‘taking advantage of affirmative action’” or “Not being recognised by others as having a leadership and decision making role for the institute I am now the director of”.

In STEM, the biggest challenge for 20 of the women was gender bias of some form or another: “Systematic devaluing of women faculty in department” or “Not being seen as possessing hard skills because of my gender and attractiveness” or “Having to be twice as competent to be viewed as good enough”. One woman wrote that “I’ve been flat out told by people ‘I wouldn’t have consulted you on this project if I knew you were a woman. But you seem okay, so we can work together.’”.

3.12. Interaction of gender bias in STEM and gender bias in leadership

One of the key questions on the survey was about the interaction of gender bias in leadership with gender bias in STEM. The survey asked: “Research suggests that the barriers for women in leadership and the barriers for women in STEM are very similar. Considering your experiences in STEM and in leadership, which best describes your experience?” Answers to this question are in Table 3.

Table 3. Responses to survey question on interaction of bias in STEM and in leadership.

| Experience | % of respondents | Number of respondents |
|---|------------------|-----------------------|
| Dealing with gender bias in STEM has helped me deal with gender bias as a leader. | 59 | 40 |
| I have not experienced gender bias in STEM, but I have as a leader. | 1.5 | 1 |
| I have not experienced gender bias as a leader, but I have as a woman in STEM. | 7 | 5 |
| Dealing with gender bias in STEM did not prepare me for gender bias as a leader. | 12 | 8 |
| I have not experienced gender bias either as a leader or as a woman in STEM. | 1.5 | 1 |

3.3. Assistance to women’s participation in leadership and in STEM

Similarly to the questions about barriers, questions on the survey asked about what help respondents had encountered in their path through STEM and their path to leadership. Table 4 lists the number and percentage of women encountering certain types of assistance in their path to leadership.

Table 4. Number and percentage of women encountering assistance to leadership.

| Type of Assistance | % of respondents | Number of respondents |
|------------------------------|------------------|-----------------------|
| Encouragement from peers | 79 | 54 |
| Support from spouse/partner | 75 | 51 |
| Mentorship | 66 | 45 |
| Encouragement from superiors | 66 | 45 |
| Informal peer networking | 65 | 44 |
| Leadership training | 54 | 37 |
| Encouragement from family | 48 | 33 |
| Sponsorship/advocacy | 40 | 27 |
| Formal networking | 22 | 15 |

A similar question was asked about help received along the path to STEM; results are shown in Table 5.

Table 5. Number and percentage of women encountering assistance to STEM.

| Type of Assistance | % of respondents | Number of respondents |
|------------------------------|------------------|-----------------------|
| Support from spouse/partner | 78 | 53 |
| Encouragement from peers | 74 | 50 |
| Informal peer networking | 74 | 50 |
| Encouragement from family | 71 | 48 |
| Encouragement from teachers | 63 | 43 |
| Mentorship | 62 | 42 |
| Encouragement from superiors | 60 | 41 |
| Sponsorship/advocacy | 43 | 29 |
| Formal networking | 22 | 15 |

Additional assistance in leadership was listed by four women, and includes experience on committees, self-awareness, and training in project management/people management. For assistance in STEM, again only four women added something: proactive learning, taking opportunities, positive interactions in graduate school, and therapy.

When asked what helped the most for leadership, 43 of 65 women mentioned something related to people: support, mentorship, encouragement, or advocacy: "support from my peers in the department - male faculty in my department...have _always_ treated me with respect and shown confidence in my leadership." Only seven women mentioned training or opportunities. One woman said she had received no help on her path to leadership.

The data are similar for what is the most helpful for women in STEM: 47 of 62 women said people: mentoring and support. There were 5 women who said they had received no help in their path through STEM: "Honestly, I don't feel I've had much "help"; it's been a struggle in every sense. The best help I have had is from graduate students and postdocs who value my work and my mentoring; and me as a scientist... I can't change my generation, but I can influence the next generation of scientists."

4. Discussion

Based on the results, women in STEM leadership positions have faced similar barriers in STEM and as a leader. The top three barriers in both areas were balancing work/family life, devaluing of achievements, and imposter syndrome. Over half of the respondents had also encountered blatant

gender bias, discouragement, and microaggressions in both STEM and leadership. These are all cultural factors that will take time to mitigate, despite the cost (and illegality) of such behaviors.

The majority of female leaders agreed that having dealt with gender bias in STEM had helped them deal with gender bias in leadership. This is encouraging, and suggests that women looking toward leadership positions in STEM may not have twice the difficulty of being a woman in solely STEM or solely leadership.

The types of assistance women received in STEM and in leadership were comparable. The most common types of help for both were support from spouse/partner, and encouragement from peers. More than half the women had gotten the same types of assistance in both STEM and in leadership: informal peer networking, mentorship, and encouragement from superiors. These data suggest that supportive *people* are at the heart of what women need to stay in STEM and to advance to leadership positions. This is consistent with work by Brue [40].

Another study of this issue is in progress, listening to female STEM leaders' experiences through personal interviews. A more focused view of barriers and assistance will be acquired, which will help in furthering the goal of encouraging women to participate in STEM leadership.

The results of this study point to cultural factors as the main barriers and personal support as the main help for women in STEM leadership. If we are to reach an equitable rate of participation for women in leadership roles in STEM, we need to be working to change the culture of STEM and the culture in leadership. From devaluing women's achievements and disrespecting their authority, we need to move towards an environment where every leader is treated with respect.

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