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”We’re Learning like Everyone Else”: Best Practices from Men Allies

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Abstract

This paper examines the motivations, perceptions, and experiences of men faculty who identify as allies for undergraduate women in engineering. As men represent the majority in engineering, efforts to create socially just, equitable cultures for women will not be successful if men are not included. There is limited, extant literature on the insights and experiences of active men allies in engineering. However, research demonstrates that faculty can impact issues that adversely affect women's interest and persistence, like those experienced in engineering. To address the lack of research on men faculty allies in engineering, this study sought to examine the following research question: How and in what ways do the efforts of men faculty allies towards gender equity manifest in their daily work within their disciplines?

Data presented in this paper were collected as part of a larger qualitative, case study with 31 men STEM faculty, of which 12 were in engineering disciplines. The data were collected through interviews, which sought to capture participants' motivations for serving as allies, examples of how they serve as such, and the ways in which their ally status affected relationships. Data analysis was conducted using both inductive and deductive coding.

Findings demonstrate that participants in this study possessed a number of shared characteristics, including an awareness of the additional barriers that women must navigate and recognition of the importance of building relationships with undergraduate women, both of which seem to be beneficial in allyship efforts. Further, while allies understood that their role as advocates evolved and developed over time, many participants exhibited an uncertainty around how best to engage others in gender equity work, which strategies to implement, and the potential efficacy of their efforts.

Allies also discussed the enactment of both informal methods and strategies that they institutionalize either in courses, within their departments, or at their institutions. The informal strategies described by allies are typically actions engaged in on a regular basis and occur daily in many of my participants' lives. Men also shared a variety of more formal approaches to demonstrating allyship, the implementation and systemization of which often require more intention and commitment. Results from this study can be used to inform training and education so that the efforts of men faculty allies can be better leveraged, as they attempt to create more equitable engineering environments for women undergraduate students.

Introduction

Women are underrepresented in engineering, earning less than 20% of all bachelor's degree in this discipline, and have been for many decades, even though women earn 58% of all bachelor's degrees broadly [1]. Although higher education has concerned itself with the dearth of women in engineering disciplines, it has focused much of its attention on understanding the experience of this population as opposed to generating practical solutions to address their attrition out of these majors. We now have a robust understanding of the barriers women often

face in engineering contexts, including gender bias that manifests as unwelcome departmental climates [2], social exclusion [3], and sexual harassment [4]. However, we have little knowledge of how men understand and describe their role in maintaining engineering cultures that privilege men and masculinity. Further, it is unknown how those men faculty who identify as allies to women describe the ways in which they tangibly advocate for this population.

Although men, as the majority, have great agency in either perpetuating or changing this negative culture for women, little research has examined men's attitudes regarding issues related to gender in engineering. Several initiatives have proven to be effective in training and utilizing men faculty as allies for their women faculty counterparts in STEM [5] - [8], and research demonstrates that faculty have the potential to greatly influence the experience of students [9], [4], [10], [11] yet, there are few studies that explore men faculty allies' advocacy efforts for undergraduate women. To address the lack of research on men faculty allies in engineering, this study sought to examine the following research question: How and in what ways do the efforts of men faculty allies towards gender equity manifest in their daily work within their disciplines?

Student/Faculty Relationships in STEM

Although engineering is dominated by men, those in this majority group who value gender equity can use their social status in these spaces to challenge the harmful effects of masculinity. In fact, men faculty in particular are distinctly positioned to serve as allies for undergraduate women in STEM disciplines. Informal relationships with faculty have a positive effect on students' academic performance. Over 40 years ago, Pascarella and Terenzini [12] found that undergraduates in their first year of college who frequently interacted with professors informally around course-related issues saw strong academic performance and intellectual growth. The body of literature on the impact of faculty/student relationships on academic outcomes and retention has grown, with more recent scholarship focusing on the experiences of specific populations in particular disciplines, including on the relationships between women undergraduates with STEM faculty and the degree to which interactions between the two parties influence persistence and retention [13] - [15], [10], [16]. The literature highlighted in this section supports the assertion that professors can significantly influence the experiences, academic performance and ultimately, persistence of undergraduate women in STEM disciplines, both positively and negatively.

Faculty members can have a substantial effect on a student's persistence in their chosen discipline [14]. Undergraduate students in STEM disciplines can be intimidated by faculty and have indicated that they have experienced a lack of empathy when describing relationships with professors [14], [10]. Students who have negative experiences with faculty in STEM disciplines also earn poor grades and a lower cumulative grade point average and are more likely to leave their STEM discipline [15], [16], highlighting the importance of positive interactions between students and professors [14]. The relationship between students' retention in STEM majors and experiences with discrimination by professors is especially significant for women and underrepresented racially minoritized students, who are more likely to self-select out of STEM

by the fourth year of college than their men, white, and Asian American classmates [10]. Of particular concern to the present study, Park et al. [10] found that nearly half of the women and Black students in the study were not retained in STEM and graduated with a non-STEM degree. Further, women students of Color experienced higher rates of racial or ethnic discrimination from faculty than men. The latter finding aligns with literature on how possessing multiple underrepresented identities can compound to further marginalize groups like women of Color, with Crenshaw's [17] theory of intersectionality offering support for these findings.

Although faculty may have a negative impact on women in STEM disciplines, there is also research that demonstrates the positive influence professors can have on students. For example, Micari and Pazos [15] found that encouraging relationships between students and professors positively predicted academic performance as well as self-efficacy. Student participants specifically indicated that admiration for their professor, comfort in approaching faculty and a sense of mutual respect between students and the professor all contributed to the correlation between the positive student-faculty relationship and positive academic performance. Other studies also underscore the importance of the student-faculty relationship; Aronson et al. [9] found that even if undergraduates do not have personal relationships with STEM faculty, the delivery of encouraging messages from professors to students can be significant. In fact, students who received clear communications from professors regarding the possibility of incremental improvement in academic abilities demonstrated higher rates of academic satisfaction and engagement and greater performance versus students who did not receive similar messages. The findings of this study indicated that positive climates that highlight the importance of learning and mastering course content as well as the ability to improve in the areas of math and science over time to have the greatest effect on historically underrepresented students in STEM [9].

The impact that faculty can have on women in STEM disciplines is not always clearly delineated as positive or negative. For example, in their study of 40 STEM graduates, Salazar et al. [11] found that the experiences of women of Color and white women varied significantly. Although all of the women in the study indicated that they experienced sexism perpetrated by their faculty, the effects were sometimes either mitigated or exacerbated by their race or ethnicity. The authors found that white women, in particular, softened the negative impact of sexism with white privilege, relying on their race to help them form closer relationships with faculty. Conversely, undergraduate women of Color found that race served as a barrier to relationship building with professors, which hindered their ability to access career-related opportunities. However, the findings of Salazar et al. [11] also indicated that exposure to professors of Color facilitated relationships with racially underrepresented students, which then gave these students access to networks that supported their career goals in STEM. Finally, the authors found that the effects of both racism and sexism were lessened when students were engaged in research. The findings of this study highlight the complex nature of professor and student relationships and the varied effects, both positive and negative, of race and gender on undergraduate women [11]. In fact, a significant portion of the research on student and faculty relationships indicates that the impact of students' interactions with faculty are qualified in some

way [10]. In short, shared racial or gender identities between students and professors, or conversely a lack of such commonalities, can significantly impact the results of these interactions, both negatively and positively. Further, this particular finding suggests that belonging to the same in- or out-group can support students' persistence, even if the out-group is underrepresented. Overall, the body of literature on the impact of STEM faculty on women students is nuanced. The influence of professors is dictated most often by both students' salient identities and faculty's own personal interests and willingness to be intentional in efforts to prevent and overcome sexism in their disciplines.

The approach in some of this literature is complicated, and in part misleading, as research regarding the experiences of students of Color with their faculty is often used to support assertions about relationships between professors and women [4]. This approach assumes that the experiences of those who are underrepresented in STEM can be described universally. Although students of Color and women are certainly marginalized in these disciplines resulting from their salient identities and each does suffer from discrimination, their experiences are not identical. Ultimately, much like the assumption that the ideal in STEM is men, researchers should not assume that women in STEM refers only to white women. Scholarship like that of Salazar et al. [11] which studies and then compares the experiences of white women with that of women of Color underscores the differences in their experiences with faculty. However, research explicitly interrogating women of Color in STEM is limited.

Ultimately, many factors work together to either support or hinder women's success and retention in STEM disciplines, but the literature makes it clear that faculty have the potential to greatly influence academic performance and persistence, especially that of underrepresented students [10], [11]. Women who persevere through a STEM discipline may have to rely on various resources and different types of capital, resources and information provided by networks of institutionalized relationships [69], to offset messages about their assumed abilities and gendered stereotypes that they can experience both in interactions with professors and those which are rooted in disciplinary practices [18] - [21]. However, institutions of higher education have the capacity to challenge and shift STEM cultures so that they do not center men and masculinity, as it further disadvantages women [4], [22]. Relationships with STEM faculty are just one piece of a larger puzzle that comprise a student's likelihood of persistence [23], [19], [24] - [26]. Many of these elements work together with disciplinary culture, which is shaped largely by faculty who can either challenge or reify disciplinary norms [27], [28]. The ways in which students experience this culture has an effect on their interest, self-concept, sense of connectedness, and persistence in STEM [29] - [31].

Men Allies in STEM

The research on the impact of faculty/student relationships, coupled with the literature on the positive effects of dominant group advocacy efforts [32] - [37], suggests that allyship may be regarded as a potential opportunity to affect women's representation in STEM [38], [6], [39], [7]. However, many men fail to even recognize the problem of gender inequity in STEM, and in

denying the existence of the challenges women in STEM are forced to navigate, men reify existing gender disparities [40] For example, in their study of over 700 participants in which 30% of respondents were faculty, Handley et al. [40] found that men were less receptive to scholarship that examines gender bias in STEM than their women peers.

The failure of the majority of men to acknowledge the well-documented issue of gender inequity in STEM makes men allies all the more important [40]. Although allies may not be able to affect the beliefs of all men, they may be able to influence some colleagues – both women and men. In the case of supporting women, the efforts of a man ally may support a woman's retention in a STEM discipline [5], [38], [6], [39], [7]. However, research suggests that without an increased willingness by those in the majority in STEM to concede that gender bias and discrimination are real obstacles for women in these disciplines, creating cultural change may prove to be difficult [40].

The literature on allyship consistently delineates several hallmarks of the practice. Allies must maintain membership in a dominant group, possess an awareness of their own privilege, and actively work against inequity and systemic oppression on behalf of an underrepresented population [41] - [43]. Although research suggests that men faculty ally programs are effective at retaining women in STEM and improving disciplinary cultures [38], [6], [39], [7], the limited body of literature on men allies has found that even when men claim to support women in STEM initiatives, they often do so philosophically, but not actively in practice [11]. This supposition may be a result of prototypicality threat, or men's fears that they may lose their position as the gender that best symbolizes STEM [44]. The findings of Danbold and Huo [44] indicated that men's beliefs that formal interventions to improve the representation of women in STEM were effective with levels of prototypicality threat have significant implications for ally research. For example, men who believed that their gender was and should be the model representative in STEM were more likely to oppose formal initiatives to champion women, demonstrated a propensity towards exclusionary behaviors, and held expectations that women should conform to masculine standards in these disciplines. Further, Danbold and Huo [44] concluded that men fear the potential loss of their status as the ideal subgroup in STEM, and the knowledge that women are expected to conform to a masculine model, serves as the primary driver of their opposition to efforts to increase the number of women in these disciplines. Additionally, men who held low prototypicality beliefs also demonstrated decreased rates of feeling that their position as the standard was threatened by any potential increases in the number of women in STEM, specifically when they viewed formal interventions as successful [44]. This finding, in particular, is important in that it identifies a sub-section of men who may be more likely to embrace the possibility of an increase in women entering STEM disciplines, and thus willing to serve as allies [45].

The ability to recognize the additional obstacles that women in STEM must overcome ultimately enables men allies to acknowledge the inequitable experiences of women. Additionally, men allies are viewed more positively than women when they confront sexist behaviors and these interactions are perceived as more serious and genuine attempts at resisting

sexism than those that are spearheaded by women [45], [46]. This suggests that not only can men allies have positive and lasting effects on efforts to address gender inequity in STEM, but also that relying on women to improve the culture for women in STEM may not be as effective as utilizing men. Given that men hold high status as the majority in STEM, leveraging their power for the sake of creating more equitable environments could be an effective method. As Broido [42] posited, allies "who are working to end the system of oppression that gives them greater privilege and power based on their social-group membership" (p. 3) are likely to affect change, due to their social status as a member of the majority.

The implications of social assumptions about gender and gender roles are significant for both men allies and women in STEM disciplines. Women enter STEM spaces at a disadvantage, often viewed as outsiders who do not belong [47], [48]. Although men allies may desire to challenge the well-established, masculine nature of STEM culture, doing so may alienate them from those who view men as the ideal representative of these fields, as well as potentially affect their own status as the dominant group [44], [46].

Methods

Data presented in this paper were collected as part of a larger qualitative, case study with 31 men STEM faculty, of which 12 were in engineering disciplines. The purpose of the larger study was to develop a better understanding of men faculty in STEM who identify as allies for undergraduate women in their disciplines. The expectation was that findings from this research might inform alternative approaches to addressing the issues related to recruiting and retaining undergraduate women in STEM disciplines. Case study, a detailed examination of a bounded system or unit of analysis was employed as the methodology to collect data [49], [50]. A case or unit of analysis may be an individual who is an ideal illustration of the phenomenon at the heart of a study [49]. As the case in this study is men faculty allies in STEM [51] and I set out to examine the phenomenon within an environment that is authentic to its everyday context (i.e., participants' STEM disciplines), case study was an appropriate methodology [52], [49].

Sample

Data for the larger study was collected from 31 men faculty in STEM disciplines; however, for this paper, only data provided by those in engineering disciplines was included. Participants were recruited based on their employment by institutions that have been awarded a National Science Foundation (NSF) ADVANCE award [53] and needed to self-identify as an ally for undergraduate women in their discipline to be included in the study. NSF ADVANCE institutions represent communities that possess initiatives, research and individuals who are committed to gender equity in STEM, which served as an ideal source from which to recruit potential participants who represent model allies [49].

Recruitment was conducted through Principal Investigators of ADVANCE awards or directly with men who are engaged in formal advocates or allies initiatives as noted on institutional websites. In both cases, snowball sampling was also utilized [54]. Although the

researcher attempted to generate a diverse sample, the majority of participants in engineering were homogenous, with only two men identifying as non-white and one man with a sexual orientation other than heterosexual (see Table 1 for more detail). Additionally, while this study ultimately aims to discover information that can be useful in challenging hegemonic disciplinary cultures [22], [40], it does operate within the gender binary. Participants were afforded the opportunity to disclose their gender identity and were asked to affirm that they identified as men to confirm they met the study criteria. Although this research sought to study men specifically, this focus could be considered problematic, as it excludes a range of individuals who may identify as agender, gender fluid, genderqueer, or non-binary [70]. Participants came from a range of STEM disciplines, and those within engineering included electrical, mechanical, biomedical, chemical, civil, and environmental, and materials design. Due to the nature of the NSF ADVANCE awards and the types of institutions likely to have the support to pursue such funding, the majority of participants came from R1 and R2 universities.

Table 1

Pseudonym	Institution type	Academic rank	Discipline	Race	Hispanic	Citizen	Age	Sexual orientation
Aiden	Public R1	Clinical Professor/ Instructor	Materials Science & Engineering	White	No	Yes	44	Heterosexual
Andres	Public R2	Assistant Professor	Engineering Education	White	Yes	No	43	Heterosexual
Casey	Public R2	Full Professor	Civil & Environmental Engineering	White	No	Yes	59	Heterosexual
Charles	Public R2	Associate Professor	Civil & Environmental Engineering	White	No	Yes	53	Heterosexual
Dimitris	Private R1	Full Professor	Electrical Engineering	White	No	Yes	>65	Prefer not to answer
Edward	Public R1	Full Professor	Civil & Environmental Engineering	White	No	Yes	50	Heterosexual
Jacob	Public R1	Associate Professor	Engineering Education Systems & Design	White	No	Yes	42	Heterosexual
James	Private R1	Full Professor	Chemical & Environmental Engineering	White	No	Yes	63	Heterosexual
John	Public R2	Adjunct Assistant Professor	Civil, Environmental, & Geospatial Engineering	White	No	Yes	39	Heterosexual
Josh	Public R1	Clinical Professor/Instructor	Biomedical Engineering	White	Yes	Yes	37	Fluid/Pansexual

Ryan	Public R2	Full Professor	Mechanical Engineering	White	No	Yes	39	Homosexual
Timothy	Public R1	Full Professor	Materials Science & Engineering	White	No	Yes	61	Heterosexual

Data Collection

Data were collected through a demographic survey, which was primarily distributed to ensure participants met the study criteria prior to interviews (see Appendix A for the demographic survey), and individual interviews with men faculty in STEM disciplines. Interviews occurred over a videoconferencing platform, given the wide geographical range from which participants were recruited [55] and lasted on average one hour. Although in-person interviews are ideal, research has demonstrated videoconferencing platforms allow researchers to build rapport with participants in a meaningful way, and ultimately can lead to a more diverse sample than if participants were solely recruited from the location of the researcher [56].

Interviews sought to capture participants' motivations for serving as allies, examples of how they serve as such, and the ways in which their ally status affected relationships with both men and women faculty colleagues. Examples of questions included share some examples of how you serve as an ally, how does your allyship influence your approach to teaching or mentorship, and have the ways in which you serve as an ally changed over time? (see Appendix B for the full interview protocol). After each interview occurred, fieldnotes were created immediately and the audio recordings were transcribed. Participants were also invited to share texts, awards, pictures and other items that they identified as visual illustrations of their role as allies.

Data Analysis

Interview data was transcribed and imported into Atlas.ti, a computer assisted qualitative data analysis software tool, to facilitate the coding process [49], [51]. Data analysis was conducted using both inductive and deductive coding [49]. Inductive coding allows patterns and themes to emerge with no previously established theory or hypothesis, enabling the data to guide the researcher as it is gathered directly from participants [49]. I also created a predetermined set of codes based on previous literature on gender in engineering and allyship. Examples of these codes include privilege, formal training, cognitive dissonance, and mentoring. Inductive codes like best practices, leader in ally program, personal growth, and tenure emerged through the memoing process. The use of both inductive and deductive coding techniques leads to a stronger analysis by enabling themes to present themselves from the data and for well-established bodies of literature to influence data analysis [49].

Although the focus of the study was not on ally training or best practices utilized by faculty, the high frequency with which both topics appeared throughout interviews highlighted the importance for participants as they described their experiences advocating for undergraduate women. The code best practices was used 95 times in analysis and due to this high number, categorizing the examples that participants gave demonstrating how they presented their allyship

into informal and formal strategies allowed me to clarify the differences among the mode of implementation and long-term effects of each method. In short, informal practices were often based on individual actions that were implemented using one's personal agency, whereas the formal strategies, policies, and actions taken often required commitment from multiple faculty or staff, their department as a whole, or their campus' institutional leadership. Given that many of the informal strategies were dependent on a single individual, their methods may not be as impactful as the formal methods utilized. However, formal strategies that are institutionalized by allies have the potential to have long-lasting effects on their campus communities.

Trustworthiness

Although scholars offer different terminology for trustworthiness and dependability, most agree that qualitative research should strive to be reliable, transferable, and free of bias [57], [49]. In order to establish trustworthiness in qualitative studies, the process used for data collection and analysis should be communicated clearly [49], [51]. In doing so, the researcher demonstrates that their findings are reasonable and plausible. To establish trustworthiness and dependability, I utilized method triangulation, or the use of multiple methods; purposeful sampling, which alludes to participant selection based on particular criterion; thick description, or interpretations of data that include contextual information; and the creation of an audit trail, a detailed description of the research steps [49]. I also engaged in peer review, member checking, the strategy of coding and recoding, and researcher reflexivity by acknowledging any potential biases I may have that could impact my interpretation of findings.

Positionality

Researcher reflexivity is a well-established method for generating trustworthiness in qualitative studies [49]. An individual's positionality statement highlights the unique position of the researcher and can include their values, assumptions, experiences, and theoretical preferences [49]. As the main research instrument [58], an individual's statement of reflexivity is a means to identify a person's potential for subjectivity throughout their study [57]. As a higher education administrator, I have had professional experience working to directly impact the recruitment, retention and academic success of undergraduate women in STEM disciplines as I worked for three years managing a program for women in STEM. In my role as the coordinator for an initiative focused on recruiting and retaining women in STEM, I organized activities aimed at building peer relationships, providing academic support and enhancing the overall experience of undergraduate women in STEM. This position allowed me to gain firsthand knowledge of the experience of undergraduate women in these disciplines, knowledge that was often a strong reflection of the literature on chilly climates and harassment that women experience in STEM.

While managing the women in science and engineering program, I enrolled in a doctoral program and immersed myself in the research on interventions like those I was implementing in my administrator role. Upon learning that most interventions were largely ineffective at influencing the representation of women in STEM, I began to explore less traditional models of

programming that may affect attrition and retention of undergraduate women in STEM. I quickly noted that men were rarely, if ever, partners in initiatives aimed at supporting this underrepresented population. As I attempted to involve men faculty and undergraduates who indicated an interest in supporting women undergraduates in STEM in the program which I managed, I experienced resistance from some women faculty involved in the program. Additionally, there seemed to be a very small pool of men faculty who were interested in engaging in the program. These observations ultimately piqued my curiosity as to why programs and formal interventions designed to encourage and support the persistence of women in STEM were intentionally insulated from the men who comprise the majority, and thus potentially have great agency to affect change, in these disciplines. I did disclose these experiences in many of my interviews with participants, which may have affected the way in which participants described their experiences. Additionally, my own experience attempting to implement an intervention to affect change for undergraduate women in STEM could certainly impact my interpretations of the data collected.

As a woman interviewing men, my gender could have affected the data that participants were comfortable sharing with me. Men who had, at multiple points prior to and during the interview, confirmed their ally status, also expressed uncertainty that they were, in fact, allies when pressed to share examples of tangible advocacy actions. Additionally, a number of participants who questioned the validity of their self-identified ally status and were referred to the study by a woman colleague, indicated that they would not have opted into the study if I had directly contacted them. As such, my own gender identity as a woman can certainly have affected the degree to which they transparently disclosed their experiences.

Limitations

The use of NSF ADVANCE awardees to create my sample has several limitations. There are 242 institutions of higher education that have received NSF ADVANCE awards. However, given that there are currently almost 4,000 colleges and universities in the U.S. [59], the use of NSF ADVANCE recipients limits the scope of the study. The majority of institutions included in the list of awardees are classified as highly productive research and doctoral granting universities [60], excluding four-year colleges where mentorship may be more likely to occur, due to smaller student populations, faculty/student ratios and less pressure on faculty to produce research. This, in and of itself, can be considered a limitation. Although it can be assumed that Principal Investigators value gender equity in STEM disciplines themselves, this may simply not have been the case. Additionally, it is possible that individuals who engage in this work in exchange for grant funding may have ulterior motivations that do not align with allyship. The simple self-selection of participants into the study could create a homogenous sample, inhibiting diversity [61]. Finally, many of the PIs in the NSF ADVANCE awardee database appeared to be women, which meant that I had to rely on the recommendations of these individuals to identify men faculty allies who fit the study's criteria and could engage in it. The limitations of snowball sampling as a method are well documented, with researchers primarily arguing that it may not

create a representative sample since it is not generated randomly [62] - [64]. In relying on individuals connected with the NSF ADVANCE program, those who may be categorized as more typical cases could have been excluded from participating in the study.

Best Practices

Findings from the larger study [65] that the data in this paper is derived from informed the best practices for men allies presented below. Appendix C provides a summary of the data that was used to develop the findings presented. First, participants in this study possessed a number of shared characteristics, which seem to be beneficial in allyship efforts. Men indicated an awareness of the additional barriers that women must navigate. Additionally, many of the allies centered the importance of building relationships with undergraduate women and thereby trust, as a foundational element of effectively supporting marginalized students. Further, while allies understood that their role as advocates evolved and developed over time, as have the ways in which they present their allyship, many participants exhibited an uncertainty around how best to engage others in gender equity work, which strategies to implement, and the potential efficacy of their efforts.

Allies also discussed the enactment of both informal methods and strategies that they institutionalize either in courses, within their departments, or at their institutions. The informal strategies described by allies are typically actions engaged in on a regular basis and occur daily in many of my participants' lives. Men also shared a variety of more formal approaches to demonstrating allyship, the formal implementation and systemization of which often require more intention and commitment. Although there is value in each type of strategy, formal mechanisms that are institutionalized in some way may be especially beneficial as they have the potential to outlast individual allies long after they leave the academy.

Ally Perspectives

Shared Characteristics

Participants in this study possessed a number of shared characteristics, those of which presented here may be especially valuable for allies to consider or revisit. Men indicated an awareness of the additional barriers that women must navigate, a factor deemed critical to allyship efforts by participants in this study. Allies highlighted the importance of possessing a knowledge of the distinct experiences of women in engineering, for the expressed purpose of working to remove the unique obstacles and challenges that this population is forced to navigate. The majority of allies stated that being aware of the negative implications of women's underrepresentation in engineering, learning more about their experiences, and thinking about how to actively use one's own privilege to create more equitable environments are all important components to being an ally. As such, education is a critical component of allyship. Individuals, departments, and institutions should invest in this education, be it in the form of providing literature, formulating mentoring circles or other forums centering discussions on gender inequity or the offering of more formal mechanisms like men's ally training programs.

Relationship Building

Allies also centered the importance of building relationships and thereby trust, as a foundational element of effectively supporting marginalized students. For many of these participants, developing or enhancing relationships with undergraduate women both enabled faculty to provide direct support and guidance to their students, as well as served as a form of education for themselves to more distinctly understand the experience of this population. Many of the participants in this study also discussed the value of engaging in self-education, identifying and consuming literature on the experiences of women in engineering. As men cannot experience the marginalization that women in engineering may encounter, those who seek to serve as allies should consider and engage in these forms of type of intentional knowledge building, as participants in this study deemed this education as impactful.

Allyship as a Journey

Participants also emphasized that their role as allies had evolved and developed over time, as did the ways in which they present their allyship, though active engagement was highlighted as an especially important component of advocacy efforts. However, despite some participants either leading or being engaged in formal programs that coached men on how to be effective allies, there remained an uncertainty around which strategies to focus on, how to successfully implement them, and generally, how to best serve the women that they seek to support. The fear of not responding appropriately or discomfort that can arise from reflecting on one's own role, as a member of the majority, in perpetuating oppression or challenging problematic views espoused by colleagues should not deter men from engaging in gender equity work. This self-doubt described by participants indicates that mentorship, further education, and engagement in formal ally training programs may be beneficial, as normalizing the uncertainty around what entails appropriate ally behavior or the reality of the dominant group's role in reifying systemic inequity may alleviate or reduce insecurities around being the ideal ally.

Informal Approaches

Cultivation of Colleagues through Education

Allies enact a number of informal methods to serve as advocates for undergraduate women in engineering. At the heart of many strategies was the importance of developing relationships, both with students and men colleagues who allies deemed in need of education related to gender equity. Building or enhancing relationships with undergraduate women in their disciplines not only furthered participants' understanding of the lived reality of this population, but it also provided them with anecdotal evidence that they could use when challenging gendered or sexist views. For example, several participants discussed the value of sharing anecdotal experiences of discrimination or sexism that they heard or observed directly when discussing the harmful consequences of women's underrepresentation with men who do not prioritize gender equity.

One particular approach that participants deemed to be effective in educating men colleagues who do not value gender equity was the importance of making the issue personal to

individuals. Allies discussed the necessity of generating connections between individuals' lives and their own personal value system versus the use of logic or data in attempting to influence those who do not value gender equity. Those participants who were able to successfully utilize this approach – taking the initiative to invest time and energy into learning about an individual's values and demonstrating a connection between their values and the goals of addressing institutional or systemic bias – perceived this method to be especially effective. Even for allies who experienced particularly problematic or challenging colleagues, they underscored the importance of remaining in connection with them, as opposed to giving up on or refusing to educate these individuals. One participant referred to this concept as "connected disruption", meaning allies must build and then remain in relationship with those they seek to educate, but simultaneously work to disrupt troubling behavior that individuals may be expressing.

Regardless of their approach to relationship building, participants underscored the importance of taking action and noted that it is essential to use their privilege as men to support women in overcoming barriers. This is especially critical as underrepresented groups often do not possess excess capital to take on the additional challenges that they are forced to conquer. Many allies discussed the negative implications of not engaging in action when they witness troubling behavior that hinders undergraduate women, highlighting the potential consequences for students' sense of belonging, academic performance, and persistence. Participants were also aware that there are varying levels of action that individuals can potentially take, but these should be determined in consultation with the women they seek to support.

Informal Best Practices

Intentional pedagogical choices, the creation of inclusive classroom and office environments, the normalization of incorporating characteristics or traits commonly associated as feminine, and engagement in student-centered spaces and events are all informal strategies employed by participants. The opportunity to create comfortable environments for women in engineering through intentional pedagogical choices can be especially beneficial. Some participants shared that they regularly seek out resources on how to create inclusive classroom environments and often adopt new strategies to help women undergraduates feel more comfortable in spaces where they are in the minority. Examples of these practices include intentionally building mixed gender small groups for project-based learning, the utilization of humanizing language (e.g., the use of the term women versus girls), emphasizing the contributions of women scientists and engineers, and incorporating relevant social issues into course discussions and lectures. Beyond pedagogical choices, providing flexibility is a small way to model to undergraduate women that their experiences are distinct. For my participants, this looked like simply checking in with women students to ensure they are comfortable in certain spaces. Some allies discussed checking in with women assigned to small groups with all men students to ensure their comfort and others highlighted providing options for student meetings and office hours that include open, public environments. Participants perceived that offering these simple options seemed to make students more comfortable with the faculty in my study, potentially increasing the likelihood that women may seek them out for support, if needed.

Faculty also highlighted the use of gender pronouns as a strategy for acknowledging gender. As engineering has been presented as "gender neutral" [66], but was built on masculinity [6], the use of gender pronouns was beneficial in both in-person and virtual learning settings, as it can create and normalize discussions around gender in spaces where it has previously been absent. Related, men allies' presentation or exhibition of traits that have historically been viewed as feminine (e.g., helping, caring, or crying) was suggested by participants as another strategy for integrating femininity into engineering spaces. An excellent example of how this idea was further enhanced was provided by an engineering education faculty member who discussed his own creation of a poster with local resources for women's sexual and reproductive health. He placed this poster on his office door with the hope that the action was perceived as a non-verbal signal to women students that he understood they possessed distinct health needs which he inherently cared about and wanted to ensure they had the resources to address.

Finally, participants underscored the value of entering student-centered, academic-adjacent spaces to identify and address gender-related concerns. For several participants, this manifested as attending meetings of student groups like the Society of Women Engineers and Women in Engineering programs. Women often, though not always, engage in discussions around their own gender-related experiences in these environments. As discussed earlier, possessing an understanding of the distinct experiences of women in engineering is critical for ally development so men's engagement in these spaces can be an important step in enhancing their perceptions of the population they seek to support. Additionally, as the majority group in engineering, men may have the capacity, power, and capital to address gender-related issues communicated by women in these settings. Not only does engagement in these types of events continue to illustrate a picture of women's distinct experiences, it also supports the building of relationships with undergraduate women and demonstrates allies' personal value and support of women in engineering.

Formal Strategies

Although I found that individual participants demonstrated their allyship in both informal and formal ways, both of which add value and are enacted with achieving gender equity in engineering, the operationalization of efforts to support undergraduate women may serve as a mechanism for sustaining institutional commitments to this underrepresented population long after individual allies have moved on from the academy.

Individual Formal Strategies

Some of the participants in my study highlighted the value of working in and through systems to enact cultural change, though not all formal strategies presented by allies were institutionalized. For example, several participants intentionally prioritized the hiring of women as Teaching and Research Assistants, explaining that because men do not experience additional barriers in securing positions such as these, faculty do not need to create advantages in support of men's co-curricular pursuits. Several faculty discussed the value of writing recommendation letters for undergraduate women in engineering that both highlighted their academic

achievements *and* acknowledged the existence of gender-based barriers that women are forced to navigate as they pursue their goal of becoming an engineer. Another participant discussed his leadership in writing a NSF grant application for funding to create a learning community for women in engineering and when secured, he served as the director for several years, working to use the co-curricular program as a recruitment and retention tool.

Formal Best Practices

Student advisory groups were another formal mechanism instituted to support undergraduate women. As chair of his department, one participant not only created the student advisory group as an approach to relationship building with students, he also hosted the meetings of this committee in conjunction with weekly departmental socials, with the goal of being widely accessible to students who may be in need of assistance or support. Another ally discussed the creation of and his leadership within mentoring circles for new faculty hires in his department. This institutional mechanism served as a mode of communicating appropriate behavior with students and provided the participant with an institutional outlet to demonstrate his allyship through the values he espoused in discussions with new faculty. Another strategy, with potentially long-standing and significant implications, was enacted by another chair whose department engaged in overnight field experiences. Upon learning about inappropriate behavior performed by men that undergraduate women in his department had to navigate on this excursion, the participant instituted departmental guidelines around acceptable conduct. This is an important contribution to that department, as the policy will likely remain intact once this ally's term as chair has ended, potentially serving as an institutional mechanism for keeping undergraduate women safe from unwanted behaviors from men.

Although informal pedagogical strategies were discussed earlier, participants also enacted mechanisms to systematically incorporate activities or content that centers gender equity into coursework. For example, one participant discussed his successful efforts to lobby the school of engineering at his institution to incorporate a book chapter on diversity, equity, and inclusion written specifically for inclusion in the text for their first semester engineering clinic. Another ally shared details about the development and inclusion of what he referred to as "perspective broadening activities" into the summer research experience for undergraduates that he organized. These activities included discussions and debates around race, gender, inequity, and privilege. Importantly, this participant referenced that what prompted the development of such activities was requests for them by his undergraduate students, all but one of whom were women and also included several women of Color.

Finally, the most formal strategies that men allies reported engaging in included broader diversity, equity, and inclusion (DEI) and gender equity trainings to enhance one's knowledge, skills, and activities. Engagement in these inclusive training programs such as those that focus efforts more broadly on DEI supported the enhancement of allies' knowledge around bias, privilege, and inequity, self-efficacy related to gender equity efforts, and overall development of tangible allyship strategies. As participants in my larger study were recruited from institutions that have received a NSF ADVANCE award, which grants funding to initiatives, research, and

individuals who are committed to gender equity in STEM [53], many allies discussed the significance of their formal engagement in these initiatives. Many ADVANCE-funded initiatives aim to ameliorate gender inequity in STEM through the development and implementation of men ally training programs, leveraging both men's numerical representation and social status in their disciplines to educate colleagues on how to effectively advocate for women. A significant number of these ADVANCE initiatives follow an "Allies and Advocates" approach, in which advocates receive extensive training so that they can lead campus workshops to encourage and cultivate men who will serve as allies, as well as collaborate with women who are involved in the initiative to guide the future of their ADVANCE programming. At the heart of the "Allies and Advocates" framework is a desire to shift "the locus of responsibility from lone actors to networks of men faculty who listen, learn, and act in response to identified issues" [68]. Ultimately, these programs aim to cultivate disruption skills, provide opportunities for solution building, allow men to explore the basis of their motivation for involvement, and offer concrete examples of how to serve as an effective ally.

Implications

Participants in this study utilized both informal and formal approaches to allyship, both of which could be enacted at the individual level, suggesting that men faculty interested in demonstrating allyship can do so within their own teaching practice and mentoring relationships. However, many of the institutionalized policy-type changes that may have longer-lasting effects often involved either individuals in positions of leadership (e.g., departmental chairs, deans, etc.) or groups of individuals. As climates vary within organizations, before enacting any type of strategy to demonstrate allyship, men should assess their classroom, departmental, and institutional cultures for undergraduate women to determine what may be the most effective change to pursue. A critical component of this climate evaluation should be learning specifically about the experiences of women in their disciplines directly from this population. Intentionally assessing how the cultures within a department or institution affects women in particular should inform any action taken to improve their experiences.

Undergraduate women who enter engineering majors deserve the opportunity to pursue their chosen degree and career field, but often the barriers they must overcome are simply too cumbersome. My hope is that in providing a myriad of approaches to serving as an ally, this study will encourage men faculty in engineering who desire to improve the experience of women in their disciplines to take some action. As many participants discussed the importance of taking some step towards serving as an ally, regardless of how small, men are urged to act within their skill sets and knowledge base, in conjunction with the results of climate assessments, as a starting point. With the support of men allies, efforts to shift the historically masculine and exclusive culture in engineering may be more effective than previously.

Conclusion

The identification of how men understand and enact their role as allies is both a worthwhile contribution to the literature and can have a practical impact in improving the experience of undergraduate women in engineering, as these findings can inform the efforts of those men faculty who desire gender equity and any evidence-based practices that may be implemented in the future. Results from this study indicate that there is a broad spectrum of informal strategies and institutionalized mechanisms that men allies enact to demonstrate their understanding of the consequences of and attempts to contribute to the amelioration of gender inequity and support of women undergraduates. The methods enacted by participants in this study can be used to inform training and education so that the efforts of men faculty allies can be better leveraged, as they attempt to create more equitable engineering environments for women undergraduate students.

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Appendix A. Demographic Survey

Thank you for your willingness to participate in this study. Please complete this brief survey to ensure you fit the study criteria. If you meet the study criteria, the researcher will follow up with you to schedule a one-hour interview within 24 hours of form submission. If you have any questions, please contact [Researcher name] at [Researcher email]

* Required

1. Name *

2. Email *

3. Institution *

4. Please select your academic rank. *

Choose one

Adjunct professor

Clinical professor/Instructor

Assistant professor

Associate professor

Full professor

Other

5. Please indicate the length of time (in years) you have been at your current institution

6. Please select your race.
Choose one

American Indian or Alaska Native

Asian

Black or African American

Native Hawaiian

Other Pacific Islander

White

Prefer not to answer

7. Do you identify as Hispanic, Latino/a or Spanish?
No, I do not identify as Hispanic, Latino/a or Spanish

Yes, I do identify as Hispanic, Latino/a or Spanish

Prefer not to answer

8. Are you a U.S. citizen?
Yes

No

Prefer not to answer

9. Please indicate your age below.

10. Please select the gender identity that most closely aligns with how you identify? *
Gender Non-conforming/Non-binary

Intersex

Man

Woman

Prefer not to answer (If you choose this option, you will not be eligible to participate in this study.)

11. Do you identify as Trans*
Yes

No

Prefer not to answer

12. Please select the sexual orientation with which you identify
Asexual

Bisexual

Fluid/Pansexual

Heterosexual

Homosexual

Queer

Prefer not to answer

13. Please indicate whether you identify as an ally using the formal definition follows: Allies must maintain membership in a dominant group, possess an awareness of one's own privilege, and actively advocate against inequity and the systemic oppression of underrepresented populations (Bishop, 2002; Broido, 2000; Patton & Bondi, 2015) *

Yes, I identify as an ally for undergraduate women in STEM

No, I do not identify as an ally for undergraduate women in STEM (If you choose this option, you will not be eligible to participate in this study.)

Unsure (If you choose this option, you will not be eligible to participate in this study.)

14. If you have recommendations for other individuals who fit the study criteria, please list their name and email or institution below. (Study criteria follows: 1.) individuals who self-identify as men 2) hold any type of faculty position in a STEM discipline at an institution of higher education that has received a NSF ADVANCE grant and 3) attest that they identify as an ally for undergraduate women in STEM will be considered as participants)

Appendix B. Interview Protocol

1. What experiences have you had teaching and mentoring undergraduate women in your discipline?
2. How do you define allyship? Describe the qualities or attributes of a strong ally for women in your discipline.
3. What skills does an ally need to have?
4. Tell me how you came to identify as an ally. Share any influences in your life that conveyed the importance or value of gender equity.
5. What formal programs or mentoring relationships, if any, have you engaged in to better serve as an ally? If you have not engaged in formal programs or mentoring relationships, why haven't you?
6. Can you share some examples of how you serve as an ally? How does it influence your approach to teaching or mentorship?
7. In what specific ways does your allyship affect the experiences of undergraduate women in your discipline? Can you give me an example to illustrate?
8. What experiences or information did you have that led you to offer this particular type of support?
9. Is it difficult to engage in ally behaviors? If yes, how so? If not, why not?
10. Have the ways in which you serve as an ally changed over time? If so, how? And why?
11. Do you notice any differences in the way you are treated by men in your discipline who do not identify as allies? If yes, how has this affected you?
12. What advice would you give to men colleagues in your discipline about how to best serve as an ally and support undergraduate women?
13. What is your approach in communicating and working with men in your discipline who do not seem to value gender equity? How is your approach different when working with men who you know identify as allies?
14. In what ways have your relationships with colleagues who identify as women changed since engaging in ally work?
15. As you might remember, as part of participating in this study, I'm asking participants to share with me a document (such as a speech transcript, email correspondence, minutes, a press release, department newsletter or program brochure) that illustrates their ally identity. Does anything come to mind for you?
16. Is there any information you can share with me about the context of the documents that would be important in understanding how they relate to your experiences?
17. Is there anything else that you would like to share with me that would be important in understanding your experiences as an ally for undergraduate women in STEM?

Appendix C. Summary of Data

Finding	Data Supporting Finding	Participant
Ally Perspectives	You need to be willing to speak up and you need to be able to do that quickly and be unafraid to do that. And, um, make sure that, especially if you see a situation where somebody's being biased against or is very uncomfortable based on what people are doing, is to just speak right up and say, "This is not okay. We're not gonna do this anymore."	Aiden
	I'm just trying to be aware and, and not be a problem, you know. It's less, it's not so much I'm trying to be an ally. I'm just trying to not be part of the problem. I'd rather be part of the solution or at least not be part of the problem.	Casey
	I prefer to speak up when I think there are things that are wrong and I need to express it.	Andres
Informal Strategies	I know if they [men colleagues who do not value women as contributors] were to explicitly say, you know, "we can't have any women on this project because X, Y, or Z," I think I would contest that, you know, very plainly and say "that's not true" or give counterexamples of where, you know, my experiences don't match what they're saying.	Edward
	Jacob shared that while "it is hard" to call out problematic colleagues, he "always has the conversation."	Jacob
	We promote what's called connected disruption so you need to stay in connection with the person, but try to disrupt the	Ryan

	behavior that they're expressing.	
Formal Approaches	I guess being aware of the extra challenges that are faced by women and minority colleagues or students that we interact with here in the academic setting. Being aware of the additional challenges and barriers that are either, you know, directly or indirectly thrown up in their faces and *working in a systematic way* to remove those obstacles so that ultimately the playing field and the opportunities are equivalent for everybody.	John
	I mean, there's certainly some people who you're not gonna move and you marginalize as chair; I would marginalize, I would make sure they weren't on a committee where it was gonna be important. For example, I minimize their role in recruiting….I think we have one case going on right now…where we have someone who doesn't have a growth mindset and is teaching a very important course, and that's not been helpful in advancing women and minorities through that course. And so the answer is, “Well, we're gonna make a change. You've taught that course for 10 years. We don't care. You're done.” So sometimes you have to marginalize people. Sometimes you have to persuade, and it's just a matter of where, you know how long of a drag it is to drag them in the right direction. Sometimes it's just too, you're not gonna change them. Or if	Timothy

	it's so, such an entrenched behavior that you can't fix it, then you make another choice.	