

## **Need Satisfaction and Need Frustration among Women and Men Faculty in Engineering: A Self-Determination Perspective**

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### **Abstract**

The workplace experiences of faculty in engineering, physics, and computer science were evaluated through the lens of self-determination theory (SDT), which posits three universal human needs (autonomy, competence, relatedness). It has been well-established that meeting these needs in the workplace is associated with higher productivity and greater employee retention. Interviews with 14 female and 10 male faculty employed at a variety of institutions across the United States were conducted, transcribed, and analyzed. Semi-structured questions regarding past and present work situations, as well as ideal and worst-case scenarios, were used to understand how needs were valued, met, or unmet in the workplace. In this study, content analysis was used to code the responses of interviewees regarding past and present workplace experiences according to the three universal needs of SDT. Results indicated that both men and women spoke to relatedness needs far more frequently than needs for autonomy and competence. Women spoke to the satisfaction of relatedness needs and the frustration of those needs about equally while men spoke primarily to relatedness satisfaction.

Across the 24 interviews, over 100 independent ideas were expressed regarding relatedness in the workplace. The satisfaction of relatedness needs was expressed in similar ways between men and women. Collaboration and frequent interactions with peers were important to both men and women and often made a critical difference in whether interviewees found their respective workplaces to be fulfilling or not. In contrast, competition from colleagues that often progressed to the point of taking ideas, credit, or otherwise thwarting a faculty member's career came up multiple times as a source of frustrated relatedness needs. Unmet relatedness needs were often expressed as isolation and loneliness and often attributed to poor representation of women in a home department or unit. The results of these interviews viewed through the lens of SDT suggest a need to support relatedness more effectively in the academic workplace, both by reducing detrimental competitiveness and by alleviating isolation among all faculty, regardless of gender.

### **Introduction**

In order to support the future STEM workforce, a key area of focus for research is on STEM faculty themselves. There is a significant long-term employment need that supports strong hiring and retention plans for faculty: the Bureau of Labor and Statistics predicts growth of 13.4% from 2014 to 2024 in jobs for STEM-related post-secondary teachers [1]. Women are a growing percentage of PhDs in STEM but are not proportionately represented among assistant professors [2]; to support this employment growth it will likely be necessary to attract more women to the faculty. Of even more significance is that STEM faculty play a critical double role in the health and gender make-up of the future STEM workforce. Research shows that role models have an important impact on career pathway decisions made by women engineering students [3]. Most engineers are first exposed to the profession through their STEM faculty, so if this group is not diverse, or if diverse workers (such as women) are perceived to be unhappier at work than colleagues, this may have an impact for women engineering students that will have multiplicative effects on future workforce diversity.

This qualitative study looks at how STEM faculty (men and women) experience their academic workplace. The lens employed is from self-determination theory, using needs satisfaction or needs frustration within the three universal needs of autonomy, competence, and relatedness [4]. A deep understanding of how these needs are being met, or not, will provide insight into how to support a thriving, productive, diverse STEM faculty.

## **Background**

Much of what is known about women faculty in STEM is similar to what is known about women in the STEM workforce in general. For example, there is a correlation between male numerical dominance and lack of female persistence in any career field, not just STEM or higher education [5]. *Numerical* male dominance refers to an environment in which men outnumber women while *normative* male dominance refers to an environment where the culture of expected behaviors is associated with males.

A “chilly climate,” which includes a social and cultural context at work that is isolating or even hostile to women, has been well-identified for women undergraduate students [6] and women working in engineering [7], [8]. Studies have found that chilly climate factors also exist for STEM faculty. A qualitative study of STEM faculty identified three key areas where gender had an impact on different career experiences for men and women: socialization, gender roles and unconscious bias, and work-family balance [9], all of which are aspects of the chilly climate concept. Britton [10] defined the chilly climate concepts in a context specific to women in academe to include “harassment by students and colleagues, inhospitable department and classroom climates, biases in hiring processes, inequitable allocations of work responsibilities, and policies that penalize women’s greater role in managing work/family responsibilities.”

One highly studied area for faculty women has been the theme of work-family balance. Qualitative studies have found that women faculty in many STEM departments feel either implicit or explicit pressure to avoid taking parental leave, tenure clock extensions, or other family-friendly accommodations [11]–[13]. Interestingly, there is greater general acceptance of family-supportive policies when they are either applied automatically or equally applied to men faculty [14]. Quantitative studies have revealed that the impact of family-support policies do affect both men and women faculty. STEM faculty (male and female) exhibited lower job satisfaction and lower intention to persist if their workplace culture presented *flexibility stigma*, or a devaluing of workers who made use of available policies for flexible work schedules to accommodate family and personal life responsibilities [15]. In many cases, either the official policies or the actual family-support attitudes of academic units contribute to the chilly climate for academic women in STEM.

Another issue associated with the “chilly climate” is that of socialization. Socialization is an aspect of the work climate that includes informal social networks and interactions, such as “after work activities, lunches, and water cooler gatherings.” In a largely male-dominated environment as almost all engineering departments are, women have less access to these social networks, whether intentionally or not. This leads to feelings of isolation but also stunts career progress. “For men who more usually find themselves in influential company, the process of networking, mentoring and sponsorship need not necessarily be a conscious activity. The enhancement of academic reputation becomes a by-product of an informal culture,” where women have less access to information, resources, and collaborations [16]. This unequal access could be

particularly hurtful to women's career success; a qualitative study of self-determination needs in the promotion and tenure process for STEM faculty found that women tend to rely more heavily on relational networks while men rely instead on written policies to gain competence in a new area (the promotion process) [17].

Gender roles and unconscious bias also play a part in the lived experiences of women faculty in STEM, although these influences are perhaps the trickiest to detect. This includes unspoken (and often, unrecognized) stereotypes about the ways that men or women both *will* and *should* behave and often carry a sanction for those who violate these norms. People are often unaware of these biases or how the biases shape their own thoughts and actions [9]. This can impact women faculty through hiring, promotion, and daily work culture, and it is more than a minor inconvenience. Research has shown that gender harassment leads to "anger, anxiety and depression," as well as "over-performance demands" for those targeted [18]. Moss-Racusin and colleagues [19] determined that faculty who held more pre-existing "unintentional negativity toward women" were also less likely to hire women, would pay them less, and would offer less mentoring.

It is important to realize that these gender biases are not only perpetuated through male faculty; in a quantitative study involving 2,290 STEM faculty at one large research university, researchers determined that 68% of men *and* 64% of women faculty displayed implicit bias associating men with leadership roles and women with support roles [18]. Both male and female science faculty displayed a bias toward hiring a (hypothetical) male rather than female student as a lab manager [19]. Furthermore, Rudman [20] demonstrated that self-promotion in women (an almost essential trait for a successful academic career) invokes a more negative response from both men *and* women than does self-promotion in men.

Complicating matters, it is common for individual women in STEM, including faculty women, to deny that they have personally experienced sexual harassment or even a "chilly climate." However, various studies would indicate that it is more prevalent than acknowledged. Both *numerical* and *normative* male dominance exist in engineering, and it has been shown that both types of male dominance are associated with increased sexual harassment [21], [22]. A qualitative study of faculty women in STEM revealed a consistent pattern of sexual harassment or discrimination by colleagues and administrators, but with each individual instance being written off by the woman as a "special case" rather than evidence of a systemic problem [10]. This and similar studies point to the likely situation that many women faculty do in fact experience a work culture that is less favorable for them than their male colleagues.

The result of these unfavorable work climates is a loss of job satisfaction and greater turnover. Callister [23] determined that women STEM faculty have lower job satisfaction and higher intention to quit, and these intentions were completely mediated by the affective and instrumental aspects of department climate. A quantitative study by Xu [24] found similar results, reporting a stronger turnover intention for women faculty was correlated with "dissatisfaction with research support, advancement opportunities, and free expression of ideas."

This qualitative study takes a needs-based look at the chilly climate problem that many women face in engineering academia. Specifically, it compares men and women faculty to identify areas where gender may lead to a differential job experience for faculty in engineering.

## Conceptual Framework

Self-Determination Theory (SDT) posits that when three basic (evolved) psychological needs of autonomy, competence, and relatedness are met above and beyond core physiological needs (food, safety, shelter), individuals become autonomously motivated and behave with willingness and choice rather than acting out of obligation or becoming demotivated altogether [25]. Unlike other needs-based theories, empirical support for SDT in the workplace is well established [26].

To meet needs for *autonomy*, individuals need to feel they are masters of their own destiny and that what they do has been chosen freely rather than out of a sense of obligation, coercion, or other external factors. Those whose autonomy needs are satisfied also tend to feel that what they are doing is consistent with their core values and life purpose [27]. Those whose autonomy needs are thwarted, in turn, tend to feel too controlled or limited by others in their workplace. While autonomy needs are met by having the freedom to pursue what one desires in the workplace, this does not presume that the individual will work independent of others [4].

When meeting needs for *competence*, individuals feel able to interact successfully with their environment. In the workplace, this means that people believe they are challenged, are contributing to the cause, are developing, exercising, and expanding skills, and are generally good at what they do. Those whose competence needs are satisfied can adapt readily to complex and changing environments and are likely to have a strong sense of self-esteem and identity [27],[28],[29].

When needs for *relatedness* are met, individuals feel cared for by significant others. Relatedness is associated with a strong sense of belonging in the workplace. All individuals have a desire to interact with others, experience connection to them, and feel cared for. This sense of being cared for must be perceived as independent of ulterior motives or alternative agendas. A person whose relatedness needs are being met feels valued and appreciated, but when these needs are frustrated, this person may feel unimportant to the organization or coworkers. Unfulfilled relatedness needs lead to feelings of isolation and loneliness [27],[30],[31].

## Methods

For this analysis, 10 men and 14 women faculty were interviewed. The participants held position titles of instructor, assistant professor, associate professor, or full professor and taught in engineering, physics, or computer science at institutions that ranged in size from 3,200 undergraduates to 46,000 undergraduates. Institutions were both public and private, teaching and research focused, and included some community colleges. Characteristics of the interview population are summarized in Table 1. IRB (Internal Review Board) approval was obtained at the lead institution on this project and a predefined recruitment protocol was used in a convenience sampling approach. Faculty are a very busy group and recruitment rates for interviews are low (less than 15%). Despite the fact that the total number of interviews for each gender were somewhat low compared to other studies, data saturation was reached in terms of the SDT-based content analysis used in this study.

Interviews began with introductory questions designed to elicit information about the education and industry experience of each participant followed by focused questions regarding the faculty member's work environments, both past and present. The

interviews included both positive (“Could you describe in as much detail as possible the work environment, aside from your home department or unit, that you enjoy the most or find the most fulfilling?”) and negative (“Describe one or two key characteristics of a “horrible” work environment.”) queries.

**Table 1: Population Characteristics**

	Women	Men	Total
Total	14	10	24
Position			
Professor	6	6	12
Associate Professor	5	0	5
Assistant Professor	1	2	3
Instructor	1	1	2
Not Stated	1	1	2
Institution Type			
Private	5	3	8
Public	9	7	16
Institution Focus			
Research	6	4	10
Teaching	8	6	14
Institution Size			
Large (>20,000 undergraduates)	7	3	10
Medium (>10,000 and <20,000 undergraduates)	1	2	3
Small (<10,000 undergraduates)	6	5	11

Interviews were conducted either in person or by phone. With consent, all interviews were audio recorded and transcribed. Identifying information was removed from the transcript prior to analysis. Once transcribed, transcripts were analyzed deductively by coding interviewee responses for references to relational, autonomy, and competence needs, both frustrated and satisfied, past and present. Although some excerpts referred to more than one need, excerpts were not coded based on length or use of particular words. Rather, transcripts were coded based on the expression of ideas. A single idea in a single place in the transcript represented a single instance of a need, regardless of how long or short it was.

## **Research Questions**

### ***Research Question #1:***

*Do faculty express awareness of and assign importance to the three basic needs?*

This question is critical to understanding whether or not emphasis on certain needs over others is a function of how important or fulfilled they are for faculty or whether faculty may not be aware of some needs over others. If some needs are rarely mentioned by any faculty, it may be due to bias in the way interview questions are posed, the interview setting, or another confounding factor.

### ***Research Question #2:***

*Do patterns or frequency of expression vary with the type of need?*

This question is important because it provides some insight into which needs rise to the top in

academic work environments. Frequently expressed needs, whether satisfied or frustrated, can suggest relevant areas of emphasis for administrators and other change agents to pursue in efforts to improve academic culture to better nourish and support faculty members.

**Research Question #3:**

*Do patterns of expressing needs for relatedness, autonomy, and competence vary between men and women?*

This question is important because it provides insight into how to better support female faculty to enter into the academe, remain there, reach full potential, and thrive as well as men do.

**Results**

The 24 interview transcripts were coded according to the needs expressed, whether those needs were frustrated or fulfilled, and whether they occurred in the primary present work role of the faculty member or in a past role, in industry or in the academe.

**Research Question #1:**

*Do faculty express awareness of and assign importance to the three basic needs?*

Overall, almost all of the men and women interviewed in this study expressed awareness of the three basic needs associated with SDT (Table 2). Within their present academic positions, 71% of women and 80% of men expressed autonomy needs in some way. 93% of women and 80% of men cited competence needs as important and relevant to their current position, and 100% of both women and men referred to relatedness needs in their current academic positions. Just as many women (8) spoke to the satisfaction of autonomy needs as to the frustration of these needs while many fewer men (3) felt that their autonomy needs were frustrated in their present position compared to those (8) who thought their autonomy needs were satisfied. In contrast, many more participants spoke to satisfaction of competence and relatedness needs than frustration of those needs. A more detailed look at the responses for each individual interviewed (discussed next) reveals a richer picture of the workplace experience for the study participants.

**Table 2: Types of Needs Expressed by Faculty Participants**

Type of Need		Number of Women		Number of Men	
		Past	Present	Past	Present
Autonomy	Satisfaction	2	8	1	8
	Frustration	3	8	6	3
Competence	Satisfaction	1	12	1	7
	Frustration	3	4	2	4
Relatedness	Satisfaction	6	13	4	10
	Frustration	4	8	6	6

**Research Question #2:**

*Do patterns or frequency of expression vary with the type of need?*

The frequency by which interviewees referred to the satisfaction and frustration of autonomy, competence, and relatedness by each faculty interviewee’s description of their present work

environment is summarized in Table 3. Overall, interviewees were generally positive about how their present academic position satisfied their needs. 60% of remarks regarding autonomy referred to how these needs were satisfied in the workplace rather than frustrated or thwarted. Similarly, 65% of remarks regarding relatedness spoke to satisfaction of those needs, and 68% of remarks regarding competence were also positive. Additionally, only six individuals spoke to overall needs frustration more often than needs satisfaction (Dawn, Jane, Margie, Marilyn, John, Luke). Gender differences that emerged within these seemingly positive results will be discussed further in the context of RQ3.

By and large, references to both satisfaction and frustration of relatedness needs dominated the interviews. 71% of individual faculty members spoke to relatedness needs more frequently than to autonomy or competence needs. How individual interviewees referred to satisfaction and frustration of relatedness needs varied by interview, by circumstance, and by institution, but still retained some common themes. Those similarities and differences are considered next.

### *Relatedness Needs*

Participants often described how relatedness needs were met or not met through the degree to which they could readily collaborate with their peers. Sometimes collaboration was supported through appropriate physical space and building design:

There are a lot of collaborative design spaces we're sort of informal meetings spaces and different ways for people to interact. And then there's kind of big Open Spaces kind of has a coffee shop feel, you know you can have some privacy, but you can be in kind of a shared space.... It had a particular culture and a particular perspective and value about collaboration. (Jenny)

The institutional culture or a microculture within the institution can also lay fertile ground for facilitating collaboration and meeting relatedness needs:

So this sort of I think exemplifies sort of the collegiality that actually exist within our program, and within our school. Where we were sitting here thinking that we have a really unique group of individuals who have different areas of expertise but there are a lot of overlap and alignments. So we decided to come together for this project and we were lucky enough to get the funding. (Rob)

However, when collaboration is thriving and then collapses, it can produce a traumatic shift in the quality of the work environment and dramatically frustrate needs for relatedness:

Until about 2 years ago we collaborated constantly in each other offices exchanging ideas resources bouncing ideas off of each other.... When the last of my two closest colleagues left, that came to a stop... So it's a direct result of having resources cut and creating an almost toxic environment. What was left is a person who I don't really interact with very much at all on a day to day basis. So the other full time faculty member and I really don't collaborate very much at all. (Liz)



In addition to work-oriented collaborative effort, needs for relatedness within a work environment can also be met through frequent interaction, whether specifically associated with work tasks or not:

... we are very social department inside a pretty social... division. One of the ways that we are social is that we have a space in the division where our in-boxes are, where the photocopy machines are, but it's also set up as a break room / lunch room. ...there's an 11 o'clock group of people to have lunch before they go to their 12 o'clock classes, then another group of people sit down and have lunch at 12 so a lot of informal back and forth goes on in there. (Judy)

**Table 3: Frequency of Satisfied and Frustrated Needs in Present Academic Position**

Participant	Autonomy		Competence		Relatedness		Total	
	<i>Satisfied</i>	<i>Frustrated</i>	<i>Satisfied</i>	<i>Frustrated</i>	<i>Satisfied</i>	<i>Frustrated</i>	<i>Satisfied</i>	<i>Frustrated</i>
<b>Women</b>								
Ann	0	0	1	0	7	3	8	3
Dawn	0	1	1	4	2	5	3	10
Debbie	1	1	1	2	3	0	5	3
Jane	0	0	0	0	1	5	1	5
Jenny	1	3	2	0	5	4	8	7
Josie	2	2	1	0	1	0	4	2
Judy	2	0	1	0	2	0	5	0
Julie	1	1	1	0	2	3	6	4
Liz	1	2	2	0	1	2	4	4
Margie	0	0	0	0	2	5	2	5
Marilyn	0	1	2	2	0	5	2	8
Mary	2	1	1	0	4	0	7	1
Megan	0	0	1	0	4	2	5	2
Ruth	2	0	2	0	6	0	10	0
<b>Total</b>	<b>12</b>	<b>12</b>	<b>16</b>	<b>8</b>	<b>40</b>	<b>34</b>	<b>70</b>	<b>54</b>
<b>Men</b>								
Bill	0	0	1	0	8	1	9	1
Bruce	2	0	0	0	8	0	10	0
Doug	0	0	1	1	1	0	2	1
Jacob	2	0	1	0	1	0	4	0
Jeremy	1	2	2	0	4	0	7	2
John	1	1	0	0	1	2	2	3
Luke	1	1	0	2	1	2	2	5
Matt	2	0	4	0	2	1	8	1
Peter	1	2	2	1	2	0	5	2
Rob	5	0	1	1	9	2	15	3
<b>Total</b>	<b>15</b>	<b>6</b>	<b>12</b>	<b>5</b>	<b>37</b>	<b>8</b>	<b>64</b>	<b>18</b>
<b>Overall</b>	<b>27</b>	<b>18</b>	<b>28</b>	<b>13</b>	<b>77</b>	<b>42</b>	<b>134</b>	<b>72</b>

On the other hand, isolation and lack of interaction can frustrate needs for relatedness. This frustration came up in multiple interviews. For example:

... the interactions that I have, you go into the office and you open your office and you close your door and maybe you get to see people go by going to the bathroom maybe you get to say hello and maybe you don't see them for months or weeks. (Jane)

Unfortunately I don't have a lot of interaction with colleagues in my department... it is lonely in my home department. (Dawn)

When coworkers value and show respect and concern for each other, this also goes a long way to meeting needs for relatedness:

Usually we go around the table and each person has a chance to chime in with what's going on with them and their classes and their students. If anyone has an issue to raise they usually raise it in advance so it's on the agenda, but we're also welcome to raise it then. We usually pray for each other, congratulate each other if something great happening or ask if something challenging is going on... It's a nice place to work. (Mary)

The atmosphere is very low key and supportive. We know each other very well, we spend a lot of time with each other outside of work. The close relationships that we have with each other is often the basis by which we are able to serve our students well. (Bill)

A lack of competitiveness or hierarchy was also viewed positively in meeting relatedness needs:

What's really unique about my department is it is truly collaborative, there is no barrier between my tenure track and my non tenured faculty. There is no class system there... they all work very well together. (Ann)

On the other hand, cutthroat or hypercompetitive behavior can frustrate needs for relatedness and create hostility in the work environment:

It was a boundary issue and an ownership issue and a competitive issue ... scenarios where people sort of see me as a particular kind of thinker and they would bring me in on their groups, and then they'll get me involved in conversation and try to get me to help developing with proposals and stuff like that. Then you know they will take my ideas. (Jenny)

Overall, every single interviewee, whether male or female, expressed the importance of relatedness needs in the workplace. When those needs were frustrated, a sense of dissatisfaction ensued, but when they were neglected all together, loneliness and isolation were common. In collaborative environments, individuals described how much they valued and appreciated genuine collaboration unfettered by competitive or unethical behavior. In these interviews, individuals tended to impart first and at length how relatedness needs were fulfilled and what a positive difference this made in their overall experience as a faculty member.

***Research Question #3:***

*Do patterns of expressing needs for relatedness, autonomy, and competence vary between men and women?*

The most striking difference that emerged from Table 3 is how often women refer to frustrated needs in the academic workplace compared to men. Overall, remarks among the 14 women interviewed regarding satisfaction of the three basic needs outnumbered frustration of those needs by only 1.25:1 while among men, positive remarks outnumbered negative remarks by over 3:1. While men and women spoke to the satisfaction of needs at about the same rates, women mentioned frustrated needs almost as often as satisfied needs while men did so at far reduced rates. This difference was especially striking with regard to relatedness needs. While women made 40 references to needs satisfaction versus 34 references to needs frustration, men made 37 references to needs satisfaction followed by only 8 references to needs frustration. Gender differences in the expression of autonomy needs followed a similar pattern. Women made an equal number of references to autonomy needs satisfaction (12) and autonomy needs frustration (also 12) while male comments regarding autonomy tended toward satisfaction (15 total remarks) over frustration (6 total remarks).

While this is a qualitative study with a relatively small sample size, and the significance of these results cannot be stated, these gender-based differences certainly suggest the need for a future study using quantitative methods to understand whether the frustration of relatedness and autonomy needs in the workplace are indeed more prevalent for women than for men. If they are, such a study should also examine which of the needs satisfaction pathways discussed by both men and women in this study are most likely to satisfy these needs.

## **Discussion**

Qualities of the work environment that helped meet relatedness needs were similar among men and women. Those interviewed described multiple ways in which their relatedness needs were being met, including ample opportunities for healthy collaboration as well as mutual trust, support, and respect. Men mentioned the fulfillment and satisfaction of these needs an average of 3.7 times per individual compared to a lower rate for women (2.85 times per individual). While this difference may or may not be significant, it does confirm that those working in the engineering academe are aware of their relatedness needs.

At a rate of 3.85 references per individual, women spoke to the frustration or thwarting of relatedness needs much more than men. Why is this the case? One possibility is simply that women have higher needs for relatedness and belonging, and therefore their work environments must provide more opportunities to meet these elevated needs. But, while women may operate in different spheres than men, preferring smaller numbers of close relationships to a larger sphere of social relationships as is the case with men, they are unlikely to be fundamentally more social beings than men with significantly greater needs for relatedness [32].

A more realistic possibility is that women enter into academic positions already at a disadvantage, which makes meeting relatedness needs a greater hurdle. Studies of social identity threat have shown that women experience a lower sense of belonging and show more cognitive and physiological vigilance when presented with the prospect of participating in male-dominated events compared to more gender-balanced events [33]. Women also report a lower sense of belonging than their male peers throughout the undergraduate [34], [35], [36] and graduate years [37], to the detriment of their studies and well-being. As Skewes *et al.* [17] write in regards to students, “As there are initially fewer women and members of minority groups in STEM courses and a fair number drop before completing, it is more difficult for members of these groups to

attain feelings of relatedness. Women and those from underrepresented minority groups are thus more likely to experience lesser feelings of relatedness.” Thus, many women in engineering are likely to exit graduate school at a relatedness deficit. These women also likely anticipate a continued relatedness deficit triggered by social identity threat as they begin academic positions in environments that continue to be male-dominated.

Belonging deficits while in school and social identity threat are compounded further by the lack of critical mass of women faculty in many engineering units and departments. Nationally, only 17% of engineering faculty are women, ranging from 11% in aerospace engineering to almost 27% in environmental engineering [38]. Research cites numbers ranging from 15% to 40% as the magic range in which a minority group reaches critical mass and can effectively engage in culture change and transformation [39]. Based on these numbers alone, most engineering departments are operating at less than or at minimal critical mass for women to negotiate change in engineering culture. Furthermore, critical mass is oft misunderstood and overused. While the percentages create clear goals for hiring strategies and projections, they do not alone guarantee what is necessary to engage in cultural change. Rather, a critical culture, not a critical mass, is what is necessary to allow women to truly fit into the engineering academe [39], and the actual numbers of women required to reach the threshold for a critical culture must account for women who follow traditional male models in academia versus those who choose the relational female or other alternative models [40]. Without enough women in engineering choosing alternative models, women will continue to face challenges in pushing for transformative culture change.

Furthermore, while women do not inherently have greater needs for relatedness than men, academic environments may be less adept at meeting those needs for women as compared to men. For example, in a study of male and female faculty’s perceptions of institutional culture in academic medicine, Pololi et al.[41] found that women felt lower levels of inclusion and workplace relationships compared with their male colleagues. Other studies of gender differences in faculty perceptions of their workplaces demonstrated that female faculty feel less satisfied than male faculty in their relationships with senior colleagues and are at risk of experiencing lower levels of belonging [42]; that female faculty feel less included in the academic workplace, personally and professionally, compared to male faculty [43]; and that female faculty experience lower levels of job satisfaction than male faculty, particularly due to departmental climate [23]. These issues are especially problematic in engineering departments, considering female assistant professors leave their positions at higher rates than men [44].

In addition to women articulating the frustration of relatedness needs far more than men, the impact of such deficits may also be different for women than for men. Our results show that, in their present positions, many women associated frustration of relatedness needs with isolation and loneliness, lack of interactions and relationships with colleagues, and lack of opportunity to collaborate. The smaller group of men who expressed frustration of relatedness needs in their present position primarily described outcomes such as feeling that their research was not valued. As a whole, men expressing frustration of relatedness needs did not associate them with negative outcomes to the extent that women did. This suggests that the consequences of failing to meet relatedness needs or thwarting those needs in the workplace can have more extensive negative consequences for women than for men. Prior studies support this interpretation. For example, in a study of the role of the three basic psychological needs in the promotion and tenure process, relatedness needs were more critical for female faculty than for male faculty. Women’s sense of

competence in the tenure process was derived primarily from relational experiences, such as interactions with colleagues, informally shared information, and feedback, whereas men's sense of competence hinged more on being informed about the tenure protocols [17]. Job satisfaction in the academe appears to depend more on internal relational supports than on academic resources for women, while men's satisfaction depends equally on these two contributions [45].

### **Limitations and Implications**

*Limitations:* This study uses qualitative research methods and is therefore poorly suited to answering questions related to: How many? How much? How significant? The representation of faculty across a range of institutions, geographical areas, and job positions, however, has cast a broad net to identify potential fundamental psychological needs neglected or supported in the academe. While faculty in all career stages were included, the interviewees were primarily tenured. Thus, this study does not capture pre-tenure experiences of faculty including those who left academe.

*Implications:* While relatedness is studied here as a basic psychological need alongside autonomy and competence, meeting this need also contributes to agency within an individual's department and work environment. Sufficient opportunities to relate to others in the workplace directly correspond with access to power, which defines productivity, progress, and overall success and job satisfaction [11]. Both men and women faculty express relatedness needs as highly relevant to their workplace experience, though perhaps in different ways. Self-determination theory places autonomy as the primary need, but in an academic environment where autonomy needs are often well-met, relatedness may become more important. The academic environment in general may be less able to meet relatedness needs of women as compared to men faculty, and the extreme gender imbalance in engineering departments likely exacerbates this.

### **Concluding Remarks**

This study has added to the existing literature on the importance of developing belonging and meeting relatedness needs for women at all levels in the engineering academe. The three basic needs of self-determination theory (autonomy, competence, relatedness) were assessed in engineering, computer science, and physics faculty using a qualitative research design. The workplace experiences that have served to meet or frustrate autonomy and competence needs of men and women faculty seem comparable, but relatedness needs reveal an important gender difference. On the whole, all faculty have needs being met in some ways, but women also spoke of needs being thwarted, especially for relatedness. Further study to confirm these results in a larger population are needed. To encourage not only retention but a thriving, productive faculty, engineering departments should support relatedness more effectively in the academic workplace, both by reducing detrimental competitiveness and by reducing isolation among all faculty, regardless of gender.

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